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Review

Cross-Section of Returns, Predictors Credibility, and Method Issues

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Abstract: The paper focuses on the relationship between firms' characteristics and cross-section returns. The author reviews and critically assesses the most recent contributions in the literature. After comparing the abnormal returns (Alpha) and t statistics of the original works with those of replication works, the author concludes that 94 characteristics are robust. The limitation of the paper is that measurement errors in the COMPUSTAT could affect the predictability of cross-section returns. The practical implication of the paper is that the author validates the practice of fundamental analysis. Investors could benefit from those discovered characteristics. The author validates the policy consequence and connects the theoretical frameworks with empirical results. The author evaluates the empirical methodology and proposes several methods to improve future research.

Keywords: accounting anomalies; abnormal return; characteristics; fundamental analysis; return predictors; risk factors

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1. Introduction

The purpose of the paper is to explore the relationship between firms' characteristics and cross-section returns. Richardson et al. (2010) made an excellent review of the literature. The author complements their review by focusing on the literature after 2010. In the last ten years, a large body of literature documented more than four hundred characteristics (Jensen et al. 2021). Chen and Zimmermann (2021) analyzed 319 characteristics in the literature. They found that 161 of the 319 characteristics predict abnormal returns. They refer to these characteristics as anomalies. Anomalies are the empirical results. These results do not agree with the theoretical predictions (Fama and French 2015). The conflicts between the theory and empirical results motivate research in both asset price theory and archival research in the stock market. On the one hand, Richardson et al. (2010) and Hou et al. (2020) provided a mispricing explanation for anomalies. On the other hand, Fama and French (1993) argued that the empirical results of anomalies could be caused by the limitation of the capital asset pricing model (CAMP). Green et al. (2017) documented that 333 predictors incrementally explain returns. They found six anomalies using the benchmark model of Carhart (1997), four anomalies using the benchmark model of Fama and French (2015) (FF5 factors), and one anomaly using the benchmark model of Hou et al. (2015). These findings focused on all-but-microcap stocks and used value-weighted least square. The results were changed using ordinary least square (OLS).

These anomalies not only attract academic researchers, but also guide investors' portfolio decisions. Fama set up a Dimensional Fund Advisor (DFA) in 1981 and directly applied the size anomaly. In the beginning, the DFA successfully made a profit, which diminished after the academic publication of the anomaly results. Researchers have called this publication decay (Green et al. 2017). Investors actively use financial statement information to forecast future earnings and to make better decisions. Less was known about how these predictors work for an individual stock. In addition, anomaly research has motivated the development of asset pricing models. Zhang (2017) developed investment CAPM, and Penman and Zhu (2022) developed consumption CAPM. Finally, the decay of anomalies provides a platform for evaluating the consequences of the SEC regulation.

The author reviewed and compared the literature and confirms the usefulness of financial reporting information in the stock market. Over the last two decades, researchers have identified more than 400 predictors of stock returns (Jensen et al. 2021). The author compares the abnormal returns (Alpha) and t statistics of the original works with those of replication works (Green et al. 2017; Hou et al. 2020; Jensen et al. 2021). By applying the 2020 accepted standard of empirical methodology, the author concludes that 94 predictors are robust. The predictability of anomalies depends on benchmark models (Green et al. 2017). Scholars have not reached a consensus on the optimal asset pricing models. The author uses Google citations as a measure of the method's popularity; the academic community did not reach a consensus on the empirical methodology. However, the most popular method is not necessarily the optimal method. The acceptance of the optimal method was slower than anticipated. The author reminds future researchers to address the method issues in the empirical asset pricing literature and proposes several methods and solutions to address these issues. The author summarizes the 94 predictors and confirms their credibility in the sample period and calls for future research to test the credibility outside of the sample period and in the international stock market setting.

This paper contributes to three areas. First, the author helps to obtain an understanding of the current research findings. The cross-section returns literature has attracted numerous top scholars in accounting, finance, and economics, with hundreds of papers published in top journals. In the last two decades, researchers found more than three hundred anomalies. Second, the author helps to develop an understanding of the debates on the cross-section returns literature. The empirical results of the cross-section returns depend on the benchmark models, on which scholars have not yet reached a consensus. Scholars also apply different empirical methodologies, meaning that the empirical results are inconsistent. Third, the author provides directions for future research.

The remainder of the paper proceeds as follows: Section 2 summarizes the recent findings and debates in the literature, Section 3 introduces the empirical methodology, and Section 4 discusses and concludes the review.

2. Literature Review

Penman and Zhang (2012) found that accounting numbers, such as inventory, research and development expenses, and advertising expenses, could predict future abnormal returns. He and Narayanamoorthy (2020) documented that earnings acceleration, defined as the quarter-over-quarter change in earnings growth, can predict abnormal returns. Chang et al. (2021) found that earnings uncertainty can become another predictor of future returns. Hou et al. (2015, 2020) modified some original accounting numbers and created "new characteristics".

Green et al. (2017) documented that 333 predictors incrementally explained returns. They found that only 12 characteristics were independent of the use of non-microcap stocks from 1980 to 2014. They also found that only two characteristics could predict returns after 2003. They found six anomalies using the benchmark model of Carhart (1997), four anomalies using the benchmark model of Fama and French (2015) (FF5 factors), and one anomaly using the benchmark model of Hou et al. (2015). These findings focused on all-but-microcap stocks and applied value-weighted least square. The results were changed using ordinary least square (OLS). Jensen et al. (2021) replicated the literature on size and BTM. They concluded that the results of these anomalies are very robust in both the published in-sample and out-of-sample periods and 93 countries.

The author summarizes the factors that could predict future returns. This summary excludes those factors that cannot be successfully replicated and those factors with lower t stats of less than 2.58. Future research could benefit from this summary. Table 1 summarize all those factors.

Table 1. Summary of factors.

Predictors	Cite	In-Sample Period	t-Stat
Dispersion in analysts€™ long-term growth forecasts	Anderson et al. (2005)	1991–1997	2.79
Hiring rate	Belo et al. (2014)	1965–2010	−3.09
Disparity between long- and short-term earnings growth forecasts	Da and Warachka (2011)	1983–2006	−2.72
Organizational capital-to-book assets	Eisfeldt and Papanikolaou (2013)	1970–2008	2.85
Accrual quality	Francis et al. (2005)	1975–2001	47.85
Asset tangibility	Hahn and Lee (2009)	1973–2001	5.04
Years 2–5 lagged returns, nonannual	Heston and Sadka (2008)	1965–2002	−5.60
Years 6–10 lagged returns, nonannual	Heston and Sadka (2008)	1965–2002	−4.62
Years 16–20 lagged returns, nonannual	Heston and Sadka (2008)	1965–2002	−3.35
Year 1 lagged return, nonannual	Heston and Sadka (2008)	1965–2002	4.20
Years 16–20 lagged returns, annual	Heston and Sadka (2008)	1965–2002	4.58
Years 2–5 lagged returns, annual	Heston and Sadka (2008)	1965–2002	5.35
Years 6–10 lagged returns, annual	Heston and Sadka (2008)	1965–2002	6.15
Years 11–15 lagged returns, annual	Heston and Sadka (2008)	1965–2002	6.43
Year 1 lagged return, annual	Heston and Sadka (2008)	1965–2002	7.60
Citations-to-R&D expense	Hirshleifer et al. (2013)	1982–2008	2.92
Price delay based on R2	Hou and Moskowitz (2005)	1966–2001	4.37
Price delay based on adjusted slopes	Hou and Moskowitz (2005)	1964–2001	7.39
Price delay based on slopes	Hou and Moskowitz (2005)	1964–2001	7.70
Industry concentration in sales	Hou and Robinson (2006)	1963–2001	−2.85
Firm age	Jiang et al. (2005)	1965–2001	−3.46
Kaplan–Zingales index	Lamont et al. (2001)	1968–1995	3.06
The Whited–Wu index of financing constraints	Whited and Wu (2006)	1975–2001	3.17
CAPEX growth (2 years)	Anderson and Garcia-Feijoo (2006)	1976–1998	−5.51
CAPEX growth (3 years)	Anderson and Garcia-Feijoo (2006)	1976–1998	−5.34
Inventory growth	Belo and Lin (2012)	1965–2009	6.64
Net debt issuance	Bradshaw et al. (2006)	1971–2000	−8.40
Net total issuance	Bradshaw et al. (2006)	1971–2000	−5.70
Net equity issuance	Bradshaw et al. (2006)	1971–2000	−3.20
Asset growth	Cooper et al. (2008)	1968–2003	−5.04
Equity net payout	Daniel and Titman (2006)	1968–2003	−4.16
Net operating assets	Hirshleifer et al. (2004)	1964–2002	−4.04
Growth in book debt (3 years)	Lyandres et al. (2008)	1970–2005	−5.91
Net stock issues	Pontiff and Woodgate (2008)	1970–2003	−6.72
Change in net noncurrent operating assets	Richardson et al. (2010)	1962–2001	−8.76
Change in current operating working capital	Richardson et al. (2010)	1962–2001	−8.72
Change in current operating assets	Richardson et al. (2010)	1962–2001	−8.71
Change in noncurrent operating assets	Richardson et al. (2010)	1962–2001	−8.44
Change in financial liabilities	Richardson et al. (2010)	1962–2001	−8.01
Total accruals	Richardson et al. (2010)	1962–2001	−6.38
Change in common equity	Richardson et al. (2010)	1962–2001	−6.25
Change in current operating liabilities	Richardson et al. (2010)	1962–2001	−4.49
Change in long-term investments	Richardson et al. (2010)	1962–2001	−3.38
Change in net financial assets	Richardson et al. (2010)	1962–2001	5.85
Operating accruals	Sloan (1996)	1962–1991	−6.15
Discretionary accruals	Xie (2001)	1971–1992	8.43
Cumulative abnormal stock returns around earnings announcements	Chan et al. (1996)	1977–1993	4.25
Revisions in analysts earnings forecasts	Chan et al. (1996)	1977–1993	3.10
Standardized earnings surprise	Foster et al. (1984)	1974–1981	9.11
Industry lead–lag effect in earnings surprises	Hou (2007)	1972–2001	5.61
Industry lead–lag effect in prior returns	Hou (2007)	1972–2001	11.00
Customer industries momentum	Menzly and Ozbas (2010)	1963–2005	4.11
Supplier industries momentum	Menzly and Ozbas (2010)	1963–2005	5.03
Tax expense surprise	Thomas and Zhang (2011)	1977–2006	6.42
Credit rating	Avramov et al. (2009)	1985–2007	−2.80

Table 1. *Cont.*

Predictors	Cite	In-Sample Period	t-Stat
Cash-based operating profits-to-lagged book assets	Ball et al. (2016)	1963–2014	5.27
Operating profits-to-lagged book assets	Ball et al. (2016)	1963–2014	8.86
Ohlson O-score	Dichev (1998)	1981–1995	−3.38
Altman Z-score	Dichev (1998)	1981–1995	3.37
Book leverage	Fama and French (1992)	1963–1990	−4.45
Operating profits-to-book equity	Fama and French (2015)	1963–2013	2.92
Quarterly return on equity	Hou et al. (2015)	1972–2012	3.11
Growth score	Mohanram (2005)	1979–2001	5.53
Gross profits-to-assets	Novy-Marx (2013)	1963–2010	4.59
Pitroski F-score	Piotroski (2000)	1976–1996	5.89
Idiosyncratic volatility from the CAPM (252 days)	Ali et al. (2003)	1976–1997	−2.69
Amihud Measure	Amihud (2002)	1964–1997	5.39
Downside beta	Ang et al. (2006)	1963–2001	5.25
Idiosyncratic volatility from the Fama–French three-factor model	Ang et al. (2006)	1963–2000	−2.86
Return volatility	Ang et al. (2006)	1963–2000	−2.86
Maximum daily return	Bali et al. (2011)	1962–2005	−6.16
Total skewness	Bali et al. (2016)	1925–2012	−4.01
Dollar trading volume	Brennan et al. (1998)	1966–1995	2.86
Coefficient of variation for share turnover	Chordia et al. (2001)	1966–1995	−6.03
Coefficient of variation for dollar trading volume	Chordia et al. (2001)	1966–1995	−5.10
The high–low bid–ask spread	Corwin and Schultz (2012)	1927–2006	12.78
Share turnover	Datar et al. (1998)	1963–1991	−8.58
Frazzini–Pedersen market beta	Frazzini and Pedersen (2014)	1926–2012	7.12
Short-term reversal	Jegadeesh (1990)	1929–1982	−18.58
Number of zero trades with turnover as a tiebreaker (6 months)	Liu (2006)	1963–2003	4.06
Number of zero trades with turnover as a tiebreaker (12 months)	Liu (2006)	1963–2003	4.40
Price per share	Miller and Scholes (1982)	1940–1978	3.00
Debt-to-market	Bhandari (1988)	1948–1979	3.93
Net payout yield	Boudoukh et al. (2007)	1984–2003	4.14
Intangible return	Daniel and Titman (2006)	1968–2003	−4.56
Equity duration	Dechow et al. (2004)	1962–1998	4.63
Operating cash flow-to-market	Desai et al. (2004)	1973–1997	8.36
Analystsâ€™ earnings forecasts-to-price	Elgers et al. (2001)	1982–1998	3.40
Assets-to-market	Fama and French (1992)	1963–1990	4.28
Long-term growth forecasts of analysts	La Porta (1996)	1982–1991	−4.19
Dividend yield	Litzenberger and Ramaswamy (1979)	1940–1980	8.79
Ebitda-to-market enterprise value	Loughran and Wellman (2011)	1963–2009	3.08
Net debt-to-price	Penman et al. (2007)	1962–2001	−3.12
Book-to-market enterprise value	Penman et al. (2007)	1962–2001	4.20

Fama and French (2015) concluded that the empirical evidence of anomalies identified either mispricing or the inadequacy of the asset pricing model. The dominant model used in the empirical literature is the capital asset pricing model (CAPM). This theoretical model predicts the positive association between risk and return.

The empirical anomalies, such as size and book-to-market (BTM), motivate the more precise model as a benchmark model to test the empirical results. Fama and French (1992) believe that size and BTM may capture the equilibrium between risk and return. The amazing explanation power of these two empirical proxies motivated Fama and French to include size and BTM in the Fama–French three-factor model (FF3). Carhart (1997) added a momentum factor and developed the four-factor model. Fama and French (2015) added profitability and investment into the FF3 and developed the five-factor model (FF5). The empirical results based on FF5 showed that the value factor becomes insignificant. The value factor was substituted by profitability and investment.

Besides the above well-cited empirical models, accounting scholars also developed several accounting-based models. For example, Penman and Zhu (2014) concluded that accounting anomalies, such as asset growth, accounting accruals, and investment, were associated with future earnings and future earnings growth. As future earnings and their growth equal expected future returns, the observed anomalies reflect the limitations of CAPM. They add accounting variables into the CAPM and develop the accounting characteristic model (PZ 2014 model). Penman et al. (2018) used the US listed firms from 1962 to 2013 and used Fama and French (1992) as a benchmark model. They found that earnings price (E/P) is the relevant risk factor without earning growth and book-to-price (B/P) is the relevant risk factor with earnings growth. Based on the above empirical findings, they developed a new asset pricing model (PRRT 2018 model).

Based on the neoclassic economic theory of demand and supply, Zhang (2017) focused on the supply side and developed an investment CAPM. Penman and Zhu (2022) focused on the demand side and developed the consumption CAPM. In the investment CAPM model, the alignment between investing policies and the cost of capital drove the empirical anomalies. In the consumption CAPM model, the accounting numbers connect to consumption and the accounting principles connect to the risk of consumption. This theory leads to a two-factor model. One factor represents a market portfolio, and another factor constructed by accounting information, a price factor, captures the risk in a bad situation when consumption is low.

Researchers debate the mispricing explanation and the inadequacy of the asset price model. The independent anomalies are diminished by applying the model of FF5 or by applying the model of Hou et al. (2015). Some of the previous findings of anomalies were due to the inadequacy of the model. McLean and Pontiff (2016) documented that US factors' returns drop by 58% after academic publications. Green et al. (2017) found that US factors' returns diminish after 2003. These studies provide direct evidence of mispricing. Chen and Zimmermann (2021) found that abnormal returns decreased gradually after publication. Their results are consistent with the notion of publication decay (Jacobs and Müller 2020). Before 2003, most anomalies reflected mispricing. Since 2003, academic publications have introduced investment opportunities for both individual investors and institutional investors. The arbitrage cost was significantly reduced after the Sarbanes–Oxley Act. At the same time, the SEC requires a short time to release firm 10-Q and 10-K filings, and the NYSE introduces auto quoting. The regulation changes the transaction cost to arbitrage mispricing from all anomalies. Green et al. (2017) found that 12 independent characteristics could predict stock returns from 1980 to 2014. However, arbitrage opportunities have diminished since 2003.

This explanation is not conclusive. The reliable causal inference of the effect of the Sarbanes–Oxley Act depends on different research designs, for example, the difference-in-differences (DID) approach, regression discontinuity, and shock-based instrumental variable. In future research, it will be promising to apply the above research designs to explore the effects of the Sarbanes–Oxley Act. To answer the question of whether the regulation eliminates the stock market inefficiency, one promising avenue is to observe more regulations. The international stock markets in different countries provide ideal platforms to answer this question. In European developed countries, the implementation of the International Financial Reporting System provides an external shock for the stock markets such as the UK, Spain, France, Belgium, and Germany. The summary of the effect of each country will provide solid evidence of whether the regulation eliminates the stock market inefficiency. Another promising area is to explore the same question in developing countries, for example, the continuous regulatory environment reforms since 1990 in China. State-owned enterprises gradually sell shares to private investors. China's stock market gradually reforms non-tradable shares and issues A share for domestic investors and B share for international investors (Lu and Fu 2014).

3. Empirical Methodology

In this section, the author first discusses the anomaly literature's replication credibility and robustness. Second, the author presents the method's issues and provides solutions to address these issues.

3.1. Replication and Robustness

The author termed replication as the process that generates the same results by using the same samples as the originals. Reanalysis includes a process that identifies the potential reason for the different results, such as different samples, different controls, regression errors, and coding errors.

Kothari et al. (1995) found that the previous results of a book-to-market anomaly are not consistent and robust. The association between book-to-market and returns is weak. Fu (2009) found that idiosyncratic volatility varies, and that the idiosyncratic volatility is positively associated with the returns. This result is based on the estimation of idiosyncratic volatility, which is measured by the exponential GARCH model.

Chen and Zimmermann (2021) replicated the published anomaly literature. They found 161 anomalies consistent with the original papers. They found 44 anomalies with weak results, and that the remaining 114 anomalies were insignificant or were modifications of other anomalies created by Hou et al. (2020). Chen and Zimmermann regressed their republication t stats on the t stats in the original papers. The coefficient is 0.9, the t statistic is greater than 1.96, and the R-square is 83%. They believed that the replication was successful.

Hou et al. (2020) argued that most anomalies cannot be reproduced. However, their methods differ from those of the original studies. They used the 2020 acceptable empirical standards to reanalyze the previous empirical literature. It is not surprising that the previous findings are not robust. Chang and Li (2022) used only publicly available sources and codes to replicate original papers. The success rate was between 30% and 50% for 67 papers. Jensen et al. (2021) used a longer sample of 93 countries and analyzed the Alpha using the CAPM as a benchmark model. The CAPM is grounded by portfolio theory. Their replication rate was 84.9%. They concluded that most studies could be replicated, but Harvey (2017) believed that p-value hacking problems affect the external validity of the results. These results are referred to as spurious results. These results may not hold for the different sample periods or for different countries.

Harvey et al. (2016) analyzed 313 factors in published research papers and concluded that some papers may suffer from data-snooping problems. This issue arises from multiple test (MT) problems. Most anomaly literature is based on individual ordinary least squares (OLS) t statistics. Harvey et al. (2016) concluded that the cut-off t statistic of 2.57 is not sufficient in multiple tests. They proposed an MT adjustment and used the cut-off t statistic of 3.0. Jensen et al. (2021) confirmed that MT adjustment is a critical step. However, they proposed a Bayesian framework to address the MT problem. Their acceptable t was lower than the t proposed by Harvey et al. (2016). Harvey et al. (2020), Fisch and Gelbach (2021), and Harvey and Liu (2021) proposed alternative methods for solving MT problems.

In addition to the MT problem, previous anomaly literature also suffers from data bias and errors. Northwestern University summarizes the data bias and errors on its website. Akey et al. (2022) concluded that the anomaly literature suffered from noisy factor issues. Jennings et al. (2020) found that most accounting researchers ignore measurement errors and that measurement errors can cause false positives. Gormley and Matsa (2014) provide guidance to improve the results suffered by the endogeneity problem. Bowen et al. (2017) proposed a novel identification strategy, while Atanasov and Black (2016, 2021) proposed an instrument to address the endogeneity problem.

3.2. Empirical Methodology

Fama and French (2015) advise using panel regression and portfolio sorts jointly. In the panel dataset, Petersen (2009) criticized the pooled OLS and advocated two-way fixed-effect regression. As the firm fixed effect is highly correlated and the year fixed effect is also highly correlated, any regressions of panel datasets should control both the firm fixed effect and the year fixed effect.

The second approach is portfolio sorts. Researchers have ranked the firm stocks based on empirical characteristics, for example, firms' size. They grouped the stocks into 10 decile subsets and formed the long–short portfolio, which takes long and short positions in the two extreme decile subsets. The researchers evaluated the abnormal returns (Alpha) based on the performance of the long–short portfolio. However, the calculated Alpha is sensitive to several subjective choices. The most common choices are value-weighted portfolios and equal-weighted portfolios. Moskowitz et al. (2012) weighed the portfolio components on their inverse volatility, which is called risky parity.

Fama and French (1993) developed the three-factor model to capture the risk factors. As an alternative, Brennan et al. (1998) applied principal components analysis to capture the risk factors, while Lehmann and Modest (2005) used maximum likelihood methods to capture the risk factors. Fama and French (1992) used portfolio sorting to correct the measurement errors of the factor loadings. Brennan et al. (1998) used risk-adjusted return as dependent variables. After transferring the loading from the right side to the left side, they avoided the measurement errors of the factor loadings. Another issue is the different periods that are used to calculate the factor loadings. For example, Brennan et al. (1998) used rolling estimates of a 60-month period to calculate the factor loadings. Petkova (2006) used full sample estimates. Akey et al. (2022) found that French's website updated and revised the factors in a timely manner. Researchers may use different versions of factors and generate different results; Ferson and Harvey (1999) argued that factor loadings may change over time, calculating the loadings based on the changes in the default spread.

Another concern is whether betas are time-varying, or beta is a constant. The dominant model in asset pricing treats beta as a constant. Lewellen and Nagel (2006) argued that the conditional CAPM fails to explain asset pricing anomalies and estimate betas over weekly and daily horizons. Agrrawal et al. (2022) found that betas are truly time-varying.

Another issue comes from microstructure noise, such as the bid–ask spread. Asparouhova et al. (2010) found that the bid–ask spread causes an upward bias of estimated returns. They proposed to use mid-quote returns to correct this bias. As an alternative procedure, they also propose to use weighted least square regression to correct this bias.

Most studies prefer the standard Fama–Macbeth approach; Petersen (2009) uses simulation results to criticize the procedure. If regression errors correlate with cross-section and time-series, it is imperative to adopt a two-way fixed-effects model. It still takes time to see the method's acceptance in future research.

Up to now, researchers have documented around 430 characteristics that could predict future returns. Matteo Bagnara (2022) names them "Factor Zoo", although this leads to econometric issues. First, the more factors in the model, the better the fit in-sample; however, the worse the fit out-sample. Second, the more factors in the model, the more severe the multicollinearity problem. Machine learning (ML) provides an alternative method to overcome the limitations of OLS. Gu et al. (2020) compared the main machine learning tools. Neural network algorithms perform the best results, although it is difficult for this approach to explain the results. In future research, developing economic theories could help interpret the empirical findings of all ML tools. Table 2 summarizes these method issues.

Table 2. Method issues and solutions.

Issues	Solutions	Authors	Popularity (Citations)
Weight scheme	Value weight	Fama and French (2015)	6691
	Equal weight	Hou et al. (2015)	2098
	Risk parity	Moskowitz et al. (2012)	1497
Risk factors	Principal components	Brennan et al. (1998)	2044
	Maximum likelihood	Lehmann and Modest (2005)	32
Measurement error factor loading	Risk-adjust return	Brennan et al. (1998)	2044
	Portfolio sorted by loadings	Fama and French (1992)	25,309
Factor loadings	Rolling estimates	Brennan et al. (1998)	2044
	Full sample estimates	Petkova (2006)	841
Time varied loadings	Varying with macroeconomic variables	Ferson and Harvey (1999)	1081
Time-varied betas	Daily, weekly, and monthly betas	Agrrawal et al. (2022) Lewellen and Nagel (2006)	41 1133
Microstructure noise bid–ask spread	Mid-quote returns	Asparouhova et al. (2010)	93
Standard errors	Firm effects, time effects	Petersen (2009)	11,964
Econometric issues	Machine learning dimensions reduction	Matteo Bagnara (2022)	0

4. Discussion and Conclusions

The paper focused on the combined factor examinations. The author validates the firms' characteristics that could predict future returns. This aligned with Hou et al. (2015), Green et al. (2017), and Jensen et al. (2021). The author has concluded that the predictability of the aggregate stock market in the US has changed over time. This aligned with Green et al. (2017) and Hou et al. (2020). Fama and French (2015) concluded that the empirical evidence of anomalies identified either mispricing or the inadequacy of the asset pricing model.

This paper contributes to gaining an understanding of current research findings conditionally and obtaining an understanding of the debates on the cross-section returns literature. The empirical results of the cross-section returns depend on the benchmark models. Scholars have not yet reached a consensus on the benchmark models and also apply different empirical methodologies. The empirical results are inconsistent; therefore, the debate on the theoretical frameworks and empirical results provides interesting and perhaps promising areas on which to work.

The theoretical implications of the paper are to analyze the theories based on empirical results in cross-section returns. The limitation of the current theories builds materials for new theories. The reconciliation of the research findings suggests that future research could extend the current knowledge of cross-section returns. Theoretically, the CAPM predicts that expected returns are positively associated with firms' risks. The disagreement comes from how to capture firms' risks. Empirical models such as the three-factor model and the five-factor model work well with the US stock data. The weak theoretical foundations of these models require future research in these areas.

There are two practical implications of this paper. First, the paper validates the practice of fundamental analysis. The published characteristics could predict future returns. This result is in alignment with Hou et al. (2015) and Jensen et al. (2021). How to apply knowledge to real investment is still an open question, and the research findings may benefit both institutional investors and individual investors. Second, the paper also validates the policy regulations. SEC regulations could eliminate some documented anomalies. Future research could explore the consequence of new policies and regulations.

In this paper, the author acknowledges that the conclusion may not be complete due to several limitations. First, it is possible that the author missed some important findings in the area. Second, due to the different methodologies, the results are difficult to reconcile across papers. Third, the omitted predictors of future returns could be around 4000 (Jensen et al. 2021). Finally, the author relies on the COMPUSTAT to compare and analyze the empirical results. However, Kothari et al. (1995) pointed out measurement errors in the COMPUSTAT. From an investors' perspective, it is a hot debate whether investors could exploit profit through those discovered factors.

In future research, several promising areas are listed below. The avenue less traveled is how those factors work for an individual firm rather than the aggregated stock market. In the accounting education tradition, fundamental analysis is still a useful tool. Professional investors analyze financial reports and use some of those factors to facilitate their decision making. Another interesting area is how institutional investors and individual investors would respond to those new academic findings. The information processing cost may affect these two groups' ability to use academic findings. If we assume that the stock market is a zero-sum game, the academic findings may benefit institutional investors at the cost of individual investors. Another potential for fertile ground is to explore the factors used by individual investors and the factors used by institutional investors. We still know little about how practitioners use the information.

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References

Agrrawal, Pankaj, Faye W. Gilbert, and Jason Harkins. 2022. Time Dependence of CAPM Betas on the Choice of Interval Frequency and Return Timeframes: Is There an Optimum? *Journal of Risk and Financial Management* 15: 520. [CrossRef]

Akey, Pat, Adriana Robertson, and Mikhail Simulation. 2022. Noisy factors. Rotman School of Management Working Paper, forthcoming.

Ali, Ashiq, Lee-Seok Hwang, and Mark A. Trombley. 2003. Arbitrage risk and the book-to-market anomaly. *Journal of Financial Economics* 69: 355–73. [CrossRef]

Amihud, Yakov. 2002. Illiquidity and stock return: Cross-section and time-series effects. *Journal of Financial Markets* 5: 31–56. [CrossRef]

Anderson, Christopher W., and Luis Garcia-Feijoo. 2006. Empirical evidence on capital investment, growth options, and security returns. *The Journal of Finance* 61: 171–94. [CrossRef]

Anderson, Evan W., Eric Ghysels, and Jennifer L. Juergens. 2005. Do heterogeneous beliefs matter for asset pricing? *The Review of Financial Studies* 18: 875–924. [CrossRef]

Ang, Andrew, Joseph Chen, and Yuhang Xing. 2006. Downside risk. *The Review of Financial Studies* 19: 1191–239. [CrossRef]

Asparouhova, Elena, Hendrik Bessembinder, and Ivalina Kalcheva. 2010. Liquidity biases in asset pricing tests. *Journal of Financial Economics* 96: 215–37. [CrossRef]

Atanasov, Vladimir A., and Bernard S. Black. 2016. Shock-based causal inference in corporate Finance and accounting research. *Critical Finance Review* 5: 207–304. [CrossRef]

Atanasov, Vladimir, and Bernard Black. 2021. The trouble with instruments: The need for pretreatment balance in shock-based instrumental variable designs. *Management Science* 67: 1270–302. [CrossRef]

Avramov, Doron, Tarun Chordia, Gergana Jostova, and Alexander Philipov. 2009. Credit ratings and the cross-section of stock returns. *Journal of Financial Markets* 12: 469–99. [CrossRef]

Bagnara, Matteo. 2022. Asset Pricing and Machine Learning: A critical review. *Journal of Economic Surveys*. [CrossRef]

Bali, Turan G., Nusret Cakici, and Robert F. Whitelaw. 2011. Maxing out: Stocks as lotteries and the cross-section of expected returns. *Journal of Financial Economics* 99: 427–46. [CrossRef]

Bali, Turan G., Robert F. Engle, and Scott Murray. 2016. *Empirical Asset Pricing: The Cross Section of Stock Returns*. New York: John Wiley & Sons.

Ball, Ray, Joseph Gerakos, Juhani T. Linnainmaa, and Valeri Nikolaev. 2016. Accruals, cash flows, and operating profitability in the cross section of stock returns. *Journal of Financial Economics* 121: 28–45. [CrossRef]

Belo, Frederico, and Xiaoji Lin. 2012. The inventory growth spread. *The Review of Financial Studies* 25: 278–313. [CrossRef]

Belo, Frederico, Xiaoji Lin, and Santiago Bazdresch. 2014. Labor hiring, investment, and stock return predictability in the cross section. *Journal of Political Economy* 122: 129–77. [CrossRef]

Bhandari, Laxmi Chand. 1988. Debt/equity ratio and expected common stock returns: Empirical evidence. *The Journal of Finance* 43: 507–28. [CrossRef]

Boudoukh, Jacob, Roni Michaely, Matthew Richardson, and Michael R. Roberts. 2007. On the importance of measuring payout yield: Implications for empirical asset pricing. *The Journal of Finance* 62: 877–915. [CrossRef]

Bowen, Donald E., Laurent Fresard, and Jerome P. Taillard. 2017. What's your identification strategy? innovation in corporate finance research. *Management Science* 63: 2529–48. [CrossRef]

Bradshaw, Mark T., Scott A. Richardson, and Richard G. Sloan. 2006. The relation between corporate financing activities, analysts' forecasts and stock returns. *Journal of Accounting and Economics* 42: 53–85. [CrossRef]

Brennan, Michael J., Tarun Chordia, and Avanidhar Subrahmanyam. 1998. Alternative factor specifications, security characteristics, and the cross-section of expected stock returns. *Journal of Financial Economics* 49: 345–73. [CrossRef]

Carhart, Mark M. 1997. On persistence in mutual fund performance. *Journal of Finance* 59: 3–32. [CrossRef]

Chan, Louis K. C., Narasimhan Jegadeesh, and Josef Lakonishok. 1996. Momentum strategies. *The Journal of Finance* 51: 1681–713. [CrossRef]

Chang, Andrew C., and Phillip Li. 2022. Is economics research replicable? Sixty published papers from thirteen journals Say â€ œOften Notâ€. *Critical Finance Review* 11: 185–206. [CrossRef]

Chang, Woojin, Steven J. Monahan, Amine Ouazad, and Florin P. Vasvari. 2021. The higher moments of future earnings. *The Accounting Review* 96: 91–116. [CrossRef]

Chen, Andrew Y., and Tom Zimmermann. 2021. Open source cross-sectional asset pricing. *Critical Finance Review*, forthcoming.

Chordia, Tarun, Avanidhar Subrahmanyam, and V. Ravi Anshuman. 2001. Trading activity and expected stock returns. *Journal of Financial Economics* 59: 3–32. [CrossRef]

Cooper, Michael J., Huseyin Gulen, and Michael J. Schill. 2008. Asset growth and the cross-section of stock returns. *The Journal of Finance* 63: 1609–51. [CrossRef]

Corwin, Shane A., and Paul Schultz. 2012. A simple way to estimate bid-ask spreads from daily high and low prices. *The Journal of Finance* 67: 719–60. [CrossRef]

Da, Zhi, and Mitch Warachka. 2011. The disparity between long-term and short-term forecasted earnings growth. *Journal of Financial Economics* 100: 424–42. [CrossRef]

Daniel, Kent, and Sheridan Titman. 2006. Market reactions to tangible and intangible information. *The Journal of Finance* 61: 1605–43. [CrossRef]

Datar, Vinay T., Narayan Y. Naik, and Robert Radcliffe. 1998. Liquidity and stock returns An alternative test. *Journal of Financial Markets* 1: 203–19. [CrossRef]

Dechow, Patricia M., Richard G. Sloan, and Mark T. Soliman. 2004. Implied equity duration: A new measure of equity risk. *Review of Accounting Studies* 9: 197–228. [CrossRef]

Desai, Hemang, Shivaram Rajgopal, and Mohan Venkatachalam. 2004. Value-glamour and accruals mispricing: One anomaly or two? *The Accounting Review* 79: 355–85. [CrossRef]

Dichev, Ilia D. 1998. Is the risk of bankruptcy a systematic risk? *The Journal of Finance* 53: 1131–47. [CrossRef]

Eisfeldt, Andrea L., and Dimitris Papanikolaou. 2013. Organization capital and the cross-section of expected returns. *The Journal of Finance* 68: 1365–406. [CrossRef]

Elgers, Pieter T., May H. Lo, and Ray J. Pfeiffer Jr. 2001. Delayed security price adjustments to financial analysts' forecasts of annual earnings. *The Accounting Review* 76: 613–32. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 1992. The Cross-Section of Expected Stock Returns. *Journal of Finance* 47: 427–65. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 1993. Common Risk Factors in the Returns on Stocks and Bonds. *Journal of Financial Economics* 33: 3–56, 55–84. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 2015. A Five-Factor Asset Pricing Model. *Journal of Financial Economics* 116: 1–22. [CrossRef]

Ferson, Wayne E., and Campbell R. Harvey. 1999. Conditioning variables and the cross section of stock returns. *The Journal of Finance* 54: 1325–60. [CrossRef]

Fisch, Jill E., and Jonah B. Gelbach. 2021. Power and statistical significance in securities fraud litigation. *Harvard Business Law Review* 11: 55. [CrossRef]

Foster, George, Chris Olsen, and Terry Shevlin. 1984. Earnings releases, anomalies, and the behavior of security returns. *Accounting Review* 59: 574–603.

Francis, Jennifer, Ryan LaFond, Per Olsson, and Katherine Schipper. 2005. The market pricing of accruals quality. *Journal of Accounting and Economics* 39: 295–327. [CrossRef]

Frazzini, Andrea, and Lasse Heje Pedersen. 2014. Betting against beta. *Journal of Financial Economics* 111: 1–25. [CrossRef]

Fu, Fangjian. 2009. Idiosyncratic risk and the cross-section of expected stock returns. *Journal of Financial Economics* 91: 24–37. [CrossRef]

Gormley, Todd A., and David A. Matsa. 2014. Common errors: How to (and not to) control for unobserved heterogeneity. *The Review of Financial Studies* 27: 617–61. [CrossRef]

Green, Jeremiah, John R. M. Hand, and X. Frank Zhang. 2017. The characteristics that provide independent information about average US monthly stock returns. *The Review of Financial Studies* 30: 4389–436. [CrossRef]

Gu, Shihao, Bryan Kelly, and Dacheng Xiu. 2020. Empirical asset pricing via machine learning. *The Review of Financial Studies* 33: 2223–73. [CrossRef]

Hahn, Jaehoon, and Hangyong Lee. 2009. Financial constraints, debt capacity, and the cross-section of stock returns. *The Journal of Finance* 64: 891–921. [CrossRef]

Harvey, Campbell R. 2017. Presidential address: The scientific outlook in financial economics. *The Journal of Finance* 72: 1399–440. [CrossRef]

Harvey, Campbell R., and Yan Liu. 2021. Lucky factors. *Journal of Financial Economics* 141: 413–35. [CrossRef]

Harvey, Campbell R., Yan Liu, and Heqing Zhu. 2016. . . . and the cross-section of expected returns. *The Review of Financial Studies* 29: 5–68. [CrossRef]

Harvey, Campbell R., Yan Liu, and Alessio Saretto. 2020. An evaluation of alternative multiple testing methods for finance applications. *The Review of Asset Pricing Studies* 10: 199–248. [CrossRef]

He, Shuoyuan, and Ganapathi Gans Narayanamoorthy. 2020. Earnings acceleration and stock returns. *Journal of Accounting and Economics* 69: 101238. [CrossRef]

Heston, Steven L., and Ronnie Sadka. 2008. Seasonality in the cross-section of stock returns. *Journal of Financial Economics* 87: 418–45.

Hirshleifer, David, Kewei Hou, Siew Hong Teoh, and Yinglei Zhang. 2004. Do investors overvalue firms with bloated balance sheets? *Journal of Accounting and Economics* 38: 297–331. [CrossRef]

Hirshleifer, David, Po-Hsuan Hsu, and Dongmei Li. 2013. Innovative efficiency and stock returns. *Journal of Financial Economics* 107: 632–54. [CrossRef]

Hou, Kewei. 2007. Industry information diffusion and the lead-lag effect in stock returns. *The Review of Financial Studies* 20: 1113–38. [CrossRef]

Hou, Kewei, and Tobias J. Moskowitz. 2005. Market frictions, price delay, and the cross-section of expected returns. *The Review of Financial Studies* 18: 981–1020. [CrossRef]

Hou, Kewei, and David T. Robinson. 2006. Industry concentration and average stock returns. *The Journal of Finance* 61: 1927–56.

Hou, Kewei, Chen Xue, and Lu Zhang. 2015. Digesting anomalies: An investment approach. *The Review of Financial Studies* 28: 650–705.

Hou, Kewei, Chen Xue, and Lu Zhang. 2020. Replicating anomalies. *The Review of Financial Studies* 33: 2019–133. [CrossRef]

Jacobs, Heiko, and Sebastian Müller. 2020. Anomalies across the globe: Once public, no longer existent? *Journal of Financial Economics* 135: 213–30. [CrossRef]

Jegadeesh, Narasimhan. 1990. Evidence of predictable behavior of security returns. *The Journal of Finance* 45: 881–98. [CrossRef]

Jennings, Jared N., Jung Min Kim, Joshua A. Lee, and Daniel J. Taylor. 2020. Measurement error and bias in causal models in accounting research. *SSRN*, 3731197. [CrossRef]

Jensen, Theis Ingerslev, Bryan T. Kelly, and Lasse Heje Pedersen. 2021. Is there a replication crisis in finance? No. w28432. *National Bureau of Economic Research*. [CrossRef]

Jiang, Guohua, Charles Lee, and Yi Zhang. 2005. Information uncertainty and expected returns. *Review of Accounting Studies* 10: 185–221. [CrossRef]

Kothari, Sagar P., Jay Shanken, and Richard G. Sloan. 1995. Another look at the cross-section of expected stock returns. *The Journal of Finance* 50: 185–224. [CrossRef]

La Porta, Rafael. 1996. Expectations and the cross-section of stock returns. *The Journal of Finance* 51: 1715–42. [CrossRef]

Lamont, Owen, Christopher Polk, and Jesús Saá-Requejo. 2001. New evidence on measuring financial constraints: Moving beyond the KZ index. *The RAND Journal of Economics* 32: 101–28.

Lehmann, Bruce N., and David M. Modest. 2005. Diversification and the optimal construction of basis portfolios. *Management Science* 51: 581–98. [CrossRef]

Lewellen, Jonathan, and Stefan Nagel. 2006. The conditional CAPM does not explain asset-pricing anomalies. *Journal of Financial Economics* 82: 289–314. [CrossRef]

Litzenberger, Robert H., and Krishna Ramaswamy. 1979. The effect of personal taxes and dividends on capital asset prices: Theory and empirical evidence. *Journal of Financial Economics* 7: 163–95.

Liu, Weimin. 2006. A liquidity-augmented capital asset pricing model. *Journal of Financial Economics* 82: 631–71. [CrossRef]

Loughran, Tim, and Jay W. Wellman. 2011. New evidence on the relation between the enterprise multiple and average stock returns. *Journal of Financial and Quantitative Analysis* 46: 1629–50. [CrossRef]

Lu, Haitian, and Jiajia Fu. 2014. Structural Changes in the Chinese Stock Market: A Review of Empirical Research. *China Accounting and Finance Review* 16: 1–27. [CrossRef]

Lyandres, Evgeny, Le Sun, and Lu Zhang. 2008. The new issues puzzle: Testing the investment-based explanation. *The Review of Financial Studies* 21: 2825–55. [CrossRef]

McLean, R. David, and Jeffrey Pontiff. 2016. Does academic research destroy stock return predictability? *The Journal of Finance* 71: 5–32. [CrossRef]

Menzly, Lior, and Oguzhan Ozbas. 2010. Market segmentation and cross-predictability of returns. *The Journal of Finance* 65: 1555–80. [CrossRef]

Miller, Merton H., and Myron S. Scholes. 1982. Dividends and taxes: Some empirical evidence. *Journal of Political Economy* 90: 1118–41.

Mohanram, Partha S. 2005. Separating winners from losers among low book-to-market stocks using financial statement analysis. *Review of Accounting Studies* 10: 133–70. [CrossRef]

Moskowitz, Tobias J., Yao Hua Ooi, and Lasse Heje Pedersen. 2012. Time series momentum. *Journal of Financial Economics* 104: 228–50. [CrossRef]

Novy-Marx, Robert. 2013. The other side of value: The gross profitability premium. *Journal of Financial Economics* 108: 1–28. [CrossRef]

Penman, Stephen H., and Xiao-Jun Zhang. 2012. Accounting conservatism, the quality of earnings, and stock returns. *The Accounting Review* 77: 237–64. [CrossRef]

Penman, Stephen H., and Julie Lei Zhu. 2014. Accounting anomalies, risk, and return. *The Accounting Review* 89: 1835–66. [CrossRef]

Penman, Stephen, and Julie Zhu. 2022. An accounting-based asset pricing model and a fundamental factor. *Journal of Accounting and Economics* 73: 101476. [CrossRef]

Penman, Stephen H., Scott A. Richardson, and Irem Tuna. 2007. The book-to-price effect in stock returns: Accounting for leverage. *Journal of Accounting Research* 45: 427–67. [CrossRef]

Penman, Stephen H., Francesco Reggiani, Scott A. Richardson, and Irem Tuna. 2018. A framework for identifying accounting characteristics for asset pricing models, with an evaluation of book-to-price. *European Financial Management* 24: 488–520. [CrossRef]

Petersen, Mitchell A. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies* 22: 435–80. [CrossRef]

Petkova, Ralitsa. 2006. Do the Fama–French factors proxy for innovations in predictive variables? *The Journal of Finance* 61: 581–612. [CrossRef]

Piotroski, Joseph D. 2000. Value investing: The use of historical financial statement information to separate winners from losers. *Journal of Accounting Research* 38: 1–41. [CrossRef]

Pontiff, Jeffrey, and Artemiza Woodgate. 2008. Share issuance and cross-sectional returns. *The Journal of Finance* 63: 921–45. [CrossRef]

Richardson, Scott, Irem Tuna, and Peter Wysocki. 2010. Accounting anomalies and fundamental analysis: A review of recent research advances. *Journal of Accounting and Economics* 50: 410–54. [CrossRef]

Sloan, Richard G. 1996. Do stock prices fully reflect information in accruals and cash flows about future earnings? *Accounting Review* 71: 289–315.

Thomas, Jacob, and Frank X. Zhang. 2011. Tax expense momentum. *Journal of Accounting Research* 49: 791–821. [CrossRef]

Whited, Toni M., and Guojun Wu. 2006. Financial constraints risk. *The Review of Financial Studies* 19: 531–59. [CrossRef]

Xie, Hong. 2001. The mispricing of abnormal accruals. *The Accounting Review* 76: 357–73. [CrossRef]

Zhang, Lu. 2017. The investment CAPM. *European Financial Management* 23: 545–603. [CrossRef]