



The Cross-sectional Performance of the Fama-French Three-Factor Model in the Turkish Equity Market

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Abstract: This study examines whether the Fama-French Three-Factor Model can explain cross-sectional differences in stock returns in the Turkish equity market, addressing a gap in existing asset pricing research. The methodology involves two main components: time-series regressions to evaluate the model's explanatory power for portfolio returns, and Fama-MacBeth cross-sectional regressions to assess the pricing of individual stocks. The sample consists of monthly data from February 2009 to December 2024 for stocks listed on Borsa Istanbul, with portfolios constructed based on firm size and book-to-market equity ratios. The time-series results demonstrate strong explanatory power, with values ranging from 0.80 to 0.89 and statistically significant positive loadings for the market and size factors. The value factor shows positive and significant effects in high book-to-market portfolios, consistent with the theoretical value premium, but displays negative loadings in other portfolios, indicating a relatively weak or inverted value effect during the sample period. In cross-sectional tests, none of the factor risk premia (market, size, value) are statistically significant, suggesting that the Fama-French model does not adequately capture cross-sectional differences in individual stock returns. The findings suggest that while the model is useful for time-series analysis, its cross-sectional limitations necessitate the inclusion of additional risk factors.

Keywords: Fama-French Three-Factor Model, Cross-Sectional Asset Pricing, Fama-MacBeth Regression, Turkish Equity Market, Emerging Markets

1. Introduction

The standard Capital Asset Pricing Model (CAPM) posits that the expected return on an asset is determined solely by its sensitivity to market risk, captured by the market beta. However, extensive empirical testing has revealed that this model often fails to fully capture cross-sectional variations in average returns. In response to this failure, multifactor asset-pricing models emerged, grounded in theoretical frameworks such as Merton (1973) and Ross (1976), which allow for multiple sources of systematic risk. As one of the seminal contributions to this literature, Fama and French (1993) proposed a new model that augments market beta with two additional factors, which proxy for size and book-to-market. The new framework gained broad acceptance in empirical asset-pricing research, offering significantly improved explanatory power over the single-factor CAPM.

While the Fama-French three-factor model, like most asset pricing models, is primarily designed to account for cross-sectional variations in expected returns, empirical tests often rely on time-series regressions, as in Fama and French (1993). However, such regressions primarily assess whether factor premiums are priced over time, rather than directly testing the model's ability to explain cross-sectional differences. Instead, they attribute return variation indirectly to differences in factor loadings (betas) across portfolios. In contrast, cross-sectional regressions, such as those developed by Fama and MacBeth (1973), explicitly test whether disparities in factor exposures explain differences in average returns across assets.

Despite its prominence, the three-factor model is rarely tested using the Fama-MacBeth cross-sectional regression framework. One notable exception is Bartholdy and Peare (2005), who applied this methodology and found that the model explained approximately 5% of the variation in average returns—only marginally outperforming the CAPM, which accounted for around 3%. Grauer and Janmaat (2010) also adopted the Fama-MacBeth approach to evaluate asset pricing models. To mitigate the issue of

diminished beta dispersion in cross-sectional tests, they introduced a procedure that replaced returns on certain portfolios with those of zero-weight portfolios. Their results found strong empirical support for the CAPM, but weaker support for the three-factor model.

Goyal (2012) provided a review of empirical asset pricing research which focuses on explaining cross-sectional differences. He noted that while time-series and cross-sectional regressions are conceptually complementary, empirical studies seldom apply both approaches together. This gap in the literature is especially pronounced in the Turkish equity market. While several studies have tested the Fama-French model, the focus has predominantly been on time-series or panel data approaches, often using firm-level characteristics such as size or equity valuation ratios as explanatory variables. Few studies have applied the Fama-MacBeth cross-sectional regression framework using factor-mimicking portfolios (such as SMB and HML) to test the model's cross-sectional validity. This highlights the need for further investigation into how effectively the three-factor model captures cross-sectional return variations within the Turkish market.

This study aims to evaluate whether the Fama-French three-factor model can effectively account for cross-sectional variations in average returns in the Turkish equity market, using the Fama-MacBeth regression framework. By doing so, it addresses a notable gap in the empirical literature on asset pricing in emerging markets. The remainder of this article is structured as follows: Section 2 provides an overview of the original Fama-French methodology, highlighting key distinctions between the 1992 and 1993 studies. Section 3 reviews prior empirical research on the Fama-French model, including studies conducted in both international and Turkish equity markets. Section 4 details the data, portfolio construction, and empirical methods employed in this study. Section 5 concludes with a discussion of the findings and their implications for asset pricing in emerging markets.

2. The Fama-French (1992, 1993) Methodology: An Overview

To establish a common ground for evaluating the diverse approaches in the literature and ensure methodological consistency, it is essential to understand how the Fama-French three-factor model was originally developed and implemented. This section provides an overview of Fama and French's 1992 and 1993 studies, highlighting their methodological distinctions and tracing the evolution of their empirical framework.

Initially, Fama and French (1992) identified factors previously found to explain average returns, such as size and book-to-market equity, and combined them with the market beta of assets in a single regression model to analyze the cross-section of stock returns. Using monthly cross-sectional regressions based on the Fama-MacBeth methodology, they found that market beta does not explain the cross-section of average stock returns, contradicting the predictions of the CAPM. In contrast, size and book-to-market exhibited strong univariate relationships with average returns.

A problem with the cross-sectional regressions of asset pricing models is measurement error in estimated betas. Black, Jensen, and Scholes (1972) proposed forming portfolios to mitigate this issue, as averaging across multiple securities reduces idiosyncratic noise. However, Fama and French (1992) avoided employing portfolios for firm-specific variables like size and book-to-market equity in their analysis of the cross-section of stock returns, as these are already precise for individual stocks and using portfolios would dilute the information. They used portfolios to obtain more precise market beta estimates. Specifically, they first sorted stocks by size and then subdivided each group by five-year pre-ranking stock betas. Betas for these portfolios were then estimated from full-sample post-ranking returns and assigned to stocks within each portfolio for cross-sectional regressions.

Subsequently, Fama and French (1993) applied a new approach that differed from their earlier work in three important aspects: (i) the type of tests employed (cross-sectional versus time-series), (ii) the unit of analysis (portfolio returns versus individual stock returns), and (iii) the basis of variable

measurement (firm-level characteristics or factor-mimicking portfolio returns). First, rather than using cross-sectional regressions and Fama-MacBeth methodology, they employed time-series regressions to examine risk-return relationships and used the GRS test developed by Gibbons, Ross, and Shanken (1989) for a joint test of regression intercepts. Second, instead of regressing individual stock returns, they regressed returns for stock and bond portfolios. Third, instead of regressing returns directly on observed firm characteristics, such as size and book-to-market equity, they regressed them on the returns of mimicking portfolios that proxy for these factors, alongside the excess market return. They found that their three stock-market factors explain a substantial portion of the common variation in stock returns, with slopes on these factors being strong and the constant terms close to zero, suggesting minimal pricing errors. The success of the three-factor model over the CAPM is supported by later studies, such as Goyal (2012), which compared actual returns with those predicted by these models.

A central component of Fama and French's (1993) methodology was the careful construction of portfolios. First, they formed six size and book-to-market equity (BE/ME) portfolios by intersecting two size groups (small and big) and three book-to-market equity (low, medium, and high) groups, sorted annually. Second, they formed two mimicking portfolios: SMB, by calculating the difference between the average returns of the three small-stock and three big-stock portfolios, and HML, by calculating the difference between the average returns of the two high-BE/ME and two low-BE/ME portfolios, based on the monthly returns of the six portfolios. Third, they formed 25 size-BE/ME portfolios by intersecting the size and BE/ME quintiles, to use their excess returns as inputs on the left-hand side of the time-series regressions. In their later study, Fama and French (1996) constructed additional portfolios sorted into deciles based on variables associated with known anomalies, such as earnings-to-price, cash-flow-to-price, and sales growth. Yet, as noted by Bollerslev and Zhang (2003) and Petkova (2006), the 25 size-BE/ME portfolios have become a standard empirical benchmark widely adopted in subsequent studies to evaluate and compare competing asset pricing models.

The factor loadings and returns from SMB and HML reveal important economic interpretations. Specifically, Fama and French (1993) designed SMB and HML portfolios to mimic risk factors, with their returns serving as proxies for the risk associated with size and book-to-market equity, capturing sensitivity to common risk factors in returns. The regression slopes of the explanatory portfolios SMB and HML represent an asset's sensitivity to the common risk sources captured by these factors and are referred to as the factor loadings. For example, a positive slope on SMB indicates that the stock's return tends to behave more like that of small firms. Additionally, as mentioned by Fama and French (2004), the regression intercepts can be used to measure how quickly stock prices incorporate new information and the unique information of portfolio managers. The average returns on SMB and HML reflect the average risk premiums associated with size and book-to-market equity. Fama and French (1993) reported positive average returns for SMB and HML, suggesting that these risk factors are priced. This aligns with the idea that small firms and high BE/ME firms earn higher returns because they are riskier, as they are more susceptible to a prolonged earnings downturn. However, as noted by Ferson and Harvey (1999), this interpretation is controversial, since the SMB and HML portfolios do not originate from a theoretical asset pricing model. Finally, although the time-series regressions in Fama and French (1993) focused on return fluctuations of stock portfolios in response to SMB and HML, they interpreted this as evidence that differences in average stock returns arise due to varying exposures to these factors.

3. Literature Review

3.1. Empirical literature on the Fama-French model in international markets

Following the introduction of the three-factor model by Fama and French (1993) and its demonstrated strong performance in US equity markets, numerous studies have examined whether the model also explains returns in other countries. Some studies tested its performance using time-series regressions on the 25 size-BE/ME portfolios formed from intersections of size and book-to-market quintiles,

following the original methodology. For example, Xie and Qu (2016) applied the model to China's Shanghai A-share market and found that it satisfactorily captures the variation in portfolio returns. They reported evidence supporting both the size and value premiums. First, the average returns of the SMB and HML portfolios were positive, indicating that smaller stocks and high book-to-market stocks earned higher returns. Second, the SMB coefficients decreased as portfolio size rankings increased within each BE/ME quintile, suggesting that the marginal size premium diminishes for larger stocks, while the HML coefficients increased as BE/ME rankings rose within each size quintile, indicating that the marginal value premium grows for stocks with higher book-to-market ratios.

Other studies have applied the three-factor model to different markets using the six size-BE/ME portfolios formed from intersections of two size and three book-to-market groups, which are then used to calculate the factors. Strong support for the model has been reported in Pakistan (Abbas et al., 2015), Iran (Firozjaee & Jelodar, 2010), Bangladesh (Hasan & Kamil, 2014), and India (Manjunatha & Mallikarjunappa, 2018), where researchers found significant size and value premiums and high explanatory power in explaining portfolio returns. In addition, studies by Ajlouni and Khasawneh (2017) in Jordan, and by Blanco (2012) on the NYSE, emphasized the model's sensitivity to portfolio construction. Ajlouni and Khasawneh (2017) found that the model explains returns better for six portfolios than for sixteen. Blanco (2012) showed that factor significance depends on the portfolio sorting variable, with size and BE/ME sorts supporting the model but dividend-yield sorts produced insignificant factor loadings.

Compared to the widespread use of time-series regressions, applications of the Fama-MacBeth (1973) two-step procedure to test the Fama-French three-factor model have remained relatively limited. Most studies employing this method rely on U.S. datasets, typically obtained from Kenneth French's data library. Since these studies often aim to refine estimation methods, introduce conditional adjustments, or investigate the impact of omitted variables, the results concerning the standard Fama-French factors were frequently secondary rather than the main focus. Across studies using the 25 size-BE/ME portfolios, a common finding is that the market risk premium is typically negative and insignificant, the size premium (SMB) is often positive but statistically weak, and the value premium (HML) tends to be significantly positive. Reported explanatory power varies notably. For example, Petkova (2006) reported an adjusted R^2 of 0.71, whereas Koch and Westheide (2013) found a lower average R^2 of 0.47. Şengül (2023), using 100 portfolios and incorporating latent macroeconomic factors, reached similar conclusions regarding the significance of the factors.

Some studies, however, diverged from this general pattern of factor signs and significance. Lettau and Ludvigson (2001) found a positive but still insignificant market premium, while Shanken and Zhou (2007) reported a significantly negative market premium estimate. Grauer and Janmaat (2010) found a marginally significant size premium for the 25 size-BE/ME portfolio dataset, which contrasts with the typically weak SMB estimates. Departing further from the portfolio-based approaches, Bartholdy and Peare (2005) applied the Fama-MacBeth procedure to individual stock returns and concluded that the three-factor model performed only slightly better than the CAPM, explaining just 5% of the variation in returns. Extending the literature beyond the US, Walkshäusl and Lobe (2014) applied the Fama-MacBeth procedure to both an international sample and individual country portfolios. For the global sample, they reported a significantly negative coefficient on market equity and a significantly positive coefficient on book-to-market, consistent with the presence of size and value premiums. However, these patterns vary across countries and are not statistically significant for Türkiye. Overall, while the Fama-MacBeth methodology provides a valuable alternative for evaluating the model, empirical findings often reveal weak support for the size and market factors, with results being highly sensitive to the empirical specification and dataset choices.

3.2. Empirical literature on the Fama-French model in Turkish markets

Given the limited application of cross-sectional methodologies in emerging markets—particularly in Türkiye—it is important to contextualize the existing empirical literature on the Fama-French three-factor model. Numerous studies have tested the performance of this model in the Turkish equity market, with varying sample periods, portfolio formation strategies, factor construction methods, and econometric techniques. To clarify this diversity, the literature can be grouped into four methodological strands: Studies using firm-level characteristics in panel regressions; those constructing factors from either size or value portfolios to explain sector indices; studies employing the full Fama-French methodology with six size-value sorted portfolios; and those comparing the three-factor model with alternative specifications such as the five-factor model.

One strand of the literature has examined the explanatory power of firm characteristics—specifically, market capitalization and price-to-book ratio—in explaining excess stock returns within the three-factor model framework. These studies typically employ annual returns and panel data regressions, reporting adjusted R^2 values of around 0.35. Atakan and Gökbulut (2010), for example, applied fixed-effects panel regression to 82 industrial sector stocks over 1993–2007, finding significant positive coefficients for the market capitalization and price-to-book, along with the market risk premium. Coşkun and Çınar (2014) analyzed a broader sample of 113 non-financial stocks from 2001 to 2013, using the natural logarithms of market capitalization and price-to-book ratio in a similar fixed-effects regression. They found a significant positive coefficient for the market risk premium, but significant negative coefficients for other factors. Kara (2016) extended the approach by estimating separate regressions for the industrial, financial, and service sectors using pooled panel regression over the period 2006–2014. They consistently found positive coefficients for the market risk premium, while other factors were significant only in the industrial sector, with market capitalization showing a positive coefficient and price-to-book ratio showing a negative coefficient. Adjusted R^2 values for the services and financial sectors exceeded those reported in the earlier two studies and in the industrial sector. Overall, the signs of the coefficients for market capitalization and valuation ratios vary across studies. It is also important to note that the price-to-book used here is actually the inverse of the book-to-market and should be interpreted accordingly.

The second strand of studies constructs the SMB and HML factors using selected portfolios formed by either firm size sorts or book-to-market ratio sorts. These studies utilize the constructed factors, along with the market risk premium, in time-series regressions to explain the excess returns of various sector indices. For instance, Gökgöz (2008) examined the explanatory power of these three factors for five major sector indices over the period 2001–2006, finding significantly positive coefficients for all and adjusted R^2 values exceeding 0.80. Gökgöz is unique among all the studies reviewed for using daily data to estimate betas and conducting a second-step time-series regression on the estimated factor loadings for each sector. More recently, Uçaktürk and Polat (2024) estimated a single time-series regression for the industrial sector's excess returns over the period 2011–2021, finding that only the market risk premium was significant, with an R^2 of 0.14.

The third strand of studies constructs the SMB and HML factors from six portfolios formed by the intersecting size and book-to-market groups, adhering more closely to the original approach of Fama and French (1993). Most studies in this group use time-series regressions to explain the excess returns of these portfolios. For example, Canbaş and Arıoğlu (2008) used a dataset that included financial firm stocks for the period 1993–2004, Kutlu and Kalaycı (2020) analyzed stocks from the BIST100 index, including financials, for the period 2008–2015, and Genç and Çömlekçi (2018) worked with a dataset of stocks from the Corporate Governance Index, excluding financials, from 2010 to 2017. Common findings across these studies include a significant positive coefficient for the market risk premium in most portfolios, a significant positive SMB coefficient in portfolios of small firms, and a positive HML

coefficient in portfolios of high book-to-market firms, though with varying significance. The first two studies reported R^2 values between 0.85 and 0.94, while the last study had an R^2 lower than 0.35.

Additional studies in this strand offer methodological variations. Kaya and Güngör (2017), for example, employed a fixed-effects panel data analysis on a quarterly dataset comprising an average of 215 non-financial firms, with the sample composition changing annually over the period 2005–2014. They found significant coefficients: positive for the market risk premium and HML and negative for SMB, with an adjusted R^2 of 0.21. Yolsal (2005), the earliest study included in this review, employed time-series regressions on 100 non-financial stocks from 1999 to 2004 to explain both raw returns and excess returns. Uniquely, Yolsal also estimated a second-step cross-sectional regression using the factor betas obtained from the first step. While the average coefficients of all factors in the time-series regressions and the average risk premia of all factors in the cross-sectional regressions were positive, only the market risk premium exhibited both a significant beta and a significant risk premium. The average R^2 value was 0.64 across the time-series regressions, but decreased to 0.27 across the cross-sectional regressions.

The fourth strand of literature compares the explanatory power of the Fama-French three-factor model with other asset pricing models, most notably its extended five-factor version. Some studies of this strand use monthly return data, construct portfolios formed by sorting firms by their characteristics (size, value, profitability, or investment) to generate the factor returns and apply time-series regressions on portfolio returns to assess model performance. For instance, Aras and colleagues (2018) analyzed all non-financial firms from 2005 to 2017 and found that the five-factor model provided a better fit. In contrast, Coşkun and Torun (2021), using data from non-financial firms listed in the BIST 100 index, examine the period between 2009 and 2018 and found that the three-factor model performed better than the five-factor version. Other studies employ a different approach, using quarterly firm-level data and substituting factor returns with firm characteristics as explanatory variables in panel data regressions. For instance, Büyükoğlu (2023) applied a common correlated effects panel estimator to non-financial firms in the BIST 30 index from 2008 to 2020 and reported identical R^2 values for the three- and five-factor models, indicating equal explanatory power. Similarly, Ertuğrul (2024) conducted a fixed-effects panel analysis on non-financial firms in the BIST 100 index for the period 2013–2022 and found that the two models had nearly equal explanatory power.

Although the Fama-French Three-Factor Model has undergone several empirical analyses in the Turkish equity market, most existing studies rely on time-series or panel regression approaches that focus on the significance of factors and model fit. Relatively little attention has been paid to whether the model explains cross-sectional variation in average returns, particularly through the Fama-MacBeth two-step regression framework. As a result, the question of whether the three-factor model can explain cross-sectional differences in average returns remains largely unanswered in the Turkish context.

4. Methodology

This study examines whether the Fama-French Three-Factor Model survives cross-sectional tests in the Turkish equity market, addressing a gap often overlooked in asset-pricing research. To establish a robust empirical foundation, the dataset is described, detailing portfolio excess returns based on size and book-to-market equity (BE/ME) ratios, along with relevant risk factor statistics. While time-series regressions serve as a comparative reference to previous studies, the primary focus remains on cross-sectional analysis. Fama-MacBeth regressions are employed to assess the persistence and explanatory power of factor premia, shedding light on their role in asset pricing dynamics.

4.1. Data

Stock market data was sourced from the Borsa Istanbul DataStore, a dedicated platform offering comprehensive Turkish market information. Among its offerings, the monthly valuation ratios

component includes data such as market value, shareholders' equity, and net cash dividend payments for individual stocks, with each variable aggregated for market indices. Market capitalization, the product of the latest closing price and paid-in capital, was used as the market equity (ME) variable, while shareholders' equity was used as the book equity (BE) variable. Observations with negative book equity values were excluded from the dataset. Interest rate data was obtained from Investing.com, a global provider of real-time data, analysis and insights for financial markets. The resulting dataset contains observations from February 2009 to December 2024.

The risk-free interest rate was proxied by the yield on Turkish government bonds, having a remaining maturity of two years, converted to monthly rates using the bond yield observed at the start of each month. Returns were calculated as monthly changes in market equity values and winsorized at the 0.5th percentile on both ends to mitigate the influence of outliers. The market return was proxied by the BIST100 index's return, a value-weighted portfolio comprising the top 100 stocks listed on Borsa Istanbul.

The market (MKT) factor is calculated as the market return minus the risk-free rate. The size (small-minus-big, SMB) and value (high-minus-low, HML) factors were constructed like those in Fama and French (1993). First, observations were divided into two equally sized groups based on market equity values and three equally sized groups based on book-to-market (BE/ME) values, sorted each month. Six portfolios were formed from the intersections of these groups and their value-weighted returns were calculated each month. Second, the SMB is derived as the difference between the average return of three portfolios comprising small firms and the average return of three portfolios comprising large firms. The HML is calculated as the difference between the average returns of two high BE/ME stock portfolios and two low BE/ME stock portfolios, skipping two medium BE/ME stock portfolios.

Table 1

Portfolio Characteristics and Risk Factors

| Panel A: Mean Excess Returns of Six Size-BE/ME Portfolios | | | | Panel B: Risk Factor Statistics | | | |
|---|-----------|--------------|------------|---------------------------------|------|------|-------|
| | Low BE/ME | Medium BE/ME | High BE/ME | | MKT | SMB | HML |
| Small | 5.78 | 2.26 | 0.63 | Mean (%) | 1.25 | 0.72 | -3.85 |
| Big | 3.50 | 2.06 | 0.96 | Std. Dev. | 7.83 | 4.64 | 5.01 |

Notes: Data cover Turkish firms from 2009 to 2024. Panel A shows monthly excess returns (%) for six portfolios formed by intersecting two size halves and three BE/ME tertiles. Panel B presents statistics for the market factor (MKT), size factor (SMB), and value factor (HML). All values are in monthly percentages.

Panel A of Table 1 presents the mean excess returns for six portfolios constructed through independent two-way sorting by size (split at the median into small and big halves) and BE/ME (split into low, medium, and high tertiles) which are used to construct the size and value factors. The results reveal two key patterns. First, small firms exhibit higher excess returns across all BE/ME groups, except the high BE/ME tertile, aligning with size premium hypothesis that smaller firms command higher returns for their greater risk. Second, and more strikingly, excess returns decline monotonically from low to high BE/ME (5.78% to 0.63% for Small; 3.50% to 0.96% for Big), directly contradicting the value premium hypothesis and Fama-French (1993) findings. They document that value firms, characterized by low stock prices relative to book value (or high BE/ME), tend to exhibit weaker earnings on assets and higher risk and should earn higher average returns as compensation for their risk profile. This reversal of the expected value effect aligns with Türkiye's 2009–2024 macroeconomic regime—characterized by high inflation, currency volatility, and growth-biased monetary policy—which may have systematically favored low BE/ME (growth-like) stocks as inflation hedges while penalizing high BE/ME firms due to investor skepticism about their fundamental health.

Panel B of Table 1 presents summary statistics for the Fama-French three factors influencing excess stock returns. The market factor (MKT), which represents the market premium, averages 1.25% monthly premium ($\sigma = 7.83\%$), reflecting the compensation investors demand for bearing overall market risk instead of holding risk-free assets. The size factor (SMB) shows a 0.72% monthly premium ($\sigma = 4.64\%$), consistent with Panel A's evidence that small firms generally outperform. However, the value factor (HML) averages -3.85% monthly ($\sigma = 5.01\%$), strongly contradicting the traditional value premium. This aligns with the portfolio-level results in Panel A, where excess returns are highest for low BE/ME stocks and decrease monotonically toward high BE/ME stocks. The magnitude of HML's negative mean (-3.85%) exceeds its volatility (5.01%), implying this reversal was economically significant and not merely noise. In this market context, high BE/ME stocks may not command a risk premium as predicted by value premium hypothesis.

4.2. Time-series tests of the Fama-French three-factor model

Following Fama and French (1993), the three-factor model is estimated using time-series regressions of excess portfolio returns:

$$R_{p,t} = \alpha_p + \beta_{MKT,p}MKT_t + \beta_{SMB,p}SMB_t + \beta_{HML,p}HML_t + \epsilon_{p,t}$$

where $R_{p,t}$ is the excess return of portfolio p in month t over the risk-free rate, MKT_t , SMB_t and HML_t represent the market, size, and value factors, respectively. The coefficients β_{MKT} , β_{SMB} and β_{HML} obtained from these time-series regressions, known as factor loadings, indicate how strongly each portfolio responds to movements in the underlying risk factors. While Fama and French (1993) tested the model using 25 value-weighted portfolios formed on size and book-to-market quintiles, the model is tested on the same six value-weighted portfolios used to derive the size and value factors. This ensures methodological consistency while adopting a parsimonious approach.

Table 2

Three-Factor Time-Series Regression Results for Size-BE/ME Portfolios

| Portfolio | α | β_{MKT} | β_{SMB} | β_{HML} | F-statistic | Adj. R ² |
|------------|-------------------------|------------------------|-------------------------|--------------------------|-------------|---------------------|
| Small-Low | 0.8573*** (2.8305) | 0.9240*** (30.4616) | 1.1522*** (22.8517) | -0.7652*** (-16.0783) | 522.6363*** | 0.8917 |
| Small-Mid | -0.1739 (-0.5156) | 0.8958*** (26.5144) | 0.8579*** (15.2741) | -0.1831*** (-3.4541) | 305.0035*** | 0.8276 |
| Small-High | -1.0811*** (-3.3176) | 0.9278*** (28.4331) | 0.8405*** (15.4945) | 0.0124 (0.2428) | 348.6396*** | 0.8459 |
| Big-Low | -1.4406*** (-3.8713) | 0.9333*** (25.0436) | -0.2765*** (-4.4628) | -1.0338*** (-17.6812) | 270.9699*** | 0.8100 |
| Big-Mid | 0.5452* (1.7080) | 0.8850*** (27.6878) | 0.0917* (1.7268) | -0.0907* (-1.8082) | 260.1528*** | 0.8036 |
| Big-High | 0.4978 (1.6442) | 0.9294*** (30.6549) | 0.0353 (0.6999) | 0.1886*** (3.9651) | 347.9372*** | 0.8456 |

Notes: Coefficients, F-statistics and adjusted R² values from time-series regressions are reported for six portfolios, constructed by sorting firms based on size (small/big) and book-to-market equity (low/mid/high), using monthly data for Turkish firms from 2009–2024. Each regression analyzes the impact of market (MKT), size (SMB), and value (HML) factors on the excess return of the relevant portfolio. The β coefficients represent factor loadings from time-series regressions. t-statistics are shown in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 2 presents the time-series regression results of the Fama-French three-factor model for the Turkish equity market. The model demonstrates strong explanatory power across all six portfolios, with adjusted R² values ranging from 0.80 to 0.89, suggesting that approximately 80-89% of the variation in

portfolio excess returns is captured by the three factors. Such high adjusted R^2 values are typical in time series analyses of size-BE/ME portfolios, with Fama and French (1996) reporting values between 0.81–0.96. All regressions have high F-statistics, confirming the model's strong explanatory power. This aligns with the model's foundational premise that market, size, and value factors collectively explain cross-sectional return differences. Notably, the market factor (MKT) loads positively and significantly (all t-statistics > 25) across all portfolios, as theoretically expected, indicating systematic market risk is consistently priced. Specifically, a 1% increase in market excess returns is associated with a 0.89–0.93% rise in portfolio returns. Similarly, the size factor (SMB) exhibits economically meaningful and statistically significant loadings for small-size portfolios (ranging from 0.84 to 1.15, all significant at the 1% level), confirming that smaller firms carry distinct risk exposures in Türkiye's market, as in other economies. The results are consistent with the findings of Fama and French (1996) on BE/ME quintiles, where portfolios of smaller firms exhibit positive sensitivity to SMB (up to 1.47), whereas portfolios of the largest firms show negative sensitivity to SMB (down to -0.16).

The value factor (HML) exhibits patterns broadly consistent with the Fama-French framework, particularly in high book-to-market portfolios. A significant positive HML loading is observed in the Big-High portfolio (0.19, $t = 3.97$), where the value premium is theoretically expected to be most pronounced. The coefficient in the Small-High portfolio is also directionally consistent, though not statistically significant. In contrast, negative HML coefficients appear in portfolios with low or mid book-to-market ratios, most notably in Small-Low (-0.77, $t = -16.08$) and Big-Low (-1.03, $t = -17.68$). These findings are consistent with prior empirical research on the Turkish equity market employing the six-portfolio Fama-French framework. For example, the HML coefficients of Big-High portfolio were positive (0.88, 0.24, and 0.66), while the HML coefficients of Big-Low portfolio were negative (-0.44, -0.42, and -0.29) in Canbaş and Arıoğlu (2008), Kutlu and Kalaycı (2020), and Genç and Çömlekçi (2018), respectively. The dominance of negative HML coefficients among mid BE/ME portfolios aligns with the negative average HML premium reported in Table 1 (-3.85%), suggesting that growth-oriented firms (i.e., those with low BE/ME ratios) generally outperformed value firms during the sample period—possibly due to their perceived role as inflation hedges or their relative benefit from expansionary fiscal and monetary policies. While evidence for a positive value premium is limited, the consistently high adjusted R^2 values confirm that the three-factor model continues to explain the majority of return variation in the Turkish market.

The intercepts (α) provide further evidence on model specification. While the three-factor model fully explains returns in two portfolios (Small-Mid and Big-High, with insignificant alphas), four portfolios exhibit significant pricing errors. Most notably, the Small-Low portfolio exhibits a large positive alpha (0.86, $t = 2.83$), while the Big-Low and Small-High portfolios have significant negative alphas (-1.44 and -1.08, respectively). Significant alphas also appear in Fama and French (1996), where in the lowest BE/ME quintile, the smallest-firms portfolio showed a significant negative alpha (-0.45, $t = -4.19$) and the largest-firms portfolio exhibited a significant positive alpha (0.20, $t = 3.14$). These systematic mispricing signals, both in Türkiye and in developed markets, suggest that while the three-factor model captures most variation in returns, additional factors may be needed to fully account for risks.

4.3. Cross-sectional tests via Fama-MacBeth regressions

To assess whether the Fama-French factors are priced in the cross-section of individual stock returns the Fama-MacBeth (1973) two-stage procedure is implemented. This approach provides a stricter test than traditional time-series regressions, as it examines whether factor exposures account for differences in average returns across individual stocks. In the first stage, stock-level betas ($\hat{\beta}_{MKT,i}$, $\hat{\beta}_{SMB,i}$, $\hat{\beta}_{HML,i}$) are estimated using the same time-series specification as in the portfolio tests. This stock-level analysis preserves precise size and BE/ME characteristics that portfolio aggregation might dilute.

Companies with fewer than 30 monthly observations are excluded to ensure reliable beta estimation, retaining 453 firms (72% of the initial sample) for cross-sectional analysis.

In the second stage, individual stock returns are regressed on the pre-estimated betas using monthly cross-sectional regressions:

$$R_{i,t} = \lambda_{0,t} + \lambda_{MKT,t}\hat{\beta}_{MKT,i} + \lambda_{SMB,t}\hat{\beta}_{SMB,i} + \lambda_{HML,t}\hat{\beta}_{HML,i} + u_{it}$$

where $R_{i,t}$ is stock i 's excess return in month t , and $\hat{\beta}$ terms are the pre-estimated factor loadings. The coefficients λ_{MKT} , λ_{SMB} and λ_{HML} are the monthly estimated risk premia for each factor. The time-series averages of them are tested for statistical significance employing Newey-West standard errors to determine whether each risk factor commands a significant premium. This approach directly addresses the CAPM's historical cross-sectional failures while evaluating if the three-factor model's time-series success extends to pricing individual securities in Turkish equity market.

Table 3

Fama-MacBeth Cross-Sectional Regression Results for Individual Stocks

| Parameter | Estimate (λ) | t-Statistic | p-value |
|-----------------|------------------------|-------------|-----------|
| Intercept | 1.6385 | 3.9453 | 0.0001*** |
| λ_{MKT} | 0.3924 | 0.5650 | 0.5727 |
| λ_{SMB} | 0.4229 | 1.1995 | 0.2318 |
| λ_{HML} | -0.3765 | -0.6893 | 0.4914 |
| Average R^2 | 0.0651 | | |

Notes: Reported estimates are cross-sectional regression coefficients averaged over time, while t-statistics are calculated using Newey-West standard errors. *** marks significance at the 1% level. The sample covers February 2009 to December 2024 (191 months) and includes 453 firms (72% of the initial universe after applying the 30-month minimum observation filter).

The Fama-MacBeth regression results in Table 3 provide a cross-sectional test of whether the three Fama-French factors are priced significantly across stocks in the Turkish equity market. Each estimated risk premium (λ coefficient) represents the average monthly excess return investors demand for exposure to its respective factor. None of the factor premia, including λ_{MKT} (0.3924), λ_{SMB} (0.4229), or λ_{HML} (-0.3765), are statistically significant. This contrasts sharply with the strong factor loadings (β coefficients) observed in the time-series regressions. However, the signs of the coefficients show partial alignment to the time-series results in Table 2. The positive SMB risk premium (λ_{SMB}) is consistent with the generally positive SMB loadings (β_{SMB}) for small-stock portfolios in Table 2, suggesting that smaller firms may have earned higher returns, though the premium is not statistically significant. The negative λ_{HML} , while insignificant, weakly mirrors the negative HML loadings of low book-to-market portfolios, hinting that growth-oriented stocks may have outperformed value stocks during the sample period. The significant positive intercept (1.6385, $p < 0.01$) suggests the presence of unexplained excess returns, possibly due to missing risk factors or market inefficiencies. This significant intercept is consistent with the findings of Walkshäusl and Lobe (2014), who reported a significant intercept but insignificant coefficients for market equity and book-to-market for Türkiye in their international analysis. The low average cross-sectional R^2 (0.0651) further highlights the model's limited ability to account for cross-sectional variation in individual stock returns. This R^2 value is considerably lower than those typically reported in studies that performed portfolio-level analyses, such as Petkova (2006), who found an adjusted R^2 of 0.71. However, it is slightly higher than the 5% average R^2 reported by Bartholdy and Peare (2005) in their stock-level analysis.

These results reveal one key limitation of the Fama-French three-factor model: while the model successfully explains intertemporal variation in portfolio returns (Table 2), it fails to explain cross-

sectional variation in individual stock returns. The statistically insignificant factor premia and low explanatory power suggest that, although the model's factors are effective at the portfolio-level time-series analysis, they cannot reliably price stocks relative to one another. This discrepancy likely stems from two sources: (1) the model's design for portfolio aggregation, which smooths idiosyncratic noise but masks firm-specific heterogeneity, and (2) potential missing risk factors (e.g., liquidity, investment) that become salient at the stock level. The significant positive intercept further underscores unexplained average returns, reinforcing the need for alternative pricing explanations in emerging markets like Türkiye. Overall, the Fama-MacBeth procedure exposes the model's cross-sectional shortcomings and shows that time-series efficacy of the three-factor model does not necessarily translate into satisfactory cross-sectional pricing power, at least in the Turkish context.

5. Conclusion

This study examines the cross-sectional validity of the Fama-French Three-Factor Model in the Turkish equity market, employing both time-series and cross-sectional tests. The analyses use a dataset spanning February 2009 to December 2024. Time-series tests involve regressing the excess returns on market, size, and value factors for each of six portfolios constructed by intersecting two size groups with three book-to-market groups, which are also used to compute size and value factors. Cross-sectional tests involve the Fama-MacBeth procedure, where factor loadings for each stock are first estimated through time-series regressions, and excess returns are then regressed on these loadings, with the estimated risk premia averaged over time.

The time-series regressions demonstrate that the model has strong explanatory power, capturing a majority of return variation across six size and book-to-market portfolios. The market and size factors exhibit statistically significant and economically meaningful loadings, underscoring their relevance in asset pricing within the Turkish context. The value factor also shows patterns broadly consistent with theoretical expectations, particularly in high book-to-market portfolios; however, negative loadings in low and mid BE/ME portfolios point to a relatively weak or inverted value premium over the sample period. These findings reflect a period in which growth-oriented firms outperformed, possibly due to macroeconomic conditions that favored such firms. Despite this variation, the three-factor model remains a robust framework for explaining return dynamics at the portfolio level in the Turkish market.

In contrast, the cross-sectional tests via the Fama-MacBeth regressions highlight a significant limitation: while the model effectively captures time-series variation, it fails to account for cross-sectional differences in individual stock returns. The factor premia are statistically insignificant, and the low R^2 values (with average of 0.0651) indicate that additional factors or alternative models may be needed to fully account for the pricing of individual stocks in the Turkish market. The positive constant terms in the Fama-MacBeth regressions suggest the presence of unexplained excess returns, potentially due to missing risk factors or market inefficiencies.

These findings underscore the importance of considering time-series and cross-sectional perspectives together when evaluating asset pricing models, particularly in emerging markets. While the three-factor model remains a valuable tool, its limitations in cross-sectional analysis underscore the need for further exploration of additional risk factors, such as liquidity or investment, that may be more relevant at the individual stock level. Future research could build on this study by incorporating such factors or by testing the model in other emerging markets to determine the generalizability of these results.

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