

Size and Book-to-Market: Comparing Factor Loadings, Characteristics, Methodologies, and Time Periods

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Abstract

We show new evidence of firm size and book-to-market as priced risk factors in an empirical asset pricing model. A robust size and value premium persists across 1963-1991 and 1992-2017 sub-samples. Characteristics-based models do a better job explaining variation in stock returns than models based on factor loadings. An instrumental variable approach using individual stocks as test assets performs better than one using portfolios. We also present a decile-based measure of size and value with risk premium estimates that are intuitive to interpret. Results have implications for how investors might better understand exposure to systematic risk factors.

I. Introduction

In attempting to explain the tremendous variation in stock returns, many researchers have focused on empirical evidence of common risk factors. The two most prominent factors are the size effect, where stocks with lower market capitalizations tend to have higher returns, and the value effect, where value stocks—typically defined in the literature by high book-to-market ratios—also have higher returns. A common view is that these higher returns are compensation for bearing more systematic risk, made immensely popular in the literature by Fama and French in their 1992, 1993, and 1996 studies. The discussion of size and value is still ongoing. Some researchers find that these risk premia are transient through time (Huang and Huang, 2013) or are gone completely (e.g., Horowitz, Loughran, and Savin, 2000; van Dijk, 2011 for the size premium). Other studies find that the factors are not correctly specified or measured, as Novy-Marx (2013) shows how gross profitability confounds the value effect, while some parameter specifications do not affect overall results, as Krueger and Johnson (1991) find. Still others argue that the reported size and value effects are artifacts of the methodology employed. Despite this discord, the original articles are heavily cited in finance literature. As of 2019, the seminal group of papers by Fama and French have almost 50,000 citations. Moreover, “smart beta” investments based on the size and value effects (among others) are increasingly being marketed to individual investors (Kahn and Lemmon, 2016). Clearly, the persistence of these risk factors in finance literature and investment practice warrants additional investigation into their methodology and robustness.

In this study, we take a closer look at size and value as priced risk factors in the cross-section of stock returns. We compare a widely cited empirical asset pricing model, the Fama French three-factor model, with a model based on actual firm characteristics as in Daniel and Titman (1997). Although size and book-to-market have been heavily studied in their ability to explain stock returns, we add to existing literature in a few areas. First, a substantial amount of time has passed since Fama and French’s original studies of 1992, 1993, and 1996, providing nice pre- and post-publication sample periods to evaluate size and book-to-market. The original papers looked at stock returns around 1963-1991, about 340 months. We examine that period and compare

it to the period 1992-2017, about 300 months. In contrast with some studies, we find significant size and value premia over both sub-samples and for the overall 1963-2017 period.

Second, we provide further insight into why size and book-to-market explain returns in the first place. Fama and French argue that regression slopes on their factor-mimicking portfolios SMB and HML proxy for common priced risk factors—stocks with high factor loadings on SMB are more sensitive to business cycle swings, which seems reasonable since small firms would ostensibly have the same sensitivity. Similarly, Fama and French argue that high HML loadings proxy for firm distress, where weaker firms with persistently low profitability have high book-to-market ratios, which practitioners would term value stocks. A natural question follows from this: why not just use a firm's actual size and book-to-market to explain stock returns, rather than regression slopes from factor-mimicking portfolios? Daniel and Titman (1997) first examine this question, and they argue that size and book-to-market as firm characteristics are favorable over factor loadings. We thoroughly compare the characteristics-based model to the Fama French three-factor model and provide new evidence that actual firm characteristics explain stock returns more robustly than SMB and HML factor loadings. In addition, we use size and book-to-market deciles as explanatory variables, and these provide estimates of size and value premia that are intuitive to interpret and also comparable across sub-sample periods. Holding other factors constant, a one-decile increase in firm market capitalization is associated with decrease in excess return of about 8 basis points. For value, a one-decile increase in book-to-market is associated with an excess return that is about 7 basis points higher.

Third, we use consistent econometric methodologies to analyze the two models. Fama and French (1992) utilize the Fama and MacBeth (1973) two-pass approach with size and book-to-market, but their regressions do not actually include the three-factor model. Fama and French (1993, 1996) look at 25 sets of factor loadings (i.e., regression coefficients), one for each of the 25 portfolios formed on size and book-to-market, but they do not utilize the Fama-MacBeth approach. They stress that the time-series statistical significance and patterns among the 25 portfolio factor loadings combine to make their model compelling. Daniel and Titman (1997) use a similar approach, but with nine portfolios. We conduct both time series and Fama-MacBeth analysis for the Fama French three-factor model and the characteristics-based model, with consistent methodology that allows for more direct comparison between the two models.

Finally, we employ a recent approach to resolving the errors-in-variables problem endemic to the Fama-MacBeth methodology. The second stage of the Fama-MacBeth approach uses estimated regression coefficients as data, and because such coefficients are estimated with sampling error, second stage risk premium estimates will be biased and inconsistent in the presence of correlated sampling errors. Fama and MacBeth (1973) address this by forming portfolios. Portfolios are less prone to errors-in-variables bias but can confound results, as documented by Lo and MacKinlay (1990) and Jegadeesh (1992), among others. In contrast, Jegadeesh et al. (2019) circumvent potential errors-in-variables bias with an instrumental variable approach using individual stocks. We compare the Fama French three-factor model to the Daniel and Titman characteristics-based model using both the portfolio-based approach and Jegadeesh et al.'s instrumental variable approach. Models that employ instrumental variables and individual stocks as test assets perform better than the more commonly-used portfolio methodology.

To our knowledge, this study is the first to analyze and compare the three-factor model and the characteristics-based model along all of these dimensions. In doing so, we hope to clarify what the model can explain and provide insight into why size and book-to-market have explanatory power over stock returns. Overall, the Daniel and Titman characteristics-based model provides more robust evidence of the size and value premia than the Fama French three-factor model, and premia estimated using the characteristics-based model are also more intuitive to interpret, especially when using a stock's size and book-to-market deciles as explanatory variables.

To be sure, size and value do not completely explain cross-sectional variation in stock returns. Researchers have presented evidence of other priced risk factors such as momentum, profitability, investment, and over 300 others (Harvey, Liu, and Zhu 2016). Our aim here is not to present a parsimonious model that fully explains stock returns. Rather, we focus on size and value because they are prominent and relatively simple to understand. Analysis of this simpler model could help individual investors make more informed decisions about risk factor exposures in their portfolios.

The rest of this paper proceeds as follows. Section II briefly reviews relevant literature and motivates our empirical approach. Section III describes data and methodology. Section IV contains summary statistics. Section V presents the main empirical results. Section VI addresses robustness, and Section VII concludes.

II. Literature review

Seminal papers

Before empirical asset pricing models were devised to explain systematic risk factors related to size and book-to-market, researchers first discovered that such stocks earned higher returns. Banz (1981) and Keim (1983) documented that smaller firms earned positive abnormal returns, and Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) found evidence that firms with higher book-to-market ratios—or to practitioners, lower price-book ratios—did as well. Basu (1983) finds evidence of the value effect with firm earnings-price ratios. These anomalies, among others, fueled the debate over market efficiency, the legitimacy of existing theoretical asset pricing models such as the CAPM, and the inability to assess simultaneously market efficiency and the validity of an asset pricing model (e.g., Roll, 1977). This study does not focus not on that debate, but rather on the empirical asset pricing models that followed.

Given the documented size and value anomalies and the inability of theoretical asset pricing models to explain observed anomalies thoroughly, Fama and French developed an empirical model that included size, value, and also a market factor (beta). Their approach would become heavily cited and widely adopted and debated in finance literature. Fama and French (1992) use the Fama-MacBeth methodology to evaluate size, book-to-market, and the market factor; however, in that study they do not include a regression with all three factors at once. To address the errors-in-variables problem caused by using beta as a regressor, Fama and French form portfolios based on firm size and beta and assign each stock the beta of its corresponding portfolio.

Fama and French (1993) formalize the three-factor model and move away from the Fama-MacBeth methodology. Instead, their evidence is based on time-series regressions of 25 portfolios

formed according to stocks' size and book-to-market quintiles. Their main explanatory variables are returns from factor-mimicking portfolios: SMB, the difference between the return on small cap stocks and large cap stocks, and HML, the difference between stocks with high (value stocks) and low (growth stocks) book-to-market ratios. Fama and French claim that the statistical significance of the regression coefficients on SMB and HML provide evidence that variation in size and book-to-market help explain stock returns. In addition, they cite the variation in the magnitude of the coefficients across portfolios as further support for this claim. For example, in their study the coefficient on SMB is higher for smaller size quintiles across all book-to-market quintiles. In other words, even after controlling for variation in book-to-market, small stocks tend to be more sensitive to SMB than larger stocks. Similarly, factor loadings on HML increase as book-to-market increases, across almost all size quintiles. Finally, Fama and French claim that the three-factor model does not leave significant variation in stock returns unexplained, as time-series intercepts from regressions for 22 out of 25 portfolios have t-statistics less than 2. Fama and French have been prolific in expanding upon the original findings involving the three-factor model, producing numerous subsequent studies in the areas of additional factors, evaluating anomalies, international evidence, investment opportunities, and other areas (see, e.g., Fama and French, 1996, 1998, 2017).

Characteristics vs. covariances

The Fama French three-factor model is based on portfolio covariances with returns on SMB and HML, and the authors argue that these covariances capture variation in stock returns due to size and value risk factors. Daniel and Titman (1997) counter Fama and French's argument by claiming that actual firm characteristics of size and book-to-market explain stock returns rather than covariances with factor-mimicking portfolios. Daniel and Titman support this claim by forming portfolios based on stock characteristics and factor loadings. They show that firms with similar characteristics but different factor loadings do not have different returns, in contrast to the Fama French three-factor model's prediction. Specifically, they show that the higher returns of small cap stocks and value stocks cannot be explained by SMB and HML factor loadings. They also report that after controlling for size and book-to-market, market beta does not have explanatory power over stock returns. Several studies have examined what specifically about size and value makes them priced risks for stocks. Krueger and Wrolstad (2012, 2013) find robust relationships between fundamental-based portfolio weightings and returns, particularly with ratios based on cash flows. The authors also find that reputation may be a driving force, as they find reputation measures have predictive power for risk-adjusted returns (Krueger and Wrolstad 2016).

Methodology: portfolio sorting vs. individual stocks

Grouping stocks into portfolios is a central component of most empirical asset pricing investigations, for a few reasons. The most prominent relates to the way asset pricing models are tested. In many cases, researchers use the two-stage methodology of Fama and MacBeth (1973). First, one estimates time-series stock return sensitivity to some factor such as the overall market return. The second stage is cross-sectional, where for a given time period stock returns are regressed on the factor sensitivity (beta) from the first stage. Because a coefficient estimate like beta is only a sample estimate of a population parameter and is thus susceptible to sampling error, there is potential for errors-in-variables bias when using betas as data in a regression. Blume (1970) points out that if sampling error for betas in a given portfolio are independent, then portfolio betas

should be less subject to errors-in-variables bias. Fama and MacBeth extend Blume's assertion to beta sampling errors that "are substantially less than perfectly positively correlated."

However, multiple studies have pointed out that sorting stocks into portfolios can yield spurious and misleading results. Lo and MacKinlay (1990) show that sorting stocks into portfolios can impart data-snooping bias. Berk (2000) argues that tests run on sorted portfolios are prone to bias. Jegadeesh (1992) shows how portfolios formed with very high correlations between size and market beta can lead to spurious results, and he finds that after controlling for size, market beta explains almost no variation in stock returns. Kim (1995) illustrates that the errors-in-variables problem can be present even in portfolio betas. Ferson, Sarkissian, and Simin (1999) show how portfolio sorting can produce a convincing case in favor of a factor model even if a factor is completely made up and has no actual relation to systematic risk. Daniel and Titman (2012), Daniel, Titman, and Wei (2001), and Lewellen, Nagel, and Shanken (2010) also raise issues with factor model testing involving portfolios.

Researchers have proposed varied solutions to the problems associated with portfolio sorting. Litzenberger and Ramaswamy (1979) and Kim (1995) propose methodologies to correct errors-in-variables bias based on maximum likelihood estimation. Brennan, Chordia, and Subrahmanyam (1998) use risk-adjusted returns for individual stocks, obviously avoiding issues related to portfolio returns, and they also argue that risk adjustment sidesteps the errors-in-variables issue, since returns properly adjusted for risk factors should be independent of other stock characteristics.

Most relevant to this study, Jegadeesh et al. (2019) combine the Fama-MacBeth methodology with an instrumental variable approach using individual stocks as test assets instead of portfolios. To address potential errors-in-variables bias, the authors estimate time-series factor sensitivities for even months and odd months. For the cross-sectional stage, regressions are estimated for even (odd) months using the odd-month (even-month) betas as instruments. Jegadeesh et al. contend that because independent variables (e.g., even-month betas) are estimated from a different sample of data than instrumental variables (e.g., odd-month betas), their sampling errors should be uncorrelated. Jegadeesh et al. prove the consistency of their instrumental variable estimator, and they show it estimates true risk premia accurately using simulation results.

III. Data, sample and methodology

The sample period for this study is January 1963 to June 2017. We obtain stock return data from CRSP for stocks listed on the New York Stock Exchange, NASDAQ, and AMEX. Following existing literature, financial firms (SIC codes 6000-6999), utilities (SIC codes 4910-4939), American Depositary Receipts, closed-end funds, preferred stocks, real estate investment trusts, and stocks with a price of less than \$1 are excluded. Following Jegadeesh et al. (2019), we exclude stocks with return data for fewer than 200 trading days in a given year. Data for the book value of equity come from COMPUSTAT. Book value of equity is computed as stockholder's equity plus deferred taxes and investment tax credit, minus preferred stock. We exclude firms whose book value of equity is negative. When computing a firm's book-to-market, we use the last available figure for book value of equity in year $t-1$ and market value of equity (price times shares outstanding from CRSP) as of the end of year $t-1$. We measure size as market value of equity in June of year t . We then use those size and book-to-market figures for analysis from July of year t

through June of year $t+1$. Factor-mimicking portfolio returns SMB and HML, market returns, the risk-free return, and portfolio size and book-to-market breakpoints all come from Kenneth French's website.¹ SMB is the return for stocks with market capitalizations below the NYSE median market cap minus the return for stocks with market caps above the NYSE median. HML is the return for high book-to-market stocks (with a ratio at or above the NYSE seventieth percentile) minus the return for low book-to-market stocks (with a ratio at or below the NYSE thirtieth percentile).

We use the Fama and MacBeth (1973) two-stage method to evaluate size and value as priced risk factors in an empirical asset pricing model. The first stage estimates time-series regression coefficients of an asset excess return r on risk factors, where each asset is a stock or portfolio i . The second stage involves cross-sectional regressions of asset excess returns on estimated betas from the first stage, for each month t . The average second-stage coefficients are the risk premium estimates for the factors in the model. For the Fama French three-factor model, the two stages are represented by Equations (1) and (2):

$$r_{i,t} = a_0 + \beta_{1,i}MKT_t + \beta_{2,i}SMB_t + \beta_{3,i}HML_t + \varepsilon_{i,t} \quad (1)$$

$$r_{i,t} = \gamma_0 + \gamma_1\hat{\beta}_{1,i} + s_i\hat{\beta}_{2,i} + h_i\hat{\beta}_{3,i} + \xi_{t,i} \quad (2)$$

Where $r_{i,t}$ is the excess return of asset i in month t ; MKT_t , SMB_t , and HML_t are the returns on the market, SMB, and HML, in month t ; and s_i and h_i are the factor loadings on SMB and HML for asset i . Equations 3 and 4 show the two stages for the Daniel and Titman characteristics-based model:

$$r_{i,t} = a_0 + \beta_1MKT_t + \varepsilon_{i,t} \quad (3)$$

$$r_{i,t} = \gamma_0 + \gamma_1\hat{\beta}_{1,i} + \gamma_2SIZE_i + \gamma_3BM_i + \xi_{t,i} \quad (4)$$

Where $SIZE_i$ and BM_i are the size and book-to-market for asset i .

For part of our analysis, we follow the instrumental variable approach of Jegadeesh et al. (2019), to address potential errors-in-variables bias in the second stage of Fama-MacBeth analysis. In the first stage, we estimate betas for even and odd months separately, using daily stock and market returns for months $t-36$ to $t-1$ to estimate betas in month t . In the second stage, we estimate cross-sectional regressions for even (odd) months using odd-month (even-month) betas as instruments. Note that size and book-to-market are observed rather than estimated and thus are not prone to errors-in-variables bias. Risk premium estimates are then the average of the even-month and odd-month second stage regression coefficients. Results are very similar when using weekly or monthly stock returns to estimate first-stage betas, and also when using one or five years of historical returns instead of three.

¹ Like so many others, we are grateful to Professor French for generously making this data publicly available at <http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html>.

IV. Summary statistics and comparison to existing literature

Table 1 presents summary statistics for the two sub-sample periods: the original Fama French sample period of July 1963-December 1991, and the subsequent period January 1992-June 2017. A few differences across the two periods are evident. First, the mean monthly excess stock return was 35.7 basis points higher in 1992-2017 compared with 1963-1991. Cross-sectional stock return variability increased as well, from 13.8% to 16.9%—although not reported in the table, the difference between sub-sample standard deviations is significant at the 1% level. Also, firm size measured by market capitalization has increased substantially and become much more dispersed. The average book-to-market ratio has declined, reflecting a number of possible drivers, including the potential for higher growth expectations due to technological advances, increased use of share repurchases, and increased demand for stock driven by much broader investor participation in the stock market. In addition, the mean number of stocks also increased by several hundred, although the number of listed companies varies by year within each sub-sample.

The factor-mimicking portfolio returns are positive. The mean return for SMB is 0.266 (0.167) percent per month during 1963-1991 (1992-2017), indicating that smaller stocks with market caps below the NYSE median have higher returns than stocks with above-median market caps. The mean return for HML is 0.392 (0.301) percent per month during 1963-1991 (1992-2017), which suggests value stocks with book-to-market ratios above the NYSE seventieth percentile have higher returns than growth stocks with book-to-market ratios below the NYSE seventieth percentile. Average factor-mimicking portfolio returns are not significantly different across the two sub-samples. Factor loadings are also positive—on average, stock excess returns are positively related to returns for SMB and HML. However, the average SMB factor loading has declined significantly, from 1.029 during 1963-1991 to 0.888 during 1992-2017. This accords with the debate in literature over the existence and magnitude of the size premium over time. Although the difference between the two sub-samples for the HML factor loading is statistically significant, the economic significance appears limited. Overall, across the sample period firms have grown larger and returns have increased and become cross-sectionally more volatile. However, despite tremendous changes in financial markets and the environment in which listed firms operate over the entire sample period, the evidence appears consistent with a size and value premium, at least on a univariate basis.

As a first attempt at incorporating multiple factors associated with stock returns, we use the familiar portfolio double-sorting methodology popularized by Fama and French. Although the vulnerabilities of portfolio sorting are detailed in Section II above, their widespread use make them a common reference point of comparison to other studies. Table 2 presents mean monthly excess returns for portfolios sorted into quintiles along two different sets of dimensions. First, portfolios are sorted by size and book-to-market quintiles, consistent with Fama and French (1993). We also sort portfolios into quintiles according to their factor sensitivities to SMB and HML, similar to Daniel and Titman (1997) and Daniel, Titman, and Wei (2001). Panel A covers July 1963 to December 1991, and Panel B covers January 1992 to June 2017.

From Fama and French's size and book-to-market sorts, we see familiar evidence to support these firm attributes as priced risk factors in the 1963-1991 sub-sample. Looking at each book-to-market quintile column, we see that stocks in lower size quintiles tend to have higher excess returns, with the exception of the lowest book-to-market quintile. This evidence is

consistent with the size effect. For each size quintile row, returns show an overall pattern of increasing when moving from low book-to-market quintiles (growth) to high quintiles (value). In the later 1992-2017 sub-sample, these patterns are not as consistent; it appears that smaller size quintiles do not always have higher returns, and the value effect is not evident in the two largest size quintiles.

Turning to portfolios sorted by SMB and HML factor loadings, it is important to clarify that the SMB loading quintiles are presented in descending order, as quintile 5—with the highest sensitivity to SMB—contains stocks that behave most like small cap stocks, and quintile 1 would be made up of large cap-like stocks. Here, results are more ambiguous. Patterns of higher returns for higher SMB factor loading quintiles (smaller stocks) and higher HML loading quintiles (value-like stocks) are not as strong, and results are especially mixed in the later 1992-2017 sub-sample. The contrast between these two sorting methodologies suggests that the firm characteristics size and book-to-market and factor sensitivities to SMB and HML are not measuring the same thing.

V. Analysis with individual stocks

Next, we shift away from portfolio returns and instead use the Fama and MacBeth (1973) method with individual stocks. As described above, in order to address potential errors-in-variables bias as well as avoid the empirical limitations of using portfolios we follow the instrumental variable approach of Jegadeesh et al. (2019). Our main interest is comparing risk premium estimates and significance using factor-mimicking portfolio returns SMB and HML to results using actual characteristics of firm size and book-to-market.

Table 3 presents second stage risk premium estimates for the Fama French three-factor model using individual stocks, estimating Equation 2. Results here are not as compelling as earlier evidence involving portfolio sorts. The size premium measured by sensitivity to the return on SMB is insignificant in both sub-samples as well as for the whole sample period. The value premium measured by the sensitivity to HML is significant in the 1963-1991 sub-sample and for the whole sample. For the whole sample, a one-unit increase in a stock's HML factor loading is associated with a 39.8 basis point increase in monthly excess return, other things equal. Although this quantifies the value premium, the fact that it is based on a rather abstract HML factor loading makes its interpretation complicated and unclear. Market beta is negative but insignificant. The average R-squared of 2.9-3.2% highlights the noise in the cross-section of expected stock returns, even when using models that have strong time-series explanatory power.

Next, we evaluate size and value using actual firm characteristics. As above, we include a stock's market beta estimated using the instrumental variable approach of Jegadeesh et al. (2019). Table 4 presents estimation results for Equation 4, showing risk premium estimates using individual stocks. Results show robust size and value premia. The sign of the coefficient on size is negative and significant, consistent with expectations. Because size is measured as the natural log of market cap, interpreting the coefficient merits clarification: based on the full sample, a one-unit increase in log market cap—for example, a change in market cap from \$1.1 billion to \$3.0 billion—is associated with a 12 basis point decrease in monthly excess stock return. The coefficient on book-to-market is positive and statistically significant at 0.144 for the full sample. A one-unit increase in book-to-market ratio is associated with a 14.4 basis point increase in monthly excess return. The coefficients on size and book-to-market are statistically significant for

the two sub-samples as well as the full sample period. As with the Fama French three-factor model using individual stocks above, market beta is insignificant, consistent with Jegadeesh et al. (2019). Intercepts are positive and significant in all specifications, indicating that beta, size, and value leave a significant portion unexplained in the cross-section of stock returns, as expected. Average adjusted R-squared for the characteristics-based model is slightly higher than the Fama French three-factor model above but still low at around 3.1-3.9%.

To sum up the results in Tables 3 and 4, a model based on actual firm characteristics of size and book-to-market provides more consistent evidence of the size and value effects than one based on factor-mimicking portfolio regression slopes. The characteristics-based model also has explanatory variables that are easier to understand than the more abstract factor loadings of the three-factor model. However, as mentioned above the use of log-transformed firm size makes interpreting the economic impact of the model coefficient estimates cumbersome.

Thus, we also estimate risk premia for individual stocks using their size and value deciles as explanatory variables. Each year stocks are assigned to deciles based on their size and book-to-market. Using a relative measure like deciles is particularly useful when firm characteristics change throughout the sample period, as they do here. For example, the impact of a \$200 million increase in market cap for the average-sized firm would be far greater in the 1960s compared to recent years. In contrast, a one-decile change captures variation relative to other firms at a given point in time. We will also see that these models yield coefficient estimates with an intuitive interpretation.

Table 5 presents risk premium estimates for the Fama French three-factor model using SMB and HML factor loading deciles as explanatory variables, and significance for SMB and HML is still mixed. For the 1963-1991 sub-sample, coefficients on the SMB and HML factor loading deciles are positive and significant. Interpreting the coefficient estimates is straightforward: a one-decile change in a stock's SMB (HML) factor loading is associated with an 7.7 (3.9) basis points increase in monthly excess stock return, other things equal. However, understanding a stock's factor sensitivity is not very intuitive, especially for the average investor. Moreover, these coefficients are insignificant in the later sub-sample, and across the entire sample period only the SMB decile is significant. When using factor loading deciles, market beta is negative and statistically significant, in contrast to the negative but insignificant beta when actual factor loadings are used as in Table 3. Intercepts remain positive and significant, and R-squared is still low at around 2-3%.

Table 6 shows risk premium estimates for the characteristics-based model with firm size and book-to-market deciles as explanatory variables, and again the model shows consistent size and value risk premia. The coefficient on a firm's size decile is negative and significant in the two sub-samples as well as for the whole sample. Interpreting the decile coefficients is quite intuitive: for the whole sample, a one-decile increase in firm size—for example, going from the 20th to the 30th percentile in market cap—is associated with an 8.3 basis point decrease in monthly excess stock return. The coefficient on book-to-market is also consistently positive and significant; for the whole sample, a one-decile increase in a firm's book-to-market ratio is associated with a 6.5 basis point increase in monthly excess return.

In comparing the results in Tables 3 through 6, the evidence suggests that actual firm characteristics of size and book-to-market consistently capture covariation in the cross-section of stock returns, whereas factor loadings on SMB and HML do not reliably do so. Thus, it appears that a stock's SMB and HML factor loadings do not measure the size and value effects as well as a firm's size and book-to-market ratio.

VI. Robustness

For completeness, we estimate size and value risk premia using portfolios rather than individual stocks. First, we test the Fama French three-factor model using 100 portfolios of stocks formed according to their size and book-to-market deciles. We use 100 portfolios instead of 25 to increase the cross-sectional sample size, as results with only 25 portfolios are largely insignificant. We use the same Fama-MacBeth methodology to estimate size and value risk premia. Table 7 presents these results, which are qualitatively similar to results for individual stocks in Table 3. In Table 7, market beta is negative but marginally significant. The size premium is also insignificant. The value premium is positive and significant for the 1963-1991 sub-sample period and for the whole sample, but it is insignificant in the 1992-2017 sub-sample. Notably, using portfolios instead of stocks as test assets increases R-squared markedly to around 23%, compared with 2-3% when using individual stocks. As with all models in this study, intercepts are positive and significant.

Next, we test the Daniel and Titman characteristics-based model with portfolios. We sort stocks into 100 portfolios based on their SMB and HML factor loading deciles. Table 8 presents risk premium estimates and show a significant but volatile size effect, with coefficients varying from -0.269 to -1.325, well beyond what would seem to be a reasonable magnitude for the size effect. The average book-to-market coefficient also varies across the two sub-samples, between 0.897 for 1963-1991 and -0.019 for 1992-2017. The limited significance of the size and value premia estimates from Tables 7 and 8 suggests that using portfolios instead of individual stocks may be confounding results, as Lo and MacKinlay (1990), Berk (2000), and several others have pointed out.

VII. Conclusion

In this study, we find new robust evidence of both the size and value premia, even after controlling for market risk. These premia persist across sub-sample periods, in contrast with other studies that find the size effect transient through time. This study is also the first of our knowledge to use thorough, consistent methodology to compare the Fama French three-factor model to a model based on firm characteristics, using both portfolios and individual stocks as test assets. A characteristics-based model with firm size and book-to-market ratio explains variation in stock returns due to size and value better than the Fama French three-factor model. Risk premium estimates are statistically significant, reasonable, and intuitive to interpret, particularly for risk premium estimates based on size and value deciles. Consistent with other studies, market beta does not have explanatory power over cross-sectional stock returns after taking into account size and book-to-market. Our main analysis avoids the empirical pitfalls associated with portfolio sorts and potential errors-in-variables bias. To do this, we use individual stocks as test assets and employ an instrumental variable approach to address any potential errors-in-variables bias.

Clearly, size and book-to-market along with the overall market factor are not sufficient to explain variation in stock returns. That is not the intent of this study. Instead, we contribute new evidence to existing literature in support of a size and value effect. Moreover, the size and value premia can be quantified in relatively simple terms. For size, a one-decile increase in firm market capitalization is associated with an excess return that is about 8 basis points lower, after controlling for value and the market return. For value, a one-decile increase in book-to-market is associated with an increase in excess return of about 7 basis points, other things equal. Again, these risk premia are stable across sub-sample periods. Practitioners may find this result of interest when advising individual investors about how they might be rewarded for bearing different kinds of risk. Beyond a simple discussion of diversification and market risk, exposure to the priced risks of small stocks and value stocks can provide higher average excess returns. Future research could expand on these results by testing realistic investment strategies for individual investors that are designed to capture the size and value risk premia, such as long-only exposure to small cap stocks and value stocks. In addition, further exploration of how these premia are sensitive to seasonal factors such as those of Krueger (1990) could clarify the scope and potential limitations of these results.

Table 1: Summary statistics

Variable	1963 - 1991		1992 - 2017		Mean Difference
	Mean	Std. Dev.	Mean	Std. Dev.	
Stock monthly excess return (%)	0.913	13.768	1.270	16.876	0.357***
Market cap (\$ millions, nominal)	392	1,984	2,962	15,783	2,570***
Market cap (2017 dollars)	1,343	7,012	3,684	19,175	2,341***
Book-to-market	1.070	1.039	0.744	1.204	-0.327***
Beta	1.220	0.542	1.178	0.806	-0.042***
Market excess return	0.409	4.593	0.642	4.190	0.234
SMB return	0.266	2.879	0.167	3.272	-0.099
HML return	0.392	2.567	0.301	3.078	-0.091
SMB factor loading	1.029	0.997	0.888	1.015	-0.141***
HML factor loading	0.123	0.949	0.095	1.150	-0.029***
# stocks per month	2,140	805	2,816	560	676***

Table 2: Summary statistics for 25 portfolios sorted by characteristics and factor loadings

Panel A: July 1963 - December 1991 (N=342 months)						Panel B: January 1992 - June 2017 (N=306 months)				
Size quintile	Mean monthly excess return:					Mean monthly excess return:				
	Book-to-market quintile					Book-to-market quintile				
	Low	2	3	4	High	Low	2	3	4	High
Small	0.31	0.67*	0.72**	0.89***	1.01***	0.21	0.92**	0.87***	1.15***	1.20***
2	0.39	0.66*	0.84***	0.92***	0.99***	0.61	0.87***	0.91***	0.94***	0.98***
3	0.42	0.71**	0.64**	0.85***	0.93***	0.59	0.89***	0.89***	0.92***	1.13***
4	0.46	0.37	0.62**	0.79***	0.88***	0.78**	0.88***	0.79***	0.95***	0.78**
Big	0.37	0.34	0.34	0.52**	0.52**	0.61**	0.74***	0.77***	0.47*	0.83**
SMB factor loading quintile	Mean monthly excess return:					Mean monthly excess return:				
	HML factor loading quintile					HML factor loading quintile				
	1	2	3	4	5	1	2	3	4	5
5	0.38	0.88*	0.90**	0.51	0.52	0.65	1.03**	0.89*	0.68	0.90**
4	0.37	0.67*	0.89**	0.47	0.56	1.03*	0.84**	0.79*	1.13***	0.88**
3	0.61	0.55	0.57*	0.61*	0.60*	0.73*	0.72*	1.10***	0.88***	0.90**
2	0.47	0.54*	0.48*	0.43	0.90***	0.89**	0.61**	0.80***	1.04***	1.09***
1	0.11	0.36	0.38	0.52**	0.48	0.78**	0.42*	0.74***	0.74***	0.77**

Table 3: Risk premium estimates for the Fama French 3-factor model using individual stocks

Parameter	1963-1991	1992-2017	Full Sample
Intercept	0.767*** (4.11)	1.302*** (7.14)	0.997*** (7.97)
Market beta	-0.268 (-1.50)	-0.322 (-1.14)	-0.268* (-1.74)
s (SMB factor loading)	0.276 (1.45)	-0.010 (-0.04)	0.135 (0.91)
h (HML factor loading)	0.507*** (2.85)	0.368 (1.59)	0.398*** (2.91)
Average R-squared	2.94%	3.07%	3.17%
Average # observations	2,145	2,846	2,307

Table 4: Risk premium estimates for the characteristics-based model using individual stocks

Parameter	1963-1991	1992-2017	Full Sample
Intercept	1.221*** (3.52)	1.568*** (4.8)	1.374*** (6.04)
Market beta	-0.144 (-0.71)	0.107 (0.31)	-0.036 (-0.19)
LN(Size)	-0.114** (-2.33)	-0.135*** (-2.73)	-0.120*** (-3.61)
Book-to-market	0.153*** (3.03)	0.150*** (3.57)	0.144*** (4.43)
Average R-squared	3.87%	3.08%	3.62%
Average # observations	2,136	2,830	2,296

Table 5: Risk premium estimates for the 3-factor model with deciles as explanatory variables

Parameter	1963-1991	1992-2017	Full Sample
Intercept	0.693*** (3.66)	1.492*** (6.87)	1.044*** (7.54)
Market beta	-0.465** (-2.36)	-0.585** (-2.01)	-0.476*** (-2.93)
SMB factor loading decile	0.077*** (2.72)	0.050* (1.79)	0.059*** (3.18)
HML factor loading decile	0.039** (2.57)	0.005 (0.15)	0.021 (1.27)
Average R-squared	3.19%	2.37%	3.01%
Average # observations	2,145	2,846	2,307

Table 6: Risk premium estimates for the characteristics-based model with deciles as explanatory variables

Parameter	1963-1991	1992-2017	Full Sample
Intercept	1.080*** (3.02)	1.007*** (2.98)	1.058*** (4.58)
Market beta	-0.161 (-0.82)	0.165 (0.52)	-0.009 (-0.05)
Size decile	-0.078** (-2.53)	-0.096** (-2.53)	-0.083*** (-3.74)
Book-to-market decile	0.059*** (3.5)	0.080*** (3.77)	0.065*** (5.02)
Average R-squared	3.87%	3.26%	3.75%
Average # observations	2,451	3,216	2,556

Table 7: Risk premium estimates for 100 portfolios sorted by size and book-to-market

Parameter	1963-1991	1992-2017	Full Sample
Intercept	0.585*** (2.64)	1.187*** (5.55)	0.869*** (5.62)
Market beta	-0.143 (-0.76)	-0.447** (-2.05)	-0.286** (-2.01)
s (SMB factor loading)	0.217 (1.52)	0.069 (0.4)	0.147 (1.34)
h (HML factor loading)	0.321** (2.56)	0.148 (0.9)	0.239** (2.36)
Average R-squared	23.69%	22.96%	23.35%
# observations per regres:	100	100	100

Table 8: Risk premium estimates for 100 portfolios sorted by factor loadings

Parameter	1963-1991	1992-2017	Full Sample
Intercept	0.955 (1.37)	6.575*** (6.02)	3.609*** (5.62)
Market beta	0.149 (0.68)	0.354* (1.88)	0.246* (1.68)
LN(Size)	-0.269** (-2.24)	-1.325*** (-6.38)	-0.768*** (-6.49)
Book-to-market	0.897*** (3.59)	-0.019 (-0.05)	0.464** (2.25)
Average R-squared	11.64%	9.11%	10.45%
# observations per regres:	100	100	100

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