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# Value Strategies

*Do stocks with low prices relative to fundamental measures of value outperform the market?*

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## ABSTRACT

This paper investigates weak-form market efficiency of the U.S. equity market by identifying market anomalies related to value strategies for portfolios formed on price-earnings, price-dividends, price-cash flow and five-year past sales rank. Value strategies are investment strategies based on buying stocks that have low prices relative to measures of value for the firms, such as earnings and dividends. We apply three asset pricing models to measure the performance of the strategies. The explanatory power of the models are evaluated and compared across subperiods. Our results indicate that three out of four value strategies outperform the market and that the more sophisticated asset pricing models capture variability in monthly stock returns to a greater extent. Furthermore, we show that the explanatory power of these models varies over time.

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# I. INTRODUCTION

Equity markets have long been, and continue to be, the subject of thorough analysis for both researchers and investors. One aim of such analysis is to find profitable investment strategies through the discovery of cross-sectional and time series patterns in the returns of stocks that deviate from the expectations of asset pricing theory. Such patterns are referred to as market anomalies and are indicators of market inefficiency. Historically, academics have recognized value strategies as market anomalies as far back as the 1930s (Graham & Dodd, 1934). These are investment strategies based on buying stocks that have low prices relative to measures of value for the firms, such as earnings and dividends.

In this paper, we investigate weak-form market efficiency of the U.S. equity market by identifying market anomalies related to value strategies in the April 1963 – March 2014 period. We expand on existing research by analyzing a larger time period than our predecessors and by comparing the results of a previously unobserved time period to the results of prior research, thereby providing a broader perspective of the existence and persistence of these market anomalies. We form portfolios of Nasdaq, NYSE and NYSE MKT (formerly known as AMEX) stocks based on price-earnings (P/E), price-dividends (P/D), price-cash flow (P/C) and five-year past sales rank to distinguish between value stocks and growth stocks. For each variable, we form six portfolios on an annual basis. One portfolio consists of all stocks with variable values of less than or equal to 0, while the remaining five portfolios are constructed based on quintiles of stocks with positive variable values. The performance of these portfolios is measured using three asset pricing models of varying levels of complexity; the capital asset pricing model (CAPM), Fama and French's three-factor model, and Carhart's four-factor model. We estimate the equations of the models by ordinary least squares regressions on monthly portfolio returns and interpret significant alphas as indicators of market anomalies. We find that three out of four value strategies, namely those for portfolios formed on P/E, P/C and five-year sales rank, seem to outperform the market. These results are supported by all three models and suggest that weak-form market efficiency does not hold for our period of analysis. In addition to this, we evaluate the explanatory power of the models both for our period of analysis and relative to the past performance in previous studies. We find that the more sophisticated asset pricing models exhibit greater explanatory power of variability in monthly stock returns. In particular, we find that the four-factor model performs better than the three-factor model, and that the three-factor model performs better than the CAPM. Moreover, we show that the explanatory power of these models varies over time and discuss the implications of this.

Our results are coherent with previous academic research on the subject of market anomalies. Lakonishok, Shleifer & Vishny (1994) document higher returns for stocks with low P/E ratios, low P/C ratios, high book-to-market equity (BE/ME), and low past five-year sales growth relative to other firms. Basu (1977), Jaffe, Keim & Westerfield (1989) and Fama & French (1992) find that portfolios consisting of firms with low P/E ratios earn higher risk-adjusted returns than portfolios of firms with higher P/E values. Keim (1985) examines the relationship between dividend yield and stock returns, and finds that firms with low P/D ratios earn higher risk-adjusted returns than high P/D firms. The higher average stock returns of firms with high BE/ME documented in Lakonishok, Shleifer & Vishny (1994) are also supported by the findings of Rosenberg, Reid & Lanstein (1985) and Fama & French (1992). Banz (1981) finds that firms with small market value earn higher risk-adjusted returns than firms with large market value, a phenomenon known as the size effect. Furthermore, De Bondt & Thaler (1985) document mean reversion in stock returns. They find indications of the reversal of long-term returns in higher future returns of stocks with low past long-term returns. This reversal is in line with the documented higher returns of value stocks. Although the focus of these studies is limited to the U.S. equity market, Chan, Hamao & Lakonishok (1991) document similar market anomalies for Japanese stocks, which suggests that these anomalies are also present internationally.

Different asset pricing models have been developed to explain the patterns in average stock returns that characterize market anomalies. Traditionally, the CAPM of Sharpe (1964) and Lintner (1965) has been the most common in estimating the expected average return of financial securities. However, subsequent research provides evidence that the CAPM is not able to explain the variability in stock returns, and thus more sophisticated models have been developed. The three-factor model by Fama & French (1993) and the four-factor model by Carhart (1997) are such models. These three asset pricing models are applied to identify market anomalies related to value strategies in our analysis. Fama & French (1996) support the use of more complex asset pricing models than the CAPM and argue that the three-factor model has superior explanatory power for portfolios formed on P/E, P/C and sales growth. The two additional market factors of the three-factor model, SMB (a size factor consisting of returns of ‘small’ firms minus the returns of ‘big’ firms as measured by market capitalization) and HML (a book-to-market equity factor consisting of returns of ‘high’ book-to-market equity firms minus the returns of ‘low’ book-to-market equity firms), are not only supported by the statistical results of Fama and French (1996) – earlier work by Fama & French (1995) shows that BE/ME and regression coefficients on HML are proxies for relative distress. Value stocks are typically referred to as being in relative distress, and have high BE//ME and positive HML coefficients. One possible explanation for the ‘distress premium’ of value stocks is that irrational investors overreact to information so that distressed stocks are underpriced while growth stocks are overpriced (Lakonishok, Shleifer & Vishny, 1994). Support for the addition of the size factor SMB is found in the work of Huberman & Kandel (1987), who identify covariation in returns for small stocks that are not captured by the market return but compensated for in average returns. This factor captures variability in average stock returns caused by the size effect documented in Banz (1981). Despite the high level of explanatory power of the three-factor model, Fama & French (1996) conclude that it is not able to capture the continuation of short-term returns found by Jegadeesh & Titman (1993). The anomaly indicates that stocks with high returns in the past 12 months have a tendency to have higher future returns over the next 3 to 12 months. Carhart (1997) incorporates this in a momentum factor to extend the three-factor model to a four-factor model accounting for the momentum effect on average stock returns.

Although market anomalies related to value stocks have been well documented in the past, the reasons for their persistence are not as clear. Lakonishok, Shleifer & Vishny (1994) suggest that applying value strategies in investing means betting against naive investors that overreact to news, that assume continuing trends and that extrapolate past earnings growth too far into the future. They argue that value strategies are contrarian strategies that involve investing in stocks that are typically associated with distress, investing relatively more in underpriced stocks and relatively less in overpriced stocks, thereby outperforming the market. Another explanation is that a value strategy is fundamentally riskier (Fama & French, 1992). That is, investors that pick stocks that are characterized by low P/E, low P/C or other value stock characteristics simply earn this higher average return as a consequence of adding risk. Ball & Kothari (1989) support this idea as the reason for higher returns and dismiss the notion that investors overreact. However, Lakonishok, Shleifer & Vishny (1994) find several value strategies that produce higher returns and no evidence of higher fundamental risk. This is consistent with our findings.

The paper proceeds as follows. The next section describes the theoretical concepts related to market efficiency and portfolio management. Section III provides details of data selection criteria and our methodology. In section IV, we present the results of time-series regressions for the investment strategies formed on P/E, P/D, P/C and five-year sales rank. We show that value stocks tend to outperform the market, and that the more sophisticated asset pricing models do a better job of explaining variability in average excess stock returns. The performance of the models is shown to vary across time periods. Section V provides further interpretation of the results on a conceptual level and proposes possible explanations for the documented market anomalies. We suggest that the phenomenon of value strategies outperforming the market is related to their nature as contrarian investment strategies and the preference of individual and institutional investors. Finally, section VI summarizes our findings.

# II. THEORY

## A. Market Efficiency

The primary role of capital markets is the allocation of the economy´s capital stock (Fama, 1970). In this context, an efficient market is a market where prices provide accurate signals for the allocation of resources and where investors and firms can make investment decisions under the assumption that prices fully reflect all available information.

Fama (1970) discusses both theoretical and empirical work on efficient markets. The empirical discussion is based on tests of market efficiency with regard to the adjustment of security prices to three relevant information subsets portraying weak-form, semi-strong form and strong-form levels of market efficiency. In weak-form market efficiency, security prices reflect solely historical prices. In semi-strong form market efficiency, security prices reflect all publicly available information. For strong-form market efficiency, security prices also reflect some investors having monopolistic access to any relevant information. Jensen (1978) provides a definition of market efficiency that encompasses the implications of the different information sets: "A market is efficient with respect to information set θ, if it is impossible to make economic profit by trading by trading on the basis of information set θ." In this context, economic profit is the risk-adjusted return net of all costs related to trading. Trading costs are mainly transaction costs and information acquisition costs. The definition by Jensen highlights the fact that markets are not frictionless and that trading costs can have a considerable impact on whether or not economic profit is attainable. If a market is efficient, security prices will adjust in such a way that trading costs exceed the implied benefit of exploiting mispricing.

The theory of efficient markets only has empirical validity in the context of a more specific model of market equilibrium that specifies the nature of market equilibrium when prices fully reflect available information (Fama, 1970). Empirical literature is based on the assumption that the conditions of market equilibrium can be stated in the terms of expected returns. This is the basis for expected return models, such as the

CAPM of Sharpe (1964) and Lintner (1965), the three-factor model of Fama and French (1993), and Carhart's (1997) four-factor model.

Furthermore, the theory is based on the assumptions that investors are rational in information processing and in decision-making. More specifically, this refers to updating expectations in accordance with the law of Bayes and making decisions in relation to ones subjective expected utility (Barberis & Thaler, 2003). With respect to this, market efficiency is partly based on agency theory. The assumptions are strict, and are not expected to be true in practice. However, from the view of efficient market hypothesis proponents, individual investors can be irrational as long as the market as a whole is rational. If the market is not rational and therefore not efficient, the efficient market hypothesis relies on the theory of arbitrage pricing to correct for mispricing in the market.

**B. Market anomalies**

Market anomalies, patterns in the returns of securities that are unexplained by asset pricing theory, are indicators of violations of the efficient market hypothesis. The efficient market hypothesis predicts that, in the case of a market anomaly, investors will arbitrage this opportunity, leading to an adjustment in prices and restored market efficiency. In this sense, it should not be possible to consistently earn abnormal returns by investing according to these patterns. Schwert (2003) supports this notion in finding evidence that such patterns diminish once they are identified. This is in contrast to the research of Basu (1977), Fama & French (1992) and Lakonishok, Shleifer & Vishny (1994), who indicate that some market anomalies seem to remain persistent.

Two possible reasons for the existence and persistence of market anomalies in previous research are data mining and data snooping (Fama, 1998 and Fama & French, 1996). Data mining refers to the discovery of market anomalies as the inevitable result of the massive amounts of research dedicated to finding unexplained patterns in stock prices. The patterns that are identified may be sample-specific and the result of statistical coincidence. The presence of data mining implicates that the results of research related to market anomalies should be closely evaluated and crosschecked by testing for different sample periods (Schwert, 2003). Data snooping refers to research where the coherence between the results and the aim is not a coincidence, but rather where the aim is determined after the unearthing of the results. This is a questionable manner of conducting research and leaves similar consequences for its validity as those of data mining.

Another factor rendering the interpretation of anomalies found by asset pricing models more complex is the joint-test problem. The problem states that any test of market efficiency is also a test of the explanatory power of the asset pricing model used (Fama, 1970). That is, if the models are not an accurate predictor of returns, separating the effects of standard errors in the model and the actual patterns in stock returns of the market anomaly will be difficult. Because there does not exist an asset pricing model that perfectly explains the returns of securities, such a consideration is a necessity for tests of market efficiency.

**C. Behavioral biases**

Behavioral finance is concerned with the psychological aspect of why investors behave in the manner they do. The field provides possible explanations of market anomalies that are not connected to asset pricing models, but rather to investor behavior. Two possible explanations relevant to our paper are the herd behavior bias and the availability bias.

Herd behavior refers to the concept that investors adopt their investment decisions to be in line with that of other investors, regardless of the information they themselves hold. This type of behavior stems from investors' fear of missing out – investors believe the investment decisions of others reflect information that they do not have access to and are therefore inclined to follow these other investors even when it is in conflict with their own information (Banerjee 1992). Additionally, herd behavior can be the product of institutional investors' preference to make investment decisions in line with the decisions of their peers in order to 'share the blame' should the results be poor (Scharfstein & Stein 1990). While an institutional investor may be blamed for poor results and possibly hurt his reputation if his investment decisions differ from the herd, he will not be ostracized if his poor results are the consequence of following the same trends as the his peers. Regardless of the reason for herd behavior, the phenomenon has implications for market efficiency. For example, positive feedback trading, a type of herd behavior that refers to investors investing when the market is bullish and disinvesting when the market is bearish, can result in an overreaction in stock prices by causing security prices to temporarily move away from their long-run value (De Long, Shleifer, Summers & Waldman, 1990). This provides a possible explanation for the momentum anomaly documented by Jegadeesh & Titman (1993).

Moreover, De Bondt & Thaler (1990) suggest that investors are subject to the availability bias found by Tversky & Kahneman (1973); that they have a tendency to overweight easily recallable information such as recent returns, while they underweight less recallable information such as long-term averages. This bias contributes to investor overreaction – investors overestimate the future performance of stocks with high prior returns, while underestimating stocks with low prior returns. This overreaction is evident in the mean reversion of stock prices (De Bondt & Thaler 1985) and serves as an explanation for why value stocks tend to outperform growth stocks.

**D. Portfolio management**

Portfolio management refers to the decision-making involved in maintaining an investment portfolio. There are two main approaches to portfolio management: active and passive. Passive portfolio management utilizes investment strategies that see the market as efficient. With such a view, any attempt to actively manage the portfolio is a wasted effort. Money managers that follow passive strategies construct portfolios that replicate the market index and follow a buy-and-hold approach. This way, they avoid the larger transaction costs and brokerage fees related to frequent trading. (Bodie, Kane & Marcus, 2008). Active portfolio management, on the other hand, rejects the efficient market hypothesis and attempts to profit from mispricing in the market. Active investment strategies are based on analysis of three types of data: (i) fundamental (ii) technical and (iii) market anomalies and security characteristics (Reilly & Brown, 2003).

Fundamental analysis involves a thorough evaluation of both quantitative and qualitative factors related to a security, such as financial reports and industry outlooks, to determine its intrinsic value. It may be performed by following either a ‘top-down’ or ‘bottom-up’ process. A top-down analysis begins with the evaluation of country-specific information and works its way down through asset and sector class allocation decisions to the specific selection of stocks. A bottom-up analysis starts with the selection of stocks without making any decisions regarding sector and asset class allocation. The type of analysis used depends on whether the active manager believes that particular individual stocks or larger parts of the market are mispriced.

Technical strategies, on the other hand, form portfolios on the basis of trends in past stock prices, under the assumption that these will continue or that they will reverse themselves. Contrarian investments are an example of technical strategies and are based on mean reversion in performance. The strategy involves buying (selling) stocks when the market is bearish (bullish) about them. In doing so, the investor aims to buy when the stocks are relatively underpriced and sell when they are relatively overpriced. The profit potential of contrarian strategies is founded in the overreaction hypothesis (De Bondt & Thaler, 1985). Because investors have a tendency to overestimate and extrapolate the future prospects of firms too far into the future, their expectations temporarily move prices away from their long-term values. This leads to profit for contrarian investors when these prices subsequently revert. On the other hand, a price momentum strategy, a technical strategy related to the findings of Jegadeesh & Titman (1993), assumes that the ongoing trends will continue in the future. Thus, the investor will invest in stocks that have performed well recently and sell those that have not performed well. Possible reasons for the success of this strategy are favorable real economic factors for companies and underreaction to new information by investors (Reilly & Brown, 2003).

Investment strategies based on market anomalies and security characteristics apply elements of both fundamental and technical analysis by linking security characteristics to patterns in stock returns. Investing in value stocks, stocks with low prices relative to measures of the firm’s fundamental value, is an example of this type of strategy.

# III. DATA AND METHODOLOGY

## A. Database & sample selection criteria

The data used in our analysis is gathered from the Center for Research of Security Prices (CRSP) and COMPUSTAT databases. Returns data, including stock prices and dividends, are collected from CRSP, while all firm accounting data is collected from COMPUSTAT. Our sample consists of industrial firms listed on Nasdaq, New York Stock Exchange (NYSE) and NYSE MKT, formerly known as the American Stock Exchange (AMEX). Given its long history under the AMEX name, we refer to NYSE MKT as AMEX for the remainder of this paper. We include only stocks with ordinary common equity; American Depositary Receipts (ADRs), Real Estate Investment Trusts (REITs) and units of beneficial interest are therefore excluded from our analysis. Based on Basu's (1977) method, we impose the following selection criteria for firms to be considered:

*For P/E, P/C & five-year sales rank:*

1. The fiscal-year end of the firm must be December 31st of year *t – 1*.
2. The firm must be listed on Nasdaq, NYSE or AMEX as of December 31st of year *t – 1*.
3. The stock must have a CRSP return for April of year *t*.
4. There must exist sufficient CRSP/COMPUSTAT data to calculate a valid variable value as per 31st December of year *t – 1*.

We impose the fiscal-year end criteria to ensure that the portfolio determinants (P/E, P/C and five-year sales rank) are based on accounting information from the same point in time and therefore comparable. While Basu (1977) restricts his analysis to NYSE firms, we follow Fama & French (1993) and Lakonishok, Shleifer & Vishny (1994) to include Nasdaq and AMEX firms as well. For our sample period, April 1963 – March 2014, a total of 9461 firms fulfill the P/E and P/C criteria for at least one year. The average number of firms meeting the criteria each year is 2131. A total of 6009 firms meet the five-year sales rank criteria for at least one year, with an average of 1385 firms fulfilling the criteria each year.

*For P/D:*

1. The fiscal-year end of the firm must be December 31st of year *t – 1*.
2. The firm must be listed on Nasdaq, NYSE or AMEX as of March 31st of year *t*.
3. The stock must have a CRSP return for April of year *t*.
4. There must exist sufficient CRSP/COMPUSTAT data to calculate a valid price-dividend value as per 31st March of year *t*.

The selection criteria for firms to be considered as part of the P/D portfolios differ slightly from the rest, in that firms must be listed on Nasdaq, NYSE or AMEX as of March 31st of year *t* rather than December 31st of year *t – 1*. We impose this changed criterion because P/D ratios are calculated as of March 31st rather than December 31st, in line with the method of Fama & French (1993). A total of 9537 firms fulfill these criteria for at least one year over the course of our sample period. The average number of firms that meet the criteria each year is 2186. For further details of the number of firms considered in our analysis, see appendix A.

**B. Portfolio construction**

We calculate P/E, P/C and five-year sales rank values as of December 31st year *t – 1* for each period. P/D values are calculated as of March 31st year *t*. For each period, firms are ranked by variable values and six portfolios of stocks are constructed accordingly. One portfolio (≤ 0) consists of all stocks with variable values of less than or equal to 0. The remaining five portfolios (Low, 1, 2, 3, High) are constructed based on quintiles of the stocks with positive variable values. The portfolios are purchased on April 1st year *t* and held until March 31st year *t + 1*.

April 1st is chosen as the investment date based on the assumption that investors do not have access to firms' earnings prior to the publication of their financial reports (Basu 1977). Like Basu (1977) and Lakonishok, Shleifer & Vishny (1994), we assume that firms have released their financial reports by April, and that investors will consequently have access to the accounting data needed to distinguish firms by the relevant variable on April 1st.

The monthly returns for each of the portfolios are calculated for the next twelve months, from April 1st year *t* to March 31st year *t + 1*. We repeat this procedure for each year of the time period April 1st 1963 to March 31st 2014, resulting in 612 months of data.

**C. Calculation of returns**

Monthly returns for each portfolio are calculated as the value-weighted return of the portfolio minus the one-month T-bill return. The monthly value-weighted return of the portfolio is calculated as

$$R_p = \sum_{i=1}^{N} \left[ r_i \frac{\text{Market equity}_\text{i}}{\text{Total market equity}_\text{p}} \right]$$

where $r_i$ is the monthly total return for firm *i*; *market equity*$_i$ is firm *i*'s stock price multiplied by outstanding shares as of the time of the portfolio's construction;
and *total market equity*$_p$ is the sum of market equity values of all firms in the portfolio at the time of construction.

Monthly total return for individual stocks is calculated as

$$r_i = \frac{P_i f_i + D_i}{P_{i-1}} - 1$$

where $P_i$ is the monthly close stock price of firm *i*; $f_i$ is the CRSP adjustment factor for firm *i* to account for distribution events such as stock splits; and $D_i$ is firm *i*'s dividend amount paid.

**D. Calculation of portfolio determinants**

D.1. Price-earnings

P/E is calculated for every period as the market value of common stock (stock price multiplied by number of shares outstanding) divided by earnings before extraordinary items available to common stockholders (earnings before extraordinary items minus interest, depreciation, taxes, and preferred dividends) as of December 31st year *t – 1* (Basu 1977).

$$\frac{\mathrm{P}}{\mathrm{E}} = \frac{\text{Market value of common stock}}{\text{Earnings before extraordinary items available to common stockholders}}$$

D.2. Price-dividends

P/D is calculated as the market value of common stock divided by common dividends issued in the previous twelve months as of March 31st year *t*.

$$\frac{\mathrm{P}}{\mathrm{D}} = \frac{\text{Market value of common stock}}{\text{Common dividends}}$$

D.3. Price-cash flow

P/C is calculated in line with Lakonishok, Shleifer & Vishny (1994) as the market value of common stock divided by cash flow (earnings before extraordinary items available to common stockholders plus depreciation) as of December 31st year *t – 1*.

$$\frac{\mathrm{P}}{\mathrm{C}} = \frac{\text{Market value of common stock}}{\text{Earnings before extraordinary items available to common stockholders+depreciation}}$$

D.4. Five-year sales rank

The firm's five-year sales rank is the weighted average of the annual sales growth ranks for the previous five years, as defined by Lakonishok, Shleifer & Vishny (1994).

$$\text{Five-year sales rank(t)} = \sum_{j=1}^{5} (6 - j) \times \mathrm{Rank}(t - j)$$

where *j* represents the number of years prior (*j* = 1 indicates one year prior, *j* = 2 indicates two years prior, etc.); and *Rank(t – j)* represents the annual sales growth rank of the firm in year (*t – j*). A low rank value indicates high relative growth, while a high rank value indicates low relative growth. Firms are ranked annually on their sales growth over the past year as calculated by

$$\ln\left[\frac{\text{Sales }(t-j)}{\text{Sales}(t-j-1)}\right]$$

The five-year sales rank is calculated only for firms with sales growth data for all five years, which leads to a smaller (though still large) number of observations than for the other variables.

**E. Models of performance measurement**

We apply three models to measure the performance of the portfolios: the CAPM, Fama & French's three-factor model and Carhart's four-factor model.

The CAPM is the one-factor model of Sharpe (1964) and Lintner (1965). The model relies on a market proxy's return over the risk-free return in relation to a firm's systematic risk, its beta, to explain average returns. We estimate portfolio returns relative to the CAPM as

$$r_i = \alpha_i + \beta_i VWRF + e_i$$

where $r_i$ is the total monthly return on portfolio $i$ in excess of the one-month T-bill rate; and $VWRF$ is the return on the CRSP value-weighted portfolio all Nasdaq, NYSE and AMEX stocks in excess of the one-month T-bill return.

The three-factor model developed by Fama and French (1993) includes two additional factors related to size and book-to-market equity values of firms to increase explanatory power. These factors are (i) SMB (small minus big), the difference between returns of a portfolio of stocks with small market equity and a portfolio of stocks with large market equity and (ii) HML (high minus low), the difference between returns of a portfolio of stocks with high book-to-market equity and a portfolio of stocks with low book-to-market equity. We estimate portfolio returns relative to the three-factor model as

$$r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$$

where *RMRF* is the excess return on Fama and French's value-weighted aggregate U.S. market proxy; *SMB* is the return on Fama and French's zero-investment factor-mimicking portfolios for size, constructed by computing the value-weighted returns of stocks with the smallest 30 percent market equity minus the value-weighted returns of stocks with the largest 30 percent market equity; and *HML* is the return on Fama and French's zero-investment factor-mimicking portfolios for book-to-market equity, constructed by computing the value-weighted returns of stocks with the 30 percent highest book-to-market equity minus the value-weighted returns of stocks with the 30 percent lowest book-to-market equity.

The final model of performance measurement we apply is Carhart's (1997) four-factor model. This model adds the momentum factor identified by Jegadeesh and Titman (1993) to the three-factor model to account for a one-year momentum anomaly in returns for high- and low-performing stocks. We estimate portfolio returns relative to the four-factor model as

$$r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$$

where *PR1YR* is the return on zero-investment factor-mimicking portfolios for momentum, constructed by computing the value-weighted returns of stocks with the highest 30 percent eleven-month returns lagged one month minus the value-weighted returns of stocks with the lowest 30 percent eleven-month returns lagged one month.

We perform ordinary least squares regressions to estimate these equations for each portfolio. We interpret α as the abnormal return of the portfolio. The factor loadings $\beta_i$, $s_i$, $h_i$ and $p_i$ represent the coefficients of the common risk factors of the models.

Table I shows summary statistics for the factor-mimicking portfolios. We find relatively low correlation between the SMB, HML and PR1YR factors, and between these factors and the market proxies. This suggests that multicolinearity does not affect the models to a large degree. Furthermore, high means in all the factor portfolios indicate that they do well in explaining time-series variability in average returns.

**Table I**

**Summary Statistics for Models of Performance Measurement Factor-Mimicking Portfolios: 4/63-3/14, 612 months**

VWRF is the value-weight stock index of the Center of Research in Security Prices (CRSP) minus the one-month T-bill rate. RMRF is the excess return on Fama & French´s aggregate market proxy. SMB and HML are Fama & French´s factor-mimicking portfolios for size and book-to-market equity. PR1YR is a factor-mimicking portfolio for eleven-month return momentum lagged one-month. For each factor-mimicking portfolio, the table shows the mean monthly return in excess of the one-month T-bill rate (Mean), the standard deviation of the monthly excess returns (Std. Dev.), and the ratio of the mean excess return to its standard error [t(mean) = Mean/(Std. Dev./$612^{1/2}$)]. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

| | | | | Cross-Correlations | | | | |
|---|---|---|---|---|---|---|---|---|
| Factor-Mimicking Portfolio | Mean | Std. Dev. | t(Mean) | VWRF | RMRF | SMB | HML | PR1YR |
| VWRF | 0.51 | 4.48 | 2.79 | 1.00 | | | | |
| RMRF | 0.52 | 4.45 | 2.87 | 1.00** | 1.00 | | | |
| SMB | 0.27 | 2.96 | 2.25 | 0.34** | 0.33** | 1.00 | | |
| HML | 0.32 | 3.21 | 2.44 | -0.17** | -0.17** | -0.14** | 1.00 | |
| PR1YR | 0.70 | 4.23 | 4.06 | -0.13** | -0.13** | -0.09* | -0.49** | 1.00 |

# IV. RESULTS

**A. Portfolios formed on P/E**

As shown in table II, the portfolios formed on P/E demonstrate large variation in mean excess return. Post-formation monthly excess returns decrease almost monotonically from the 'Low' portfolio to the 'High' portfolio. This constitutes a pattern in line with the one documented by Jaffe, Keim & Westerfield (1989). The extreme portfolios ('Low' and 'High') exhibit a spread of 51 basis points (bp). The higher average mean excess return is not accompanied by an increase in volatility, as variance in returns for both the 'High' and 'Low' portfolios are similar. Furthermore, the summary statistics indicate that the 'Low' portfolio consists of firms with smaller average market equity than any other positive P/E portfolio.

Based on CAPM regressions, we estimate the two lowest positive P/E portfolios ('Low' and '1') to have significant abnormal returns at the 1 percent level of 42 bp and 33 bp, respectively (see table III). However, it seems that the CAPM is not able to explain the returns of portfolios formed on P/E. This is evident in the generally small differences in the market proxy coefficient (β) and the large differences in alphas (α) and average excess returns. The beta represents systematic risk, and classic portfolio theory suggests that higher systematic risk should be rewarded with higher expected returns. The regression results show that the betas of the different P/E portfolios lie close to 1.0 and are in some cases equal to each other. Portfolios with the same beta should be expected to achieve the same return within the model. Our results are evidence that this is not the case. This implies that the CAPM does not capture all the cross-sectional variability in excess returns of the P/E portfolios and thus supports the findings of Basu (1983).

Similarly, for regressions of the three-factor model, we find that both the 'Low' and '1' portfolios have positive abnormal returns, of 22 bp and 19 bp, significant at the 5 percent level and 1 percent level, respectively. The three-factor model appears, however, to do a better job of explaining returns and measuring performance of the P/E portfolios due to the introduction of the SMB and HML factors. Both of these factors have substantial explanatory power, as coefficients are largely significant and

**Table II**

**Summary Statistics for Monthly Excess Returns (in Percent) on the P/E, P/D, P/C and Five-Year Sales Rank Value-Weighted Portfolios: 4/63-3/14, 612 months**

Portfolios are formed on April 1st of year *t*, 1963 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-earnings (P/E), price-dividends (P/D), price-cash flow (P/C) and five-year sales rank of firms with positive values. Stocks of firms with negative values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 612 months, from April 1963 to March 2014. P/E is the market value (stock price times number of shares outstanding) of common stock on December 31st year *t – 1* divided by earnings before extraordinary income available to common stockholders for the fiscal year *t – 1*. P/D is the market value of common stock on March 31st year *t* divided by common dividends issued in the previous 12 months as of March 31st year *t*. P/C is the market value of common stocks on December 31st year *t – 1* divided by earnings before extraordinary income available to common stockholders plus depreciation for the fiscal year *t – 1*. Five-year sales rank is the weighted average of the firm's past five years' annual sales growth rank as defined by

$$\text{Five-year sales rank(t)} = \sum_{j=1}^{5} (6 - j) \times \text{Rank}(t - j)$$

where *j* represents the number of years prior (*j* = 1 indicates one year prior, *j* = 2 indicates two years prior, etc.); and *Rank(t – j)* represents the annual sales growth rank of the firm in year (*t – j)* where rank 1 is given to the firm with the highest sales growth. Sales growth is calculated as $\ln \left[\frac{\text{Sales }(t-j)}{\text{Sales}(t-j-1)}\right]$.

The table shows mean monthly return in excess of the one-month T-bill rate (Mean), the standard deviation of the monthly excess returns (Std. Dev.), the ratio of the mean excess return to its standard error [t(mean) = Mean/(Std. Dev./$612^{1/2}$)] and the average market equity (in $ millions) of firms for each portfolio, averaged across the 612 sample months.

| | Portfolio | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **P/E** | | | |
| Mean | 0.95 | 0.91 | 0.76 | 0.55 | 0.57 | 0.40 |
| Std. Dev. | 7.91 | 5.05 | 4.41 | 4.25 | 4.41 | 5.17 |
| t(Mean) | 2.97 | 4.44 | 4.29 | 3.18 | 3.18 | 1.92 |
| Avg. ME | 459.29 | 1885.91 | 2284.61 | 2648.41 | 2736.32 | 2071.01 |
| | | | **P/D** | | | |
| Mean | 0.66 | 0.58 | 0.54 | 0.52 | 0.59 | 0.63 |
| Std. Dev. | 6.82 | 3.99 | 4.48 | 4.89 | 5.19 | 5.66 |
| t(Mean) | 2.39 | 3.62 | 2.97 | 2.65 | 2.81 | 2.77 |
| Avg. ME | 669.13 | 1299.07 | 1449.18 | 2212.27 | 3622.55 | 5901.14 |
| | | | **P/C** | | | |
| Mean | 0.88 | 0.92 | 0.70 | 0.56 | 0.52 | 0.38 |
| Std. Dev. | 9.18 | 4.65 | 4.43 | 4.37 | 4.59 | 5.23 |
| t(Mean) | 2.38 | 4.91 | 3.90 | 3.17 | 2.78 | 1.79 |
| Avg. ME | 317.73 | 1959.57 | 2345.18 | 2335.37 | 2251.04 | 2104.35 |
| | | | **Five-Year Sales Rank** | | | |
| Mean | | 0.49 | 0.59 | 0.43 | 0.60 | 0.81 |
| Std. Dev. | | 5.13 | 4.55 | 4.30 | 4.41 | 4.53 |
| t(Mean) | | 2.37 | 3.20 | 2.50 | 3.36 | 4.45 |
| Avg. ME | | 2598.70 | 2639.95 | 2920.78 | 2484.73 | 1674.95 |

range from 0.88 to -0.13 and from 0.47 to -0.05, respectively. The introduction of the new market factors results in the alphas for all portfolios moving towards zero. This is an indication of a better performance measurement model, as the theoretical result of regression on the model predicts an alpha of zero for all portfolios. It is also shown in increasing R-squared for all portfolios except the 'High' portfolio, where it remains constant at 0.86. Coefficients on the HML factor are in line with Fama and French (1993), with the highest coefficient for the 'Low' portfolio (0.47) and a negative coefficient (-0.05) for the 'High' portfolio. Low P/E portfolios tend to produce similar HML coefficients to those of high BE/ME portfolios and vice versa, since both of these ratios characterize some of the same fundamental relationships on stocks (Fama and French, 1992 & 1993). Both low P/E and high BE/ME are characteristics of value stocks, while high P/E and low BE/ME are characteristics of growth stocks. Since HML coefficients predict the value of the BE/ME for securities and portfolios, our coefficients support the notion of characterizing the 'Low' and 'High' portfolios as portfolios of value and growth stocks, respectively. Fama & French (1993) suggest that value stocks earn a high average return that are associated with stocks in distress that have typically fallen out of favor in the market, while growth stocks have high earnings on book equity that lead to higher prices relative to book equity, and a low average return. Our results support this, as both average monthly excess returns (see Table II) and alphas (see Table III) decrease from the 'Low' portfolio to the 'High' portfolio.

The addition of the momentum factor in the four-factor model does not seem to greatly increase explanatory power. Our four-factor regressions estimate an abnormal return of 20 bp significant at the 5 percent level for the 'Low' portfolio. This is in line with the CAPM and three-factor model regressions and suggests that the 'Low' portfolio indeed outperforms the market.

Breaking our analysis up into two subperiods, we find differences in the performance of the three-factor model over the July 1963 – December 1991 period, which was analyzed by Fama and French (1993), and the later January 1992 – March 2014

**Table III**

## Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Earnings: 4/63-3/14, 612 Months

Portfolios are formed on April 1st of year *t*, 1963 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-earnings (P/E) of firms with positive values. Stocks of firms with negative P/E values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 612 months, from April 1963 to March 2014. P/E is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year *t – 1* divided by earnings before extraordinary income available to common stockholders for the fiscal year *t – 1*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/E | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | 0.23 | 0.42** | 0.33** | 0.11 | 0.10 | -0.14 |
| | (1.21) | (3.92) | (3.85) | (1.55) | (1.58) | (-1.77) |
| β | 1.42 | 0.96 | 0.87 | 0.87 | 0.92 | 1.07 |
| | (33.22) | (40.30) | (46.11) | (54.78) | (64.31) | (61.40) |
| $R^2$ | 0.64 | 0.73 | 0.78 | 0.83 | 0.87 | 0.86 |
| | | | **Three-factor model** | | | |
| α | -0.05 | 0.22* | 0.19** | 0.04 | 0.08 | -0.13 |
| | (-0.33) | (2.38) | (2.60) | (0.62) | (1.34) | (-1.57) |
| β | 1.27 | 1.00 | 0.93 | 0.92 | 0.96 | 1.08 |
| | (32.79) | (46.42) | (55.43) | (60.95) | (65.35) | (56.85) |
| s | 0.88 | 0.08 | -0.05 | -0.13 | -0.13 | -0.05 |
| | (15.19) | (2.55) | (-2.17) | (-5.84) | (-5.96) | (-1.89) |
| h | 0.35 | 0.47 | 0.36 | 0.21 | 0.07 | -0.05 |
| | (6.74) | (16.47) | (16.40) | (10.40) | (3.55) | (1.83) |
| $R^2$ | 0.75 | 0.81 | 0.85 | 0.87 | 0.88 | 0.86 |
| | | | **Four-factor model** | | | |
| α | 0.14 | 0.20* | 0.14 | 0.06 | 0.12 | 0.05 |
| | (0.81) | (2.11) | (1.88) | (0.82) | (1.89) | (0.62) |
| β | 1.24 | 1.01 | 0.94 | 0.92 | 0.95 | 1.05 |
| | (31.67) | (45.54) | (54.91) | (59.48) | (63.73) | (56.78) |
| s | 0.85 | 0.09 | -0.05 | -0.14 | -0.14 | -0.08 |
| | (14.80) | (2.60) | (-1.90) | (-5.89) | (-6.19) | (-2.90) |
| h | 0.22 | 0.48 | 0.40 | 0.20 | 0.04 | -0.16 |
| | (3.65) | (14.28) | (15.14) | (8.38) | (1.88) | (-5.80) |
| p | -0.18 | 0.02 | 0.04 | -0.01 | -0.04 | -0.17 |
| | (-4.04) | (0.61) | (2.24) | (-0.81) | (-2.16) | (-7.87) |
| $R^2$ | 0.75 | 0.81 | 0.85 | 0.87 | 0.88 | 0.87 |

period (see appendix B). The model seems to do a considerably better job of explaining returns in the earlier period, and we find no significant abnormal returns for any of the portfolios during this time. This is consistent with the findings of Fama and French (1993). For the later period, however, the model indicates significant abnormal returns for several portfolios. Conversely, the four-factor model finds no significant abnormal returns for any of the portfolios at the 5 percent level for either of the periods. This suggests that the four-factor model has greater explanatory power than the three-factor model for the later period. It also indicates that the three-factor model does a good job of explaining variability in excess returns for the earlier time period analyzed by Fama and French (1993), but that this high level of performance is sample-specific.

**B. Portfolios formed on P/D**

The mean excess returns for portfolios formed on P/D indicate a weak 'V' pattern - the largest mean excess returns are found in the zero-dividend and high P/D portfolios and the smallest mean excess returns are found in portfolios '1' and '2' (see Table II). This is in contrast to the distribution pattern documented by Keim (1985). Keim finds the zero-dividend and low P/D portfolios to have high mean excess returns while the remaining portfolios have low excess returns distributed rather evenly. We find mean risk-adjusted returns to be highest for the 'Low' portfolio and lowest for the zero-dividend portfolio. Spreads in returns are lower than for portfolios formed on P/E, P/C or sales rank.

Table IV shows that for regressions performed on the CAPM, the 'Low' portfolio has an abnormal return of 17 bp, significant at the 1 percent level. The CAPM is therefore not able to explain variability in average excess returns. As with the portfolios performed on P/E, we do not find coherence with the classic theoretical relationship between beta and expected return. There is no indication of any tax penalty on stocks that pay higher dividends in the pattern of alphas, in contrast to Keim (1985). He finds alphas to be monotonically decreasing from the 'Low' P/D portfolio to the 'High' P/D portfolio and argues that higher returns for high-dividend paying stocks adjust for differential taxation of dividends and capital gains. Our contrasting results suggest that this is not the case.

## Table IV

## Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Dividends: 4/63-3/14, 612 Months

Portfolios are formed on April 1st of year *t*, 1963 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-dividends (P/D) of firms with positive values. Stocks of firms with zero dividends are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 612 months, from April 1963 to March 2014. P/D is the market value (stock price times number of shares outstanding) of common stock on March 31st year *t* divided by common dividends issued in the previous 12 months as of March 31st year *t*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha ($\alpha$), the coefficient for the market proxy ($\beta$), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/D | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | -0.04 | 0.17** | 0.07 | 0.01 | 0.04 | 0.05 |
| | (-0.37) | (2.65) | (1.02) | (0.17) | (0.53) | (0.54) |
| β | 1.39 | 0.82 | 0.92 | 1.01 | 1.09 | 1.16 |
| | (54.46) | (57.21) | (59.42) | (60.31) | (69.21) | (55.81) |
| $R^2$ | 0.83 | 0.84 | 0.85 | 0.86 | 0.89 | 0.84 |
| | | | **Three-factor model** | | | |
| α | -0.13 | 0.13** | 0.02 | -0.05 | -0.01 | -0.03 |
| | (-1.37) | (2.62) | (0.34) | (-0.64) | (-0.12) | (-0.27) |
| β | 1.25 | 0.90 | 1.00 | 1.06 | 1.09 | 1.11 |
| | (56.18) | (74.50) | (69.62) | (63.24) | (63.06) | (51.34) |
| s | 0.61 | -0.27 | -0.21 | -0.13 | 0.06 | 0.25 |
| | (18.50) | (-14.79) | (-9.56) | (-5.31) | (2.30) | (7.80) |
| h | -0.07 | 0.18 | 0.19 | 0.18 | 0.06 | 0.06 |
| | (-2.32) | (11.01) | (9.73) | (7.89) | (2.76) | (2.03) |
| $R^2$ | 0.89 | 0.90 | 0.89 | 0.87 | 0.88 | 0.85 |
| | | | **Four-factor model** | | | |
| α | 0.10 | 0.10 | 0.07 | 0.02 | 0.09 | 0.04 |
| | (1.09) | (1.87) | (1.10) | (0.29) | (1.15) | (0.46) |
| β | 1.21 | 0.90 | 0.99 | 1.05 | 1.07 | 1.10 |
| | (56.61) | (73.67) | (67.96) | (61.74) | (61.79) | (49.97) |
| s | 0.58 | -0.26 | -0.21 | -0.14 | 0.05 | 0.24 |
| | (18.46) | (-14.46) | (-9.87) | (-5.70) | (1.78) | (7.48) |
| h | -0.22 | 0.20 | 0.15 | 0.13 | -0.00 | 0.01 |
| | (-6.81) | (10.61) | (6.83) | (5.01) | (-0.02) | (0.36) |
| p | -0.22 | 0.03 | -0.05 | -0.06 | -0.09 | -0.07 |
| | (-8.89) | (2.33) | (-2.76) | (-3.26) | (-4.52) | (-2.57) |
| $R^2$ | 0.90 | 0.90 | 0.89 | 0.88 | 0.89 | 0.85 |

The three-factor regressions generally explain variability in mean excess return for the portfolios formed on P/D well. However, we find the 'Low' portfolio to have abnormal returns of 13 bp, significant at the 1 percent level and thus unexplained by the three-factor model. Although coefficients for HML are as not high for the low P/D portfolio as for the low P/E portfolio, there is evidence that the low P/D portfolio also represents a value strategy; relatively high dividends are a characteristic of value stocks that earn the high return associated with relative distress (Fama & French, 1993).

The four-factor model explains the variability in the average excess returns for our portfolios formed on P/D. All alphas are practically and statistically close to zero, within 10 bp of 0. Thus, the regressions provide evidence of the existence of the four common risk factors and their ability to capture the cross-section of average excess returns.

As with portfolios formed on P/E, we find that the three-factor model seems to perform better in explaining returns for July 1963 – December 1991 than the later January 1992 – March 2014 period (see appendix C). The regressions show no significant abnormal returns for the first period. In the later period, however, the model leaves significant abnormal returns of the 'Low' portfolio. Again, these results indicate that the high level of explanatory power of the three-factor model is sample-specific. The four-factor model, on the other hand, performs better and is able to explain the variability in mean excess returns for this later period with its additional momentum factor.

**C. Portfolios formed on P/C**

Portfolios formed on P/C show a similar distribution of average excess return to that of the P/E portfolios: risk-adjusted returns increase from the negative P/C portfolio to the lowest P/C portfolio and then decrease monotonically across the positive P/C portfolios (see table II). Both the distribution pattern and the overall spread in returns are stronger than the ones demonstrated by the P/E portfolios and are consistent with the findings of Lakonishok, Shleifer & Vishny (1994).

**Table V**

## Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Cash flow: 4/63-3/14, 612 Months

Portfolios are formed on April 1st of year *t*, 1963 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-cash flow (P/C) of firms with positive values. Stocks of firms with negative P/C values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 612 months, from April 1963 to March 2014. P/C is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year *t – 1* divided by earnings before extraordinary income available to common stockholders + depreciation for the fiscal year *t – 1*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios on P/C | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | 0.12 | 0.47** | 0.25** | 0.11 | 0.03 | -0.16 |
| | (0.46) | (4.90) | (3.15) | (1.53) | (0.43) | (-1.94) |
| β | 1.52 | 0.89 | 0.89 | 0.90 | 0.97 | 1.07 |
| | (27.30) | (41.87) | (50.97) | (58.25) | (70.13) | (57.14) |
| $R^2$ | 0.55 | 0.74 | 0.81 | 0.85 | 0.89 | 0.84 |
| | | | **Three-factor model** | | | |
| α | -0.18 | 0.30** | 0.12 | 0.04 | 0.00 | -0.14 |
| | (-0.84) | (3.53) | (1.91) | (0.60) | (-0.01) | (-1.65) |
| β | 1.29 | 0.93 | 0.96 | 0.95 | 1.01 | 1.06 |
| | (25.52) | (47.09) | (62.25) | (61.83) | (71.58) | (52.31) |
| s | 1.20 | 0.07 | -0.10 | -0.09 | -0.12 | 0.00 |
| | (15.79) | (2.48) | (-4.42) | (-3.78) | (-5.63) | (0.05) |
| h | 0.24 | 0.41 | 0.34 | 0.18 | 0.09 | -0.09 |
| | (3.50) | (15.65) | (16.55) | (8.95) | (4.56) | (-3.33) |
| $R^2$ | 0.68 | 0.81 | 0.87 | 0.87 | 0.90 | 0.84 |
| | | | **Four-factor model** | | | |
| α | 0.14 | 0.24** | 0.10 | 0.06 | 0.10 | 0.06 |
| | (0.65) | (2.72) | (1.51) | (0.88) | (1.62) | (0.71) |
| β | 1.24 | 0.94 | 0.96 | 0.94 | 0.99 | 1.03 |
| | (24.46) | (46.79) | (61.19) | (60.31) | (70.75) | (52.40) |
| s | 1.15 | 0.08 | -0.10 | -0.09 | -0.13 | -0.03 |
| | (15.39) | (2.76) | (-4.25) | (-3.89) | (-6.43) | (-0.96) |
| h | 0.02 | 0.45 | 0.35 | 0.17 | 0.02 | -0.23 |
| | (0.24) | (14.62) | (14.65) | (7.01) | (0.88) | (-7.51) |
| p | -0.31 | 0.06 | 0.02 | -0.02 | -0.09 | -0.19 |
| | (-5.27) | (2.45) | (1.15) | (-1.08) | (-5.82) | (-8.53) |
| $R^2$ | 0.69 | 0.81 | 0.87 | 0.87 | 0.91 | 0.86 |

Based on the CAPM regressions shown in table V, we document the two lowest positive P/C portfolios (portfolios 'Low' and '1') to have abnormal returns significant at the 1 percent level of 47 bp and 25 bp, respectively. These findings are similar to that of the P/E portfolio. The CAPM does not seem to capture the differences in average excess returns for the portfolios formed on P/C - betas are close to 1 and similar for most portfolios, while mean excess returns and alphas for the positive portfolios decrease monotonically from the 'Low' portfolio to the 'High' portfolio.

The three-factor model seems to do a better job of explaining variability in average excess returns for portfolios formed on P/C. As with the CAPM regressions, we find positive abnormal returns significant at the 1 percent level for the 'Low' portfolio, of 30 bp. However, the three-factor alphas approach zero for all positive portfolios and t-statistics decrease. The book-to-market factor HML appears to be the main reason for the shift in alphas towards zero for these portfolios. HML coefficients are large for the 'Low' portfolio and negative for the 'High' portfolio. Again, the distribution of HML coefficients is in line with the findings of Fama and French (1993). Differences in average excess returns of the portfolios are supported by the classification of value and growth stocks, where value stocks (low P/C and high BE/ME) have the highest average excess returns while growth stocks (high P/C and low BE/ME) have the lowest average excess returns.

Using the four-factor model, we again find the 'Low' portfolio to have an abnormal return (24 bp) significant at the 1 percent level. The four-factor model appears to have more slightly more explanatory power than the three-factor model; all positive portfolios except the 'Low' portfolio have alphas within 10 bp of 0 (t-statistics vary from 0.65 to 1.62). Momentum coefficients are monotonically decreasing from the lowest P/C portfolio to the highest P/C portfolio. This corresponds with the pattern of average excess returns seen in table II.

As with portfolios formed on P/E and P/D, we find that the three-factor model seems to do a better job of explaining returns for the July 1963 – December 1991 period than the later January 1992 – March 2014 period (see appendix D). For the first period, we find no significant abnormal returns. For the second period, however, the model estimates significant abnormal returns of 38 bp for the 'Low' portfolio. Again, the four-factor model seems to have greater explanatory power for the second period and is able to explain the variability in mean excess returns.

**D. Portfolios formed on five-year sales rank**

We find large variation in the mean excess returns between the portfolio consisting of firms with high five-year sales ranks and the portfolio of firms with low five-year sales ranks, though we distinguish no clear pattern of distribution (see table II). The 'High' portfolio has the highest mean excess return, as well as the smallest average market equity of firms. This is in line with the size effect documented by Banz (1981).

In the CAPM regressions, we find the 'High' and '3' portfolios to have positive abnormal returns of 36 and 14 bp per month, significant at 1 percent and 5 percent levels, respectively (see table VI). As with the previous portfolios, we find sizeable variation in mean excess returns, but smaller variation in betas, indicating that the betas do not account for the differences in returns. This violates the risk-return relationship of classic portfolio theory, and suggests that the CAPM regressions do not capture variability in returns of portfolios formed on past five-year sales rank.

For three-factor regressions, we find only the 'High' portfolio to have positive abnormal returns (22 bp), significant at the 1 percent level. The model seems to do a better job of explaining returns than its one-factor counterpart, evident in the significance of the size and book-to-market factors for most portfolios, a general increase in R-squared values and smaller alphas. It fails, however, to explain the mean excess returns of the 'High' portfolio. HML coefficients for the portfolios are monotonically decreasing from the 'High' portfolio to the 'Low' portfolio. The highly positive HML coefficient for the 'High' portfolio is in line with previous results for our other portfolios. As described, this is a characteristic of value stocks. Further evidence of the 'High' portfolio representing value stocks is shown in the low average market equity of the portfolio (see table II).

We find that the addition of the momentum factor does not lead to great improvement

## Table VI

## Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Five-Year Sales Rank: 4/63-3/14, 612 Months

Portfolios are formed on April 1st of year *t*, 1963 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for five-year sales rank of firms. Value-weighted returns for portfolios are calculated for 612 months, from April 1963 to March 2014. Five-year sales rank is the weighted average of the firm's past five years' annual sales growth rank as defined by

$$\text{Five-year sales rank(t)} = \sum_{j=1}^{5} (6-j) \times \text{Rank}(t-j)$$

where $j$ represents the number of years prior ($j$ = 1 indicates one year prior, $j$ = 2 indicates two years prior, etc.); and $Rank(t-j)$ represents the annual sales growth rank of the firm in year $(t-j)$ where rank 1 is given to the firm with the highest sales growth. Sales growth is calculated as ln $\left[\frac{\text{Sales}\,(t-j)}{\text{Sales}(t-j-1)}\right]$.

The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on five-year sales rank | | | | |
|---|---|---|---|---|---|
| | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | |
| α | -0.05 | 0.11 | -0.01 | 0.14* | 0.36** |
| | (-0.59) | (1.65) | (-0.16) | (2.02) | (4.34) |
| β | 1.06 | 0.95 | 0.88 | 0.91 | 0.90 |
| | (61.63) | (63.75) | (57.94) | (59.00) | (49.34) |
| $R^2$ | 0.86 | 0.87 | 0.85 | 0.85 | 0.80 |
| | | | **Three-factor model** | | |
| α | -0.05 | 0.10 | -0.06 | 0.05 | 0.22** |
| | (-0.60) | (1.60) | (-1.01) | (0.85) | (3.01) |
| β | 1.07 | 1.01 | 0.97 | 0.98 | 0.94 |
| | (56.86) | (69.26) | (74.06) | (72.50) | (55.65) |
| *s* | -0.04 | -0.21 | -0.26 | -0.14 | 0.03 |
| | (-1.43) | (-9.81) | (-13.04) | (-7.09) | (1.08) |
| *h* | -0.01 | 0.09 | 0.19 | 0.27 | 0.33 |
| | (-0.38) | (4.45) | (10.90) | (14.83) | (14.69) |
| $R^2$ | 0.86 | 0.89 | 0.90 | 0.90 | 0.85 |
| | | | **Four-factor model** | | |
| α | 0.11 | 0.12 | -0.01 | 0.11 | 0.19* |
| | (1.36) | (1.82) | (-0.21) | (1.78) | (2.47) |
| β | 1.05 | 1.01 | 0.96 | 0.97 | 0.95 |
| | (56.40) | (67.60) | (72.33) | (70.90) | (54.84) |
| *s* | -0.06 | -0.22 | -0.26 | -0.15 | 0.03 |
| | (-2.31) | (-9.86) | (-13.35) | (-7.50) | (1.25) |
| *h* | -0.12 | 0.07 | 0.16 | 0.23 | 0.35 |
| | (-4.06) | (3.24) | (7.83) | (10.87) | (13.26) |
| *p* | -0.15 | -0.02 | -0.04 | -0.05 | 0.03 |
| | (-7.01) | (-1.01) | (-2.74) | (-3.41) | (1.50) |
| $R^2$ | 0.87 | 0.89 | 0.90 | 0.90 | 0.85 |

in the general explanation of variability in mean excess returns. However, the four-factor model seems to do a slightly better job of explaining returns for the ‘High’ portfolio than the other two models. Using this model, we estimate significant abnormal returns of the ‘High’ portfolio of 19 bp at a 5 percent level.

All three regressions estimate positive abnormal returns significant at either a 1 percent or 5 percent level for the ‘High’ portfolio. The combination of market proxy, size, book-to-market equity and momentum factors cannot explain the variability in mean excess returns, which suggests that there exists a market anomaly. Furthermore, we suspect that this anomaly is the product of a more recent period. We find that neither regressions done with the three-factor nor the four-factor model for July 1963 - December 1991 estimate significant abnormal returns for the ‘High’ portfolio (see appendix E). In the later period January 1992 – March 2014, however, we find that regressions on both models, as well as CAPM, estimate abnormal returns of 24 to 38 bp, significant at the 1 percent level for CAPM and the three-factor model, and at 5 percent for the four-factor model. In contrast to portfolios formed on P/E, P/D and P/C, this represents the only mean excess returns not explained by the four-factor model for this period. This indicates that the anomaly is a relatively recent development that cannot be attributed to the momentum effect.

## V. INTERPRETATION OF RESULTS

Our results indicate that value stocks outperform the market for portfolios formed on P/E, P/C and five-year sales rank in the April 1963 – March 2014 period. As shown in tables III, V & VI, we find this to hold for three models of performance measurement with increasing levels of complexity. The anomalies support the findings of Basu (1977) and Lakonishok, Shleifer and Vishny (1994), but stand in contrast to Fama and French (1993 & 1996). Moreover, the results suggest that the market is not efficient. We believe that the main explanation for this stems from the relative overestimation of growth stocks and relative underestimation of value stocks. Investors seem to inaccurately extrapolate past growth too far into the future, expecting strong past growth of growth stocks and poor past growth of value stocks to continue. This is inconsistent with the tendency of mean reversion in growth, which is supported by our results. Furthermore, the risk-return profiles of the portfolios documented in table II act as empirical evidence against the traditional theoretical relationship between risk and return. Unlike the theoretical concept, we do not find portfolios with higher risk to be compensated with higher average returns.

Another possible explanation for our results is that both individual and institutional investors have a preference for growth stocks over value stocks (Lakonishok, Shleifer and Vishny 1994). Individual investors have a preference for growth stocks because they 'look' better. We find value stocks to have relatively low market equity (see table II) and investors may therefore be less familiar with them. Growth stocks, on the other hand, are typically stocks of firms with strong reputations and strong past performance that appear to be relatively good investments, and may therefore seem more attractive than their value stock counterparts. However, these types of stocks tend to be overvalued because of the herd behavior bias, which leads investors to irrationally flock to the stock (De Long, Shleifer, Summers & Waldman, 1990). For example, on the basis of an investment tip from advisors or analysts who recommend these types of stocks. Despite being aware of the higher mean excess returns of value stocks that we document, institutional investors have incentives to create portfolios consisting of growth stocks (Lakonishok, Shleifer, Vishny, 1994). The selection of growth stocks is easier to justify, even if they result in losses, because the stocks have had strong past performance. On the other hand, it is less appealing for these investors to include value stocks in their portfolios. In the event of a loss, a client may be unsatisfied with any explanation for why their funds were placed into the stocks of financially distressed firms. Investing in value stocks could, in this case, result in the risk of both losing clients and hurting career aspirations, and is therefore a less attractive option.

Black (1993) argues that most market anomalies are the product of data mining and tend to disappear quickly after their discovery. This begs the question why the anomalies we have found, and which others have found decades prior to us and in numerous markets, still exist. We suspect that it is because the technology required to recognize these patterns on a large scale has not been commonly available historically (Lakonishok, Shleifer & Vishny, 1994). This is supported by our findings of the January 1992 – March 2014 (see appendix B - E) period, where the four-factor model renders alphas close to zero and insignificant for all but one value strategy. The remaining anomaly that persists in the later period is that of portfolios formed on high five-year sales rank (see appendix E). We believe this anomaly remains because investors less accurately extrapolate growth into the future when the criteria for forming portfolios are the past growth rates of sales than for other variables such as P/E and P/C, despite the mean reverting characteristics of growth.

As we document in tables III to VI, the more sophisticated models have more explanatory power in the variability of average monthly returns. The three-factor model greatly improves upon the CAPM in explaining market anomalies, and the four-factor model generally improves upon the three-factor model. As Fama and French (1996) point out, this is not surprising since the factors aimed at explaining size, book-to-market equity and momentum anomalies do so for the same time period in which these anomalies have been documented. Black (1993) suggests that the massive amounts of work by thousands of researchers related to finding profitable investment strategies using roughly the same data inevitably results in the discovery of market anomalies. The anomalies may therefore be specific to the sample in question and may not be present out-of-sample. Our results provide evidence in support of this. In analyzing both the July 1963 – December 1991 period studied by Fama and French (1993) and the January 1992 – March 2014 period, we find, like Fama and French, that the three-factor model does a good job of explaining market anomalies in the earlier period. For the later period, however, there are market anomalies for every value strategy when using the three-factor model as a measure of performance. On the other hand, the four-factor model is able to explain all but one of these anomalies. Our results raise suspicion that most of the anomalies left unexplained by the three-factor model in this period, namely the ones found for portfolios formed on P/E, P/D and P/C, are not indicators of market inefficiency, but rather indicators of weak explanatory power of the three-factor model in the recent period. This leads us to question whether the high explanatory power of the three-factor model documented by Fama and French (1993 & 1996) perhaps is sample-specific, and a product of data snooping.

# VI. CONCLUSION

In this paper we document market anomalies related to value strategies for portfolios formed on price-earnings (P/E), price-cash flow (P/C) and five-year past sales rank for April 1963 to March 2014. Through the application of three asset pricing models, we find that value stocks seem to outperform the market. We propose that this can be explained by the relative underestimation of value stocks and investor preferences. The results indicate that weak-form market efficiency does not hold for the U.S. equity market for the period of analysis.

We argue that the reason for the persistence of these market anomalies, which are also documented in prior research, is related to the historical lack of commonly available technology necessary to recognize these patterns. This explanation is supported by the results of regressions on the four-factor model for the more recent January 1992 – March 2014 subperiod of our analysis, for which we find no market anomalies except for that of value strategies based on portfolios formed on five-year sales rank. We suggest that this anomaly remains due to inaccurate extrapolation of growth by investors.

Furthermore, we show that the more sophisticated asset pricing models perform better in explaining variability in monthly stock returns. In line with Carhart (1997), we find the four-factor model to exhibit greater explanatory power than the CAPM and three-factor model. The three-factor model performs very well in explaining variability in stock returns for the July 1963 – December 1991 period studied by Fama & French (1993), but renders residual alphas for all value strategies in the later period. This leads us to believe that the previously documented high level of performance for the model could be the result of data snooping.

Finally, there are important limitations to our work. Firstly, it is possible that the patterns we find in stock returns are sample-specific. This means that they may not persist in an out-of-sample period and could therefore leave our findings of little use to investors in the future. Secondly, our results are plagued by the joint-test problem. The alphas found in our regressions are not necessarily evidence of abnormal returns, but perhaps a lack of explanatory power of the asset pricing models used. Lastly, we perform our analysis assuming a frictionless market. Abnormal returns found for the value strategies tested are likely to be affected by the introduction of trading costs, and may not necessarily be evidence of market inefficiency.

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# APPENDIX

## A. Overview of number of firms included in portfolios

**Table A.1.**
**Summary of Average Number of Firms Included in Portfolios: 4/63 to 3/14, 612 months**

Average number of firms

| | Portfolio | | | | | | |
|---|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High | Total |
| **P/E** | 446 | 337 | 337 | 337 | 337 | 337 | 2131 |
| **P/D** | 971 | 243 | 243 | 243 | 243 | 243 | 2186 |
| **P/C** | 311 | 364 | 364 | 364 | 364 | 364 | 2131 |
| **Sales rank** | - | 277 | 277 | 277 | 277 | 277 | 1385 |

**Figure A.1.**
**Number of firms included in portfolios formed on price-earnings**

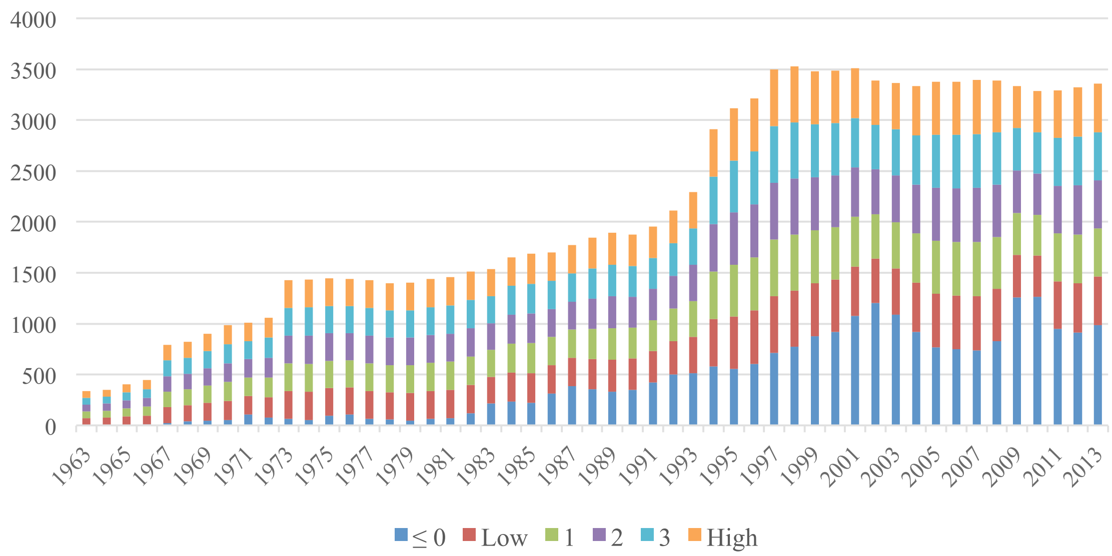



**Figure A.2.**
**Number of firms included in portfolios formed on price-dividends**

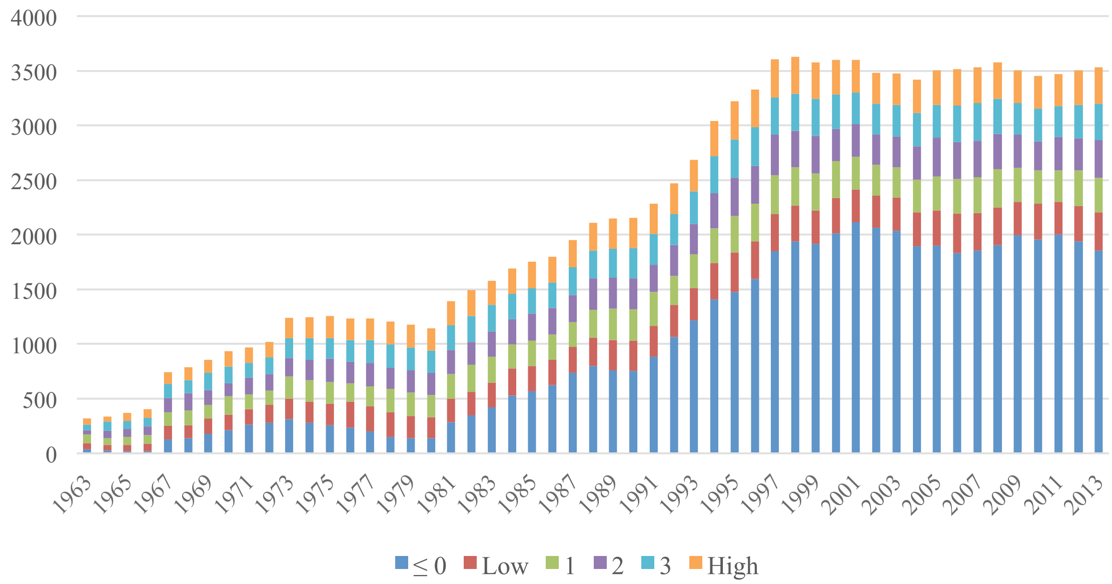


**Figure A.3.**
**Number of firms included in portfolios formed on price-cash flow**

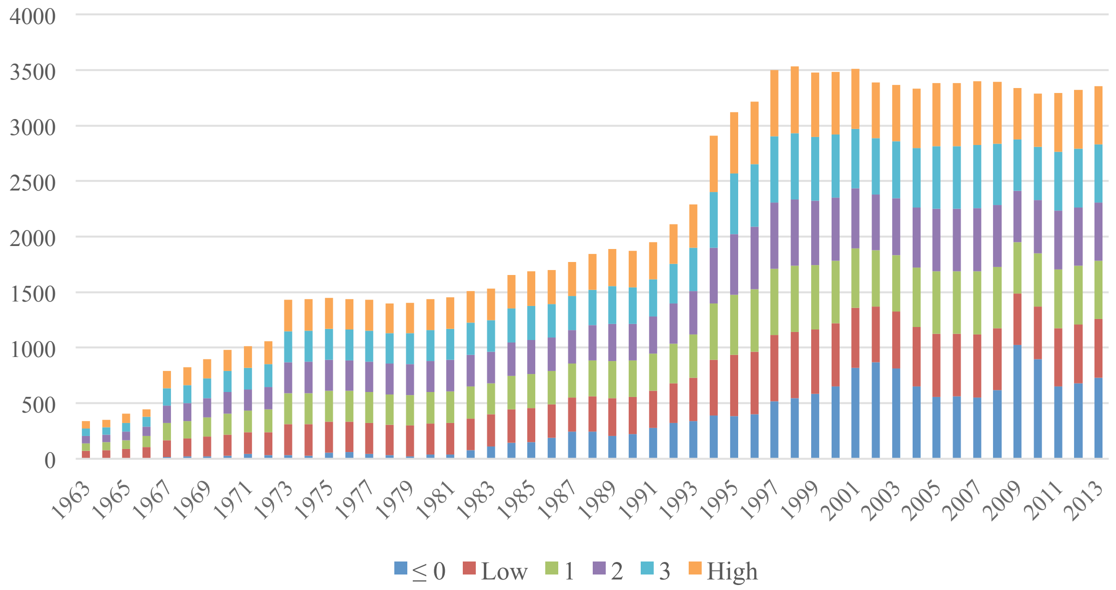
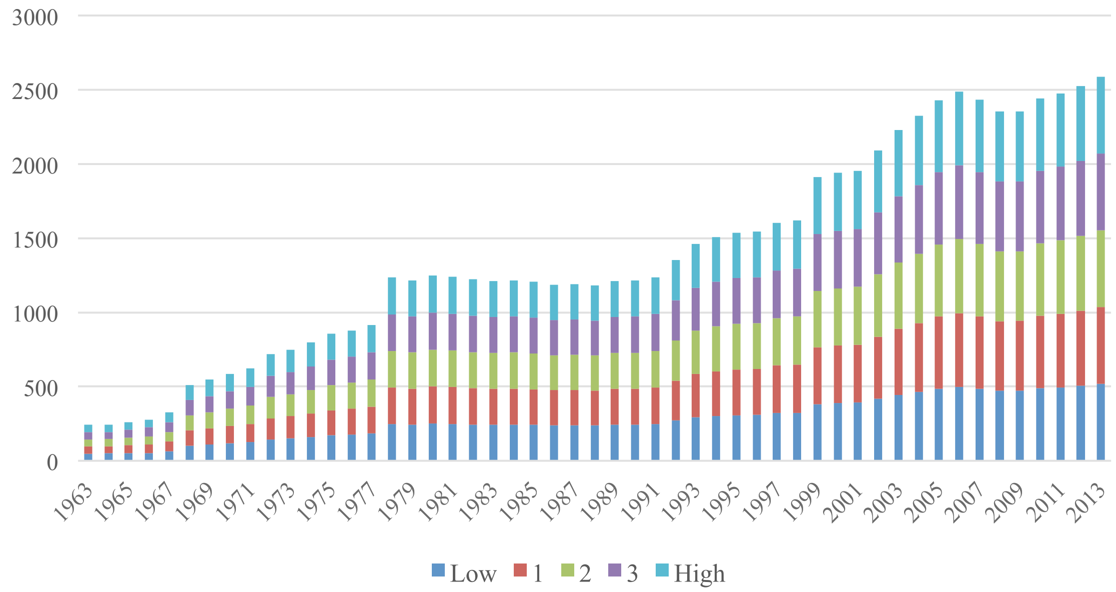



**Figure A.4.**
**Number of firms included in portfolios formed on five-year sales rank**



## B. Supplemental tables for portfolios formed on P/E

**Table B.1.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Earnings: 7/63-12/91, 341 Months**

Portfolios are formed on April 1st of year *t*, 1963 to 1991. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-earnings (P/E) of firms with positive values. Stocks of firms with negative P/E values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 341 months, from July 1963 to December 1991, the period studied by Fama and French (1993). P/E is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year $t-1$ divided by earnings before extraordinary income available to common stockholders for the fiscal year $t-1$. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/E | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | 0.54 | 0.38** | 0.31** | 0.05 | 0.07 | -0.14 |
| | (1.83) | (2.81) | (3.02) | (0.58) | (0.89) | (-1.25) |
| β | 1.39 | 0.96 | 0.90 | 0.91 | 0.95 | 1.03 |
| | (21.34) | (32.59) | (40.60) | (49.73) | (55.89) | (43.54) |
| $R^2$ | 0.57 | 0.76 | 0.83 | 0.88 | 0.90 | 0.85 |
| | | | **Three-factor model** | | | |
| α | 0.06 | 0.08 | 0.10 | -0.06 | 0.09 | 0.06 |
| | (0.26) | (0.75) | (1.17) | (-0.69) | (1.11) | (0.61) |
| β | 1.24 | 1.04 | 0.98 | 0.96 | 0.96 | 0.95 |
| | (21.25) | (37.87) | (46.50) | (47.71) | (49.80) | (40.96) |
| s | 1.16 | 0.16 | 0.02 | -0.03 | -0.08 | -0.06 |
| | (13.36) | (3.90) | (0.47) | (-0.97) | (-2.84) | (-1.67) |
| h | 0.62 | 0.58 | 0.43 | 0.22 | -0.04 | -0.45 |
| | (6.30) | (12.52) | (12.18) | (6.53) | (-1.30) | (-11.61) |
| $R^2$ | 0.74 | 0.84 | 0.88 | 0.89 | 0.91 | 0.89 |
| | | | **Four-factor model** | | | |
| α | 0.20 | 0.20 | 0.15 | 0.05 | 0.12 | 0.12 |
| | (0.81) | (1.75) | (1.69) | (0.59) | (1.45) | (1.25) |
| β | 1.24 | 1.04 | 0.98 | 0.96 | 0.96 | 0.95 |
| | (21.34) | (38.55) | (46.72) | (49.11) | (49.87) | (41.25) |
| s | 1.13 | 0.14 | 0.01 | -0.05 | -0.09 | -0.07 |
| | (13.00) | (3.42) | (0.18) | (-1.63) | (-3.02) | (-2.00) |
| h | 0.58 | 0.55 | 0.42 | 0.19 | -0.05 | -0.47 |
| | (5.85) | (11.85) | (11.65) | (5.76) | (-1.54) | (-11.93) |
| p | -0.14 | -0.12 | -0.05 | -0.11 | -0.03 | -0.07 |
| | (-2.04) | (-3.68) | (-2.06) | (-4.61) | (-1.42) | (-2.41) |
| $R^2$ | 0.74 | 0.85 | 0.88 | 0.89 | 0.91 | 0.89 |

**Table B.2.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Earnings: 1/92-3/14, 267 Months**

Portfolios are formed on April 1st of year *t*, 1991 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-earnings (P/E) of firms with positive values. Stocks of firms with negative P/E values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 267 months, from January 1992 to March 2014, post-Fama and French (1993). P/E is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year *t – 1* divided by earnings before extraordinary income available to common stockholders for the fiscal year *t – 1*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/E | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | -0.25 | 0.46** | 0.36* | 0.20 | 0.17 | -0.16 |
| | (-1.23) | (2.63) | (2.50) | (1.62) | (1.54) | (-1.40) |
| β | 1.47 | 0.96 | 0.83 | 0.81 | 0.88 | 1.13 |
| | (32.05) | (24.14) | (25.28) | (29.35) | (35.96) | (43.96) |
| $R^2$ | 0.79 | 0.69 | 0.71 | 0.76 | 0.83 | 0.88 |
| | | | **Three-factor model** | | | |
| α | -0.38* | 0.35* | 0.29* | 0.17 | 0.15 | -0.21 |
| | (-2.06) | (2.32) | (2.48) | (1.76) | (1.52) | (-1.84) |
| β | 1.37 | 0.97 | 0.87 | 0.87 | 0.92 | 1.14 |
| | (31.15) | (27.06) | (31.54) | (37.73) | (39.90) | (42.31) |
| s | 0.53 | -0.02 | -0.14 | -0.25 | -0.17 | 0.02 |
| | (8.38) | (-0.33) | (-3.59) | (-7.55) | (-5.16) | (0.39) |
| h | 0.15 | 0.42 | 0.34 | 0.21 | 0.13 | 0.14 |
| | (3.05) | (10.85) | (11.44) | (8.26) | (5.17) | (4.73) |
| $R^2$ | 0.83 | 0.77 | 0.81 | 0.85 | 0.86 | 0.88 |
| | | | **Four-factor model** | | | |
| α | 0.00 | 0.23 | 0.17 | 0.10 | 0.17 | -0.06 |
| | (0.01) | (1.47) | (1.42) | (1.03) | (1.64) | (-0.51) |
| β | 1.26 | 1.00 | 0.90 | 0.89 | 0.91 | 1.09 |
| | (30.51) | (26.99) | (31.89) | (36.95) | (37.55) | (40.29) |
| s | 0.45 | 0.01 | -0.12 | -0.24 | -0.17 | -0.02 |
| | (7.95) | (0.15) | (-3.02) | (-7.12) | (-5.20) | (-0.41) |
| h | -0.21 | 0.53 | 0.45 | 0.27 | 0.11 | -0.00 |
| | (-3.49) | (9.93) | (11.04) | (7.74) | (3.18) | (-0.04) |
| p | -0.40 | 0.13 | 0.12 | 0.07 | -0.02 | -0.16 |
| | (-8.42) | (3.00) | (3.85) | (2.58) | (-0.69) | (-5.05) |
| $R^2$ | 0.86 | 0.78 | 0.82 | 0.85 | 0.86 | 0.89 |

## C. Supplemental tables for portfolios formed on P/D

**Table C.1.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Dividends: 7/63-12/91, 341 Months**

Portfolios are formed on April 1st of year *t*, 1963 to 1991. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-dividends (P/D) of firms with positive values. Stocks of firms with zero dividends are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 341 months, from July 1963 to December 1991, the period studied by Fama and French (1993). P/D is the market value (stock price times number of shares outstanding) of common stock on March 31st year *t* divided by common dividends issued in the previous 12 months as of March 31st year *t*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/D | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | 0.07 | 0.13* | 0.03 | -0.04 | 0.01 | 0.07 |
| | (0.40) | (1.99) | (0.56) | (-0.54) | (0.13) | (0.55) |
| β | 1.43 | 0.84 | 1.01 | 1.02 | 1.11 | 1.17 |
| | (38.65) | (59.47) | (78.78) | (71.47) | (60.36) | (41.84) |
| $R^2$ | 0.82 | 0.91 | 0.95 | 0.94 | 0.92 | 0.84 |
| | | | **Three-factor model** | | | |
| α | 0.00 | 0.09 | 0.05 | -0.00 | 0.04 | 0.01 |
| | (0.01) | (1.75) | (0.91) | (-0.01) | (0.49) | (0.10) |
| β | 1.20 | 0.92 | 1.05 | 1.01 | 1.04 | 1.06 |
| | (37.93) | (69.65) | (77.41) | (62.35) | (52.26) | (36.42) |
| s | 0.79 | -0.23 | -0.15 | -0.02 | 0.18 | 0.42 |
| | (16.86) | (-11.64) | (-7.43) | (-0.98) | (6.06) | (9.88) |
| h | -0.19 | 0.14 | -0.02 | -0.11 | -0.17 | -0.07 |
| | (-3.64) | (6.11) | (-0.80) | (-3.93) | (-5.17) | (-1.36) |
| $R^2$ | 0.90 | 0.94 | 0.96 | 0.94 | 0.93 | 0.87 |
| | | | **Four-factor model** | | | |
| α | 0.14 | 0.11 | 0.12* | 0.09 | 0.13 | 0.05 |
| | (1.04) | (1.94) | (2.15) | (1.40) | (1.61) | (0.37) |
| β | 1.20 | 0.92 | 1.05 | 1.01 | 1.04 | 1.06 |
| | (38.64) | (69.63) | (79.64) | (64.64) | (53.46) | (36.41) |
| s | 0.77 | -0.23 | -0.16 | -0.04 | 0.16 | 0.42 |
| | (16.49) | (-11.65) | (-8.21) | (-1.73) | (5.57) | (9.64) |
| h | -0.23 | 0.13 | -0.04 | -0.13 | -0.20 | -0.08 |
| | (-4.33) | (5.83) | (-1.65) | (-4.95) | (-5.95) | (-1.52) |
| p | -0.14 | -0.02 | -0.07 | -0.09 | -0.09 | -0.03 |
| | (-3.73) | (-0.93) | (-4.56) | (-5.14) | (-4.10) | (-0.98) |
| $R^2$ | 0.90 | 0.94 | 0.96 | 0.95 | 0.93 | 0.87 |

**Table C.2.**
**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Dividends: 1/92-3/14, 267 Months**

Portfolios are formed on April 1st of year *t*, 1991 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-dividends (P/D) of firms with positive values. Stocks of firms with zero dividends are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 267 months, from December 1992 to March 2014, post-Fama and French (1993). P/D is the market value (stock price times number of shares outstanding) of common stock on March 31st year *t* divided by common dividends issued in the previous 12 months as of March 31st year *t*. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on P/D | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | -0.17 | 0.23 | 0.14 | 0.07 | 0.08 | 0.04 |
| | (-1.12) | (1.92) | (1.06) | (0.48) | (0.62) | (0.26) |
| β | 1.34 | 0.78 | 0.80 | 0.99 | 1.06 | 1.14 |
| | (40.06) | (28.38) | (26.24) | (28.92) | (38.54) | (36.57) |
| $R^2$ | 0.86 | 0.75 | 0.72 | 0.76 | 0.85 | 0.84 |
| | | | **Three-factor model** | | | |
| α | -0.24 | 0.22* | 0.09 | 0.02 | 0.03 | -0.01 |
| | (-1.81) | (2.37) | (0.90) | (0.12) | (0.24) | (-0.10) |
| β | 1.26 | 0.85 | 0.86 | 1.04 | 1.08 | 1.13 |
| | (40.46) | (38.78) | (37.11) | (35.10) | (37.47) | (34.14) |
| s | 0.44 | -0.31 | -0.24 | -0.21 | -0.04 | 0.09 |
| | (9.90) | (-9.73) | (-7.16) | (-5.01) | (-0.84) | (1.80) |
| h | -0.03 | 0.20 | 0.31 | 0.31 | 0.17 | 0.09 |
| | (-0.95) | (8.63) | (12.41) | (9.47) | (5.33) | (2.64) |
| $R^2$ | 0.89 | 0.86 | 0.86 | 0.84 | 0.85 | 0.83 |
| | | | **Four-factor model** | | | |
| α | 0.09 | 0.12 | 0.07 | -0.04 | 0.06 | 0.06 |
| | (0.72) | (1.31) | (0.72) | (-0.30) | (0.43) | (0.43) |
| β | 1.16 | 0.88 | 0.86 | 1.06 | 1.07 | 1.11 |
| | (42.29) | (38.95) | (35.23) | (33.84) | (35.23) | (31.89) |
| s | 0.38 | -0.29 | -0.23 | -0.20 | -0.04 | 0.07 |
| | (9.94) | (-9.24) | (-6.96) | (-4.70) | (-0.95) | (1.47) |
| h | -0.33 | 0.29 | 0.32 | 0.35 | 0.14 | 0.03 |
| | (-8.23) | (9.02) | (9.18) | (7.84) | (3.25) | (0.50) |
| p | -0.33 | 0.10 | 0.02 | 0.06 | -0.03 | -0.08 |
| | (-10.55) | (3.88) | (0.55) | (1.56) | (-0.76) | (-1.96) |
| $R^2$ | 0.92 | 0.87 | 0.86 | 0.84 | 0.85 | 0.84 |

## D. Supplemental tables for portfolios formed on P/C

**Table D.1.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Cash Flow: 7/63-12/91, 341 Months**

Portfolios are formed on April 1st of year *t*, 1963 to 1991. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-cash flow (P/C) of firms with positive values. Stocks of firms with negative P/C values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 341 months, from April 1963 to December 1991, the period studied by Fama and French (1993). P/C is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year $t-1$ divided by earnings before extraordinary income available to common stockholders + depreciation for the fiscal year $t-1$. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios on P/C | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | 0.41 | 0.47** | 0.24* | 0.05 | -0.01 | -0.17 |
| | (1.04) | (3.90) | (2.47) | (0.66) | (-0.12) | (-1.50) |
| β | 1.48 | 0.90 | 0.88 | 0.94 | 0.98 | 1.04 |
| | (17.01) | (33.95) | (41.50) | (52.96) | (58.58) | (42.70) |
| $R^2$ | 0.46 | 0.77 | 0.84 | 0.89 | 0.91 | 0.84 |
| | | | **Three-factor model** | | | |
| α | -0.12 | 0.18 | 0.08 | -0.00 | 0.00 | 0.02 |
| | (-0.36) | (1.88) | (0.92) | (-0.03) | (0.06) | (0.17) |
| β | 1.22 | 1.00 | 0.98 | 0.96 | 0.99 | 0.94 |
| | (15.32) | (43.29) | (46.61) | (47.55) | (51.62) | (39.24) |
| s | 1.58 | 0.11 | -0.10 | -0.01 | -0.05 | 0.02 |
| | (13.36) | (3.31) | (-3.10) | (-0.31) | (-1.82) | (0.61) |
| h | 0.56 | 0.61 | 0.37 | 0.10 | -0.05 | -0.46 |
| | (4.17) | (15.68) | (10.65) | (2.87) | (-1.46) | (-11.50) |
| $R^2$ | 0.66 | 0.87 | 0.88 | 0.89 | 0.91 | 0.89 |
| | | | **Four-factor model** | | | |
| α | 0.19 | 0.27** | 0.10 | 0.05 | 0.09 | 0.11 |
| | (0.57) | (2.84) | (1.08) | (0.59) | (1.14) | (1.08) |
| β | 1.22 | 1.00 | 0.98 | 0.96 | 0.99 | 0.94 |
| | (15.54) | (44.07) | (46.57) | (47.83) | (52.71) | (39.82) |
| s | 1.52 | 0.10 | -0.10 | -0.02 | -0.07 | 0.01 |
| | (12.95) | (2.82) | (-3.17) | (-0.62) | (-2.40) | (0.14) |
| h | 0.47 | 0.58 | 0.37 | 0.08 | -0.07 | -0.48 |
| | (3.54) | (15.02) | (10.33) | (2.42) | (-2.19) | (-12.09) |
| p | -0.31 | -0.10 | -0.02 | -0.05 | -0.09 | -0.09 |
| | (-3.35) | (-3.65) | (-0.73) | (-2.24) | (-3.95) | (-3.35) |
| $R^2$ | 0.67 | 0.87 | 0.88 | 0.90 | 0.92 | 0.89 |

**Table D.2.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Price-Cash Flow: 1/92-3/14, 267 Months**

Portfolios are formed on April 1st of year *t*, 1991 to 2014. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for price-cash flow (P/C) of firms with positive values. Stocks of firms with negative P/C values are allocated to the ≤ 0 portfolio. Value-weighted returns for portfolios are calculated for 267 months, from January 1992 to March 2014, post-Fama and French (1993). P/C is calculated as the market value (stock price times number of shares outstanding) of common stock on December 31st year $t-1$ divided by earnings before extraordinary income available to common stockholders + depreciation for the fiscal year $t-1$. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios on P/C | | | | | |
|---|---|---|---|---|---|---|
| | ≤ 0 | Low | 1 | 2 | 3 | High |
| | | | **CAPM** | | | |
| α | -0.25 | 0.46** | 0.25 | 0.18 | 0.09 | -0.17 |
| | (-0.93) | (2.97) | (1.90) | (1.53) | (0.88) | (-1.31) |
| β | 1.59 | 0.88 | 0.90 | 0.84 | 0.94 | 1.12 |
| | (26.62) | (24.91) | (30.52) | (31.28) | (40.76) | (37.91) |
| $R^2$ | 0.73 | 0.70 | 0.78 | 0.79 | 0.86 | 0.84 |
| | | | **Three-factor model** | | | |
| α | -0.38 | 0.38** | 0.17 | 0.14 | 0.07 | -0.21 |
| | (-1.61) | (2.63) | (1.66) | (1.37) | (0.75) | (-1.54) |
| β | 1.45 | 0.88 | 0.94 | 0.89 | 0.99 | 1.12 |
| | (26.15) | (26.00) | (38.36) | (37.82) | (47.11) | (35.10) |
| s | 0.74 | -0.00 | -0.11 | -0.16 | -0.17 | 0.04 |
| | (9.26) | (-0.05) | (-3.22) | (-4.72) | (-5.77) | (0.85) |
| h | -0.00 | 0.32 | 0.32 | 0.23 | 0.15 | 0.07 |
| | (-0.02) | (8.67) | (12.24) | (8.99) | (6.49) | (2.12) |
| $R^2$ | 0.79 | 0.75 | 0.86 | 0.85 | 0.90 | 0.84 |
| | | | **Four-factor model** | | | |
| α | 0.09 | 0.22 | 0.12 | 0.11 | 0.14 | -0.02 |
| | (0.43) | (1.51) | (1.12) | (1.02) | (1.56) | (-0.12) |
| β | 1.32 | 0.93 | 0.95 | 0.90 | 0.97 | 1.07 |
| | (25.05) | (26.72) | (37.10) | (36.22) | (44.37) | (33.26) |
| s | 0.64 | 0.03 | -0.10 | -0.15 | -0.19 | 0.00 |
| | (8.90) | (0.62) | (-2.89) | (-4.47) | (-6.29) | (0.02) |
| h | -0.43 | 0.47 | 0.37 | 0.26 | 0.08 | -0.10 |
| | (-5.72) | (9.27) | (10.03) | (7.19) | (2.49) | (-2.22) |
| p | -0.48 | 0.16 | 0.05 | 0.03 | -0.08 | -0.20 |
| | (-8.09) | (4.16) | (1.85) | (1.14) | (-3.11) | (-5.41) |
| $R^2$ | 0.83 | 0.77 | 0.87 | 0.85 | 0.90 | 0.85 |

## E. Supplemental tables for portfolios formed on five-year sales rank

**Table E.1.**

**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Five-Year Sales Rank: 7/63-12/91, 341 Months**

Portfolios are formed on April 1st of year *t*, 1963 to 1991. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for five-year sales rank of firms. Value-weighted returns for portfolios are calculated for 341 months, from July 1963 to December 1991, the period studied by Fama and French (1993). Five-year sales rank is the weighted average of the firm's past five years' annual sales growth rank as defined by

$$\text{Five-year sales rank(t)} = \sum_{j=1}^{5} (6-j) \times \text{Rank}(t-j)$$

where *j* represents the number of years prior (*j* = 1 indicates one year prior, *j* = 2 indicates two years prior, etc.); and *Rank(t – j)* represents the annual sales growth rank of the firm in year $(t-j)$ where rank 1 is given to the firm with the highest sales growth. Sales growth is calculated as ln $\left[\frac{\text{Sales}\ (t-j)}{\text{Sales}(t-j-1)}\right]$. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on five-year sales rank | | | | |
|---|---|---|---|---|---|
| | **Low** | **1** | **2** | **3** | **High** |
| | | | **CAPM** | | |
| α | 0.03 | 0.08 | -0.10 | 0.16 | 0.34** |
| | (0.32) | (1.01) | (-1.21) | (1.87) | (3.15) |
| β | 1.04 | 0.96 | 0.89 | 0.89 | 0.93 |
| | (51.50) | (56.89) | (51.58) | (48.98) | (39.10) |
| $R^2$ | 0.89 | 0.91 | 0.89 | 0.88 | 0.82 |
| | | | **Three-factor model** | | |
| α | 0.11 | 0.12 | -0.13 | 0.09 | 0.15 |
| | (1.21) | (1.62) | (-1.80) | (1.11) | (1.49) |
| β | 0.99 | 0.99 | 0.98 | 0.96 | 0.97 |
| | (44.73) | (55.46) | (56.21) | (49.35) | (39.80) |
| *s* | 0.03 | -0.18 | -0.23 | -0.14 | 0.11 |
| | (0.97) | (-6.75) | (-8.94) | (-4.90) | (3.03) |
| *h* | -0.23 | -0.06 | 0.12 | 0.18 | 0.37 |
| | (-6.11) | (-1.88) | (4.24) | (5.45) | (9.01) |
| $R^2$ | 0.90 | 0.92 | 0.92 | 0.89 | 0.85 |
| | | | **Four-factor model** | | |
| α | 0.18 | 0.13 | -0.06 | 0.18* | 0.17 |
| | (1.96) | (1.70) | (-0.84) | (2.29) | (1.61) |
| β | 0.99 | 0.99 | 0.98 | 0.96 | 0.97 |
| | (45.19) | (55.40) | (57.04) | (50.64) | (39.76) |
| *s* | 0.02 | -0.18 | -0.24 | -0.16 | 0.11 |
| | (0.57) | (-6.75) | (-9.45) | (-5.59) | (2.91) |
| *h* | -0.25 | -0.06 | 0.11 | 0.15 | 0.36 |
| | (-6.60) | (-1.94) | (3.62) | (4.69) | (8.73) |
| *p* | -0.07 | -0.01 | -0.07 | -0.10 | -0.02 |
| | (-2.87) | (-0.54) | (-3.34) | (-4.37) | (-0.64) |
| $R^2$ | 0.90 | 0.92 | 0.92 | 0.90 | 0.85 |

**Table E.2.**
**Time-Series Regressions for Monthly Excess Returns (in Percent) on Portfolios Formed on Five-Year Sales Rank: 1/92-3/14, 267 Months**

Portfolios are formed on April 1st of year *t*, 1992 to 2013. Nasdaq, NYSE and AMEX stocks are allocated to portfolios according to the quintile breakpoints for five-year sales rank of firms. Value-weighted returns for portfolios are calculated for 267 months, from January 1992 to March 2014, post-Fama and French (1993). Five-year sales rank is the weighted average of the firm's past five years' annual sales growth rank as defined by

$$\text{Five-year sales rank(t)} = \sum_{j=1}^{5}(6-j) \times \text{Rank}(t-j)$$

where *j* represents the number of years prior (*j* = 1 indicates one year prior, *j* = 2 indicates two years prior, etc.); and *Rank(t – j)* represents the annual sales growth rank of the firm in year $(t-j)$ where rank 1 is given to the firm with the highest sales growth. Sales growth is calculated as ln $\left[\frac{\text{Sales }(t-j)}{\text{Sales}(t-j-1)}\right]$. The table shows the regressions of portfolio returns in excess of the one-month T-bill rate ($r_i$) on (i) the excess return of the CRSP value-weighted market proxy (VWRF) (ii) the excess return of Fama and French's value-weighted aggregate market proxy (RMRF) and the factor mimicking portfolios for size (SMB) and book-to-market equity (HML) (iii) RMRF, SMB, HML, and the factor-mimicking portfolio for prior one-year return momentum (PR1YR). For each portfolio, the table shows the alpha (α), the coefficient for the market proxy (β), and the coefficients for the factor-mimicking portfolios for size (s), book-to-equity (h) and one-year momentum (p). $R^2$ is the adjusted r-squared. T-statistics are shown in parentheses. Significance at the 5 percent and 1 percent levels is indicated by * and **, respectively.

(i) CAPM: $r_i = \alpha_i + \beta_i VWRF + e_i$

(ii) Three-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + e_i$

(iii) Four-factor model: $r_i = \alpha_i + \beta_i RMRF + s_i SMB + h_i HML + p_i PR1YR + e_i$

| | Portfolios formed on five-year sales rank | | | | |
|---|---|---|---|---|---|
| | **Low** | **1** | **2** | **3** | **High** |
| | | | **CAPM** | | |
| α | -0.15 | 0.16 | 0.11 | 0.11 | 0.38** |
| | (-1.12) | (1.35) | (0.88) | (0.94) | (2.98) |
| β | 1.10 | 0.93 | 0.87 | 0.93 | 0.87 |
| | (36.43) | (35.14) | (31.86) | (34.86) | (30.09) |
| $R^2$ | 0.83 | 0.82 | 0.79 | 0.82 | 0.77 |
| | | | **Three-factor model** | | |
| α | -0.16 | 0.14 | 0.08 | 0.04 | 0.30** |
| | (-1.20) | (1.41) | (0.87) | (0.44) | (2.95) |
| β | 1.12 | 0.99 | 0.93 | 0.97 | 0.90 |
| | (34.54) | (40.65) | (44.93) | (49.67) | (37.58) |
| *s* | -0.09 | -0.23 | -0.27 | -0.13 | -0.07 |
| | (-1.84) | (-6.68) | (-9.22) | (-4.71) | (-1.95) |
| *h* | 0.08 | 0.16 | 0.23 | 0.31 | 0.31 |
| | (2.16) | (6.01) | (10.10) | (14.63) | (12.02) |
| $R^2$ | 0.83 | 0.87 | 0.89 | 0.91 | 0.86 |
| | | | **Four-factor model** | | |
| α | 0.02 | 0.12 | 0.08 | 0.02 | 0.24* |
| | (0.12) | (1.17) | (0.84) | (0.20) | (2.26) |
| β | 1.07 | 0.99 | 0.93 | 0.98 | 0.92 |
| | (32.58) | (38.70) | (42.48) | (47.31) | (36.61) |
| *s* | -0.12 | -0.23 | -0.27 | -0.13 | -0.05 |
| | (-2.71) | (-6.47) | (-9.08) | (-4.50) | (-1.57) |
| *h* | -0.09 | 0.18 | 0.23 | 0.33 | 0.37 |
| | (-1.92) | (4.76) | (7.15) | (10.99) | (10.20) |
| *p* | -0.19 | 0.02 | 0.00 | 0.02 | 0.07 |
| | (-5.01) | (0.71) | (-0.01) | (0.86) | (2.27) |
| $R^2$ | 0.84 | 0.87 | 0.89 | 0.91 | 0.86 |