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Origin and Evolution of Momentum: A Literature Review

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Abstract. The multi-factor models are playing an indispensable role in understanding the systematic risk and the market perception of value across assets. Within the zoo of factors, the momentum factor and the robustness of its associated returns have captured substantial attention in the asset pricing research. We briefly tracked the evolution of the multi-factor models with a particular emphasis on the multidimensional elaboration of momentum. We present a comprehensive review of the theoretical underpinnings and empirical evidence pertaining to momentum, as documented in extant literature. Our analysis synthesizes the current state of knowledge, illuminating the significance of momentum in contemporary asset pricing and its implications on the financial markets.

Keywords: momentum, asset pricing, factor model, behavioral finance

1. Introduction

The examination of risk factors constitutes a fundamental area of inquiry in asset pricing, with the primary goal of understanding and forecasting asset returns to aid investors in effective portfolio management. This field has witnessed significant advancements, particularly through the introduction of the multi-factor models, which have enhanced our comprehension of market risk and propelled the development of asset pricing theory. The field was initially grounded in the Capital Asset Pricing Model (CAPM) [1,2], which employed a single market factor to explain returns of all risky assets. However, empirical research soon revealed substantial limitations in this approach, particularly when addressing phenomenon such as the other factors discovered later that aimed to compensate for the ineffectiveness of the CAPM.

In response to these shortcomings, recent scholarly efforts have concentrated on refining these multi-factor models to better capture systematic risk in a more pragmatic and manageable manner by incorporating additional factors to the models or refining the construction of existing ones. One of the major merits of the multi-factor models originate from its comparison with the traditional mean-variance optimalization approach, as proposed by Markowitz [3], which have become increasingly impractical when applied to a vast array of individual securities due to the complexity involved in

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estimating expected returns, variance, and correlations. Multi-factor models tackle this issue by identifying a limited set of common factors that explain returns across various securities and asset classes. This allows investors to strategically diversify their portfolios by focusing on more investable and replicable risk factors, making the models more practical and effective in investment decision-making. Over time, influential models like the Fama-French three-factor model [4] were developed, incorporating factors such as size and value to offer a more comprehensive explanation of stock returns. These advancements laid the groundwork for further model extensions, including the Carhart four-factor model [5] and the Fama-French five-factor model [6]. These innovations not only improved the explanatory power of asset pricing models in the interpretation of asset returns, but also expanded their applicability in areas such as portfolio management, risk control, and financial market regulation. These ongoing developments in multi-factor modeling enhance the precision of expected return predictions, improve risk exposure estimation, and provide more reliable benchmarks for the assessment of investment performance.

Of the various anomalies observed, the price momentum effect presents the greatest challenge to be reconciled within the traditional risk-based asset pricing framework. The prelude of the momentum effect in Jegadeesh and Titman [7] has sparked widespread academic discussion in the formation of this phenomenon which has already been utilized widely in the formulation of investment strategies that typically involve buying portfolios of stocks that have performed the best in the past and shorting those that have performed the worst, thereby achieving excess returns. Although as simple as the strategy it is, and as effectiveness the strategy it is over the past few decades, there remains considerable debate and unresolved questions regarding the driving factors behind the momentum effect and its temporal sustainability.

Therefore, we will delve into the momentum effect particularly in a literature review fashion to examine the breadth and persistence of the momentum effect and assess its effectiveness under varying market conditions. The rest of the article proceeds as follows. Section II generally delineates the evolution of factor models, with a particular focus on the empirical testing of the CAPM and the significance of the Fama-French three-factor model. Section III looks closer at the initial introduction of the momentum factor through Carhart's [5] four-factor model. Section IV covers the different characteristics of the momentum strategies' performance across diverse markets and assets. Section V presents different views on the driving factors of momentum. Section VI provided an outlook on the new ideas on momentum. Section VII concludes.

2. Background: evolution of factor models

2.1. Capital asset pricing model

The Capital Asset Pricing Model (CAPM) is a foundational model in financial economics. The fundamental idea of the CAPM is to determine an asset's expected return solely based on its associated market risk beta as a measure of its systematic risk exposure, thus providing investors with a simple tool for informed investment decision-making.

In practice, however, the CAPM often struggles to accurately predict returns. The hypothesized linear relationship between the market beta and expected returns do not align with actual empirical observations. Although past research such as Douglas [8], Black, Jensen, and Scholes [9], and Blume and Friend [10] have found a positive relationship between assets' average return and their market beta, the relationship found is too "flat" to be the complete answer in explaining risk premium. This discrepancy could be driven by certain limitations of the model. For example, the assumptions of the CAPM are overly simplistic, as the CAPM assumes that investors can borrow

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without limitation at the risk-free rate, which is unrealistic. To address this, Fischer Black [11] introduced an amended version of the CAPM in 1972 that excluded risk-free borrowing and posit that when investors allocate their chosen efficient portfolio based on the stocks they invest in, the resulting portfolio becomes the market portfolio, making it the efficient portfolio that the investors will select.

Additionally, the CAPM assumes that the market operates with full efficiency, meaning quick incorporation of all available information to asset prices, leaving no room for investors to timely obtain excess returns through information imbalances utilization. However, markets are not always fully efficient in reality. Asset prices can deviate from their true value due to factors such as information asymmetry, market frictions, and behavioral biases. Information asymmetry arises when certain participants hold insider information, causing price distortions. Behavioral biases, such as overconfidence and herd mentality, can lead to price fluctuations that don't align with underlying fundamentals. Moreover, market frictions, including transaction costs, taxes, and liquidity constraints, can hinder market information transmission. These challenges are explored in Fama and French [12].

Furthermore, accurately estimating the market risk premium can be challenging. The market risk premium is usually considered as the gap between the expected return of the market portfolio and the risk-free rate. However, since the on the market expected return refers to a future value, it cannot be directly observed. Therefore, investors must rely on historical data or forecasting models to estimate this expected return, but historical data does not always accurately reflect future conditions. The volatility of market returns across different time periods can lead to significant variations in the estimated expected return based on different historical windows. This can result in an unstable estimate of the market risk premium. Also, since the risk-free return is usually represented by the Treasury bond yield, but since government bonds have different maturities, investors must choose an appropriate maturity for risk-free rate determination. In practice, the choice of bond maturity often depends on the investor's investment horizon, which further complicates the estimation of the market risk premium.

Finally, it is important to acknowledge the limitations of the data. Through testing, it becomes evident that the CAPM equation is applicable to the relationship between expected returns and portfolio beta for any mean-variance efficient portfolio, rather than being solely limited to the market portfolio. However, the efficiency of these portfolios is based on several unrealistic assumptions, including unanimous investor agreement and the ability to borrow or short sell risk assets without restrictions. However, it is important to note that all significant models incorporate some level of unrealistic simplification. One of the key assumptions of the CAPM model is the existence of a "market portfolio" that includes all investable assets. The market indices we typically use are only approximations of the market portfolio and do not fully represent the entire set of investable risky assets. Since the market portfolio itself cannot be fully observed or measured, the reliability and accuracy of beta, as a measure of systematic risk relative to the market portfolio, are inherently subject to scrutiny.

The CAPM is a single-factor model, meaning it focuses solely on market risk as the primary factor determining asset expected returns. However, Roll [13] argued that in reality, numerous additional risk factors can affect asset returns as well, which are overlooked within the CAPM framework and the calculation of beta. This suggests that relying exclusively on market beta to predict or explain an asset's expected returns is often inadequate, as these omitted risk factors can have a significant impact on the actual returns.

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2.2. Multi-factor models

The Arbitrage Pricing Theory (APT) is an asset pricing model introduced by economist Stephen Ross in 1976 [14]. APT serves as the theoretical base to alternative models to the CAPM which aim to explain an asset's expected return by using multiple systematic risk factors. The core idea of APT is that an asset's price should reflect the multiple systematic risk factors it is exposed to, in a market with no arbitrage opportunities, an asset's price should reflect these risk factors. If the price deviates from the fair value based on these factors, arbitrageurs will profit from buying and selling the asset until the price returns to equilibrium. Unlike the CAPM, which only considers the market risk factor. APT assumes that the expected return of an asset is determined by a linear combination of various systematic risk factors. These factors may include economic growth rates, inflation rates, interest rates, exchange rate fluctuations, energy prices, and more. APT provides a theoretical framework for multi-factor models, suggesting that different risk factors (such as macroeconomic variables, industry-specific factors, etc.) jointly determine the expected return of an asset. This flexibility allows APT to serve as a more generalized model, laying the theoretical groundwork for the development of future multi-factor models.

The Fama-French three-factor model [4] extends the traditional CAPM with two additional factors to more accurately capture cross-sectional stock returns variations. In addition to the market risk premium, the model incorporates SMB (Small Minus Big) and HML (High Minus Low), where SMB captures the difference in returns between small-cap and large-cap stocks, reflecting the higher risks and potential returns associated with small-cap companies. HML captures the return differential between stocks with a high book-to-market ratio, referred to as value stocks, and those with a low book-to-market ratio, known as growth stocks. Value stocks are generally seen as having higher return potential compared to growth stocks, as their market prices are relatively undervalued in relation to their book values. The Fama-French three-factor model offers several advantages over the CAPM as the additional factors' inclusion enables the model to more accurately explain stock portfolio returns by capturing the tendency in size and value effects. Consequently, the three-factor model significantly reduces the alpha values (the pricing error) that were originally substantial in the CAPM model. Moreover, the Fama-French three-factor model has extensive empirical support using data from the U.S. stock market, where it has shown good fit [4]. It has been applied not only in stock market analysis but also in fund performance evaluation and offers investors more extensive analytical tools to better understand the market, optimize asset allocation, and manage risk.

However, the model also has its drawbacks. It neglects other potential stock return anomalies, such as momentum and profitability effects. To address this, subsequent research such as Jegadeesh and Titman [7] and Carhart [5] have brought the momentum effect into the model, while Fama and French [6] have introduced the five-factor model to account for profitability and investment factors based on the Fama-French three-factor model. Additionally, the factors associated with size and book-to-market ratio can exhibit instability across different time periods, affecting their predictive abilities under varying market conditions. The model does not allow dynamical adjustments on the weights of these factors, which can lead to poor performance during certain periods. Lastly, while the three-factor model performs well in the U.S. markets, its applicability in other emerging markets could be limited, as the size and value effects can differ across countries and regions [15]. As financial markets evolve, newer risk factors have emerged, further expanding the investment analysis toolkit.

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3. Discovering momentum factor

3.1. Definition and origin of the momentum factor

Generally speaking, momentum refers to the momentum of price, which is the inertia in the market price of an asset to maintain its current direction of movement. Momentum typically points to the likelihood that assets with historical outperformance are likely to maintain their upward trend, while assets with a historical underperformance tend to continue on a downward trajectory. And consequently, it suggests the predictive power in the asset's historical returns on its future returns.

The momentum strategy was first brough to light by Jegadeesh and Titman [7] in the U.S. common stock market using data from 1927 to 1990, where they manage “formation period” and “holding period” for the performance capitalization of the momentum strategy. They achieved this by ranking stocks based on their short-term performance over the previous three to twelve months, the top 10% of the highest-performing stocks were placed in a “winners” portfolio, while the bottom 10% were grouped into a "losers" portfolio. A zero-cost portfolio is then formed by longing the “winners” portfolio and shorting the “losers” portfolio at the beginning of the month after the formation period and is maintained for the holding period, such as 3, 6, 9, or 12 months. Risk-adjusted returns were evaluated using the beta- and size- based subsamples to account for other potential systematic risk factor exposures, and various formation and holding period combinations were tested to assess their effectiveness. Over different timeframes, the momentum strategy yielded significant excess returns generally. For example, a momentum strategy based on the previous six months’ returns generated an average monthly excess return of around 1% over the next six months. The significant zero-investment portfolio returns demonstrated that past price momentum could forecast future returns effectively. Even after factoring in transaction costs, the momentum strategy remained highly profitable, challenging the traditional efficient market hypothesis. This research laid the groundwork for Carhart’s [5] four-factor model.

3.2. Carhart's interpretation and construction of the momentum factor

Camerer [16] introduced the concept of the "hot hand" effect in the context of basketball games. Although Camerer's study revealed the existence of this phenomenon, there is no practical application of this finding for investors due to market commissions limiting potential profits. Building on this idea, Hendricks, Patel, and Zeckhauser [17], Goetzmann and Ibbotson [18], and Brown and Goetzmann [19] documented the short-term performance persistence of mutual funds for up to three years. Their studies consolidate the “hot hand” effect by showing that certain funds consistently outperform and maintain that performance for subsequent short periods, while underperforming funds show similar persistence in their poor performance.

According to Brown et al. [20], the research on mutual fund performance persistence was often hampered by survivor bias. It typically originates from the closing down of underperforming mutual funds, thus contaminate the result towards the edge of confusion on whether the observed persistence is in fact a consequence of momentum. Therefore, subsequent studies have largely accounted for the effect of survivor bias. For instance, Hendricks, Patel, and Zeckhauser [17] addressed this issue by using a more focused collection of growth-oriented open-end and equity mutual funds from 1974 to 1988, which helped reduce survivorship bias. Fama and French [4] improved the study's systematic approach later in the same year. The empirical evidence on testing their three-factor model showed that all three factors can explain the returns of the majority of fund strategies, but not momentum at all.

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Carhart [5] investigated the short-run persistence of mutual fund performance based on the CAPM and the Fama-French three factor model and proposed a four-factor model with an additional momentum factor. Carhart begins his study by pointing out that although the three-factor model is more accurate in explaining mutual fund returns, however, it is not significantly economically different from the CAPM in general. He noted that the momentum-related pricing alpha calculated using the three-factor model remained significant, indicating that the model does not fully capture the returns driven by momentum strategies. Additionally, survivor bias must be taken into account: Fama and French's [4] three-factor model might primarily reflect the performance of surviving, well-performing funds, which could result in an underestimation of alpha and an overestimation of the model's explanatory power. Second, from Hendricks, Patel, and Zeckhauser [17], it is found that a more comprehensive data span can increase the precision of the data. To address this issue, Carhart built on Jegadeesh and Titman's [7] study by incorporating a momentum factor into Fama and French's [4] three-factor model. He also utilized a longer and more comprehensive dataset of U.S. mutual funds from 1962-1993, free from survivor bias. This broader dataset allowed for more accurate results and significantly reduced the impact of survivor bias on the study, enhancing the reliability of the findings. In Carhart's model, he constructed an zero-investment factor mimicking portfolio (labeled PY1YR) to replicate the momentum factor. This portfolio captures the returns difference between the bottom 30% worst-performing stocks and the top 30% best-performing stocks over the previous 11 months, using an equal-weighted approach. Empirical results demonstrated the effectiveness of this added momentum factor. The average absolute pricing error was reduced to 0.14% per month using the Carhart's four-factor model, in contrast to 0.31% for the three-factor model and 0.35% for the CAPM. The inclusion of the momentum factor significantly improved the model's explanatory power to the cross-sectional stock return variations, and have almost eliminated systematic pricing errors. Furthermore, Carhart's model revealed a 0.67% difference in excess monthly return between the "winners" and "losers" portfolios, translating to an 8.04% annual difference. This substantial return difference proved the statistically significant role of the momentum effect during the sample period, driving notable variations in returns across different portfolios.

Carhart [5] also finds that the short-term performance persistence of mutual fund as shown in former studies is largely driven by the short-term momentum [7]. Therefore, the four-factor model can capture the short-term fund performance in a more comprehensive manner. However, despite its effectiveness in return estimation, the Carhart's [5] model does have inherent flaws towards our expectation in understanding the driving factors behind the momentum effect. Since Carhart's [5] momentum factor is only a rough transformation of the returns from the momentum phenomenon, it does not offer almost any intuitive underlying explanations from either a risk-compensating perspective or a behavioral perspective, which we will further explore in section V.

4. Momentum strategies in different assets and markets

Momentum strategies, i.e., buying past winners and selling past losers, which have been fully discussed about its origin in last part, have also been extensively researched across various markets and asset classes. In this section, three parts will be discussed. In the first part, we will explore the performances of momentum strategies in different assets, including stock, currencies, commodities, futures and bonds. Then the momentum effect across countries will be investigated in the second part and we will focus on market integration lastly.

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4.1. Momentum in different assets

4.1.1. Momentum in stock market

Historically, Levy [21] proposes a trading phenomenon that demonstrates the stock market momentum effect. He states, investors bought stocks whenever their prices were significantly higher than their moving average, which led to significant abnormal returns. At that time, most of the academic debate concentrates on contrarian strategies (essentially, sell past winners and buy past losers), and Levy's trading rule was questioned by Jensen and Bennington [22], though strong trading rules are widespread among practitioners. Based on the tendency shown by Grinblatt and Titman [23,24], most mutual fund companies bought stocks that gained and succeeded in the Value Line rankings. It suggests that the strategies of Relative Strength from Levy [21] can achieve abnormal returns in stock.

The momentum strategy was born in the United States stock market from 1965 to 1989, based on Jegadeesh and Titman [7] and Asness [25]. The former claims that winners in the recent US stock market outperform previous losers by up to 1.49% monthly, indicating that momentum-based strategies are better than contrarian-based strategies. Their follow-up study confirms that the profitability of the strategies from 1990 to 1997 persist [26]. Meanwhile, Asness [25] concludes that one-year momentum represents a third factor, alongside the firm size factor and the book-to-market ratios factor. Besides, by using new data from the London Stock Exchange and post-Depression U.S. markets during the Victorian era, Chabot, Ghysels and Jagannathan [27] discover that the strategies have yielded over-140-years abnormal returns. Later, Geczy and Samonov [28] identified the role of momentum premium as an interface between asset classes.

Interestingly, several psychological biases have been highlighted as potential factors of price momentum in behavioral finance literature like Grinblatt and Han [29]: driven by "prospect theory" and "mental accounting", some investors tend to hold on to losing stocks. This can impede informational diffusion and then the price momentum in stocks. More details will be discussed in the next part.

4.1.2. Momentum in currencies market

The profitability of momentum also shown in currencies. Earlier, several behavioral factors indicate it is in the best interest of individual traders to stimulate the continuous correlation of currencies if they believe that the emotions of investor would stably remain. They can push the value of a currency off its value by trading with the market within a relatively short period of time [30]. Also, Kho [31] finds evidence of momentum profitability of currencies in both developing and developed markets.

The momentum strategies in currencies were first proved by Okunev and White [32]. They demonstrate that strategies that shorting the least appealing currencies but buying the most appealing currencies could gain excess returns and the momentum strategy on stocks also applies to currencies and persisted throughout the 1980s and 1990s. By using bootstrapping as methodology, they also show that the momentum performance in currencies relies on the autocorrelation of the currency returns.

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4.1.3. Momentum in futures market

Momentum also appears in the futures market. Fung and Hsieh [33] document that the most active trading advisors in commodity are trendy. Spurgin [34] points out that momentum strategy pursued by trend followers relies on the presumption that previous performance is ideal to future returns, suggesting that momentum-based strategies have earned a significant amount of pay-off in commodity futures. Attempts have also been made to implement cross-sectional momentum strategies in this kind of markets. Erb and Harvey [35] documents that, while the portfolio's commodity future constituents lack average and median excess return annually, the portfolio can gain equity-like profits by reconstructing it. After that, Shen et al [36]. discovers a significance returns from the statistical information. It is also noteworthy of the finding of Moskowitz, Ooi, and Pedersen [37] that the future time-series momentum, which occurs over various assets, produces substantial abnormal returns during pessimistic market conditions. Gorton, Hayashi, and Rouwenhorst [38] also connect time-series and cross-sectional change in commodity futures to the level of physical commodity inventories.

4.1.4. Momentum in bonds market

Momentum effects also exist in bonds. For example, Jostova et al. [39] documents skyrocketing profitability in bonds of US firms over the time span from 1973 to 2008. Similarly, Asness, Moskowitz, and Pedersen [40] obtain data in bond relevant to government; it has been profitable across 10 countries from 1982 to 2011, where its lower bound of country bond returns is 5%.

Jostova et al. [39] find some evidence that juxtaposes bonds with stocks. The momentum profits in stock mostly originate from the short side of the transaction when the rating is downgraded. However, bond momentum arises from the long side and the momentum profits of corporate bonds do not come solely from periods before and after the changes of rating. They removed the year-long data around the change of rating and discovered that the bond momentum is still significant. Furthermore, they show that bond momentum is resilient to systematic risk adjustments, such as in term premium and default risk premium. The claim indicates that the short-selling rule cannot explain the profitability of momentum in bonds.

Although literatures on corporate bonds find that investment grade bonds do not display momentum, like Jostova et al. [39], there are findings that show relations between bonds and stocks. For example, evidence has first shown in Gebhardt, Hvidkjaer, and Swaminathan [41] that corporate bond returns display momentum patterns that are similar to the equity market. They document that the company whose equity returns previously earn or low high would have corresponding bond returns. This indicates that there is a significant stock-bond momentum spillover within one company. Moreover, they also find that the stock-bond spillover effect is related to future changes in bond ratings. Specifically, past stock returns are indicative of future bond rating revisions. This means the credit profile of the stock winners will improve, while losers will deteriorate; their bonds will linger at the two extremes of performance over time. However, the latter finding is a bit different from Jostova et al. [39], whose research does not consider the cross-sectional effect, that the bond momentum effect would not necessarily relate to the ratings. Also, the spillover effect is further shown in Pitkäjärvi, Suominena and Vaittinen [42], which indicates that the returns of past bond markets are positive predictors of the returns of future stock market, and vice versa.

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4.1.5. Momentum in ETFs

The momentum-focused ETFs are the continued academic interest in momentum strategies. In chapter six of 'Market Momentum: Theory and Practice' written by Satchell and Grant [43], ETFs have become more and more popular since 2000s, and momentum ETFs have become a hot topic recently. In Cole, Schneider, Hemley, and Nations [44], momentum strategies are determined to be used as sector rotation strategies, even though there is little literature on testing these momentum strategies while using ETF because they are still relatively new. Interestingly, Dimkpah and Ngassam [45] found that there is no momentum when examining portfolios constructed with ETFs. However, when using the 'winner-loser' strategy, there seems to be a significant increase in returns. It is also worth noting that Ribeiro [46] tests the implementation of momentum ETFs using 20 tech ETFs that traded daily from 2010 to 2019. It finds that ETFs can have positive returns for 'losers' portfolios due to overconfident agents and government politics, which is evidenced by the stellar performance of the Technology Index.

4.2. Momentum in different markets

According to Chui, Titman, and Wei [47], investors in different cultures interpret information in a cognitively subjective manner. Influenced by the cultural differences, the momentum effect will not be identical in different markets. Medium-term (3 to 12 months) price momentum has been present and documented for the developed countries like US, Europe, and the developing markets.

Cross-sectional momentum has been well documented in equities market in different countries. By filtering out the previous well-performed portfolios, Jegadeesh and Titman [7] shows, compared to the average amount, firms in US equity market continue to outperform if they previously hold good a performance. Rouwenhorst [48] demonstrates that using momentum strategies in European equity markets could also earn profits. Grinblatt and Keloharju [49] utilize Finland's unique data set, showing that foreign investors prefer using momentum strategies, while domestic investors prefer the contrarian strategies. Evidence is not limited to developed countries. Rouwenhorst [50] documented the unpredictable factors in expected stock returns in emerging markets are qualitatively similar to developed markets, indicating that stocks in emerging market also exhibit momentum. For example, using stock market data in India, Balasubramaniam, Campbell, Ramadorai, and Ranish [51] find considerable heterogeneity in household portfolio composition, which shows discrepancy from the CAPM prediction. Meanwhile, China has also been detailed in work like Jones, Shi, Zhang, and Zhang [52], indicating that there will be some momentum patterns in retail investors whose accounts are small because of the individual preferences such as overconfidence and gambling activities. Then, retail investors whose account balances are large can take public news into account and thus predict future returns accurately, displaying contrarian patterns. We also see other evidence about other information of momentum in China stock market. For example, by making an analysis on Chinese A-share market, Yang, Gebka and Hudson [53] concluded that the momentum effects last longer in the pre-2001 period than the afterward period.

4.3. Momentum in global markets

We have already mentioned in the future market that there exists a 'time series momentum', a timing strategy utilizing past returns of each particular asset, in various asset classes, for global assistance [37]. This finding differs from the cross-sectional momentum strategies studied by Asness, Moskowitz and Pederson [40]. We also see evidence of momentum such as Frazzini and Pedersen

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[54] and Koijen, Moskowitz, Pedersen and Vrugt [55], which reveal the consistent returns in 'betting against beta' and global carry profits, respectively, considering the international equities and other assets.

Notably, international stock returns are explained by Fama and French [56] with their four-factor model, while Karolyi and Wu [57] identify stocks, both domestically and internationally, to build their size, value, and momentum factors, respectively. On the other hand, Cooper, Mitrache, and Priestley [58] show that factors from macroeconomic risk account for the value and momentum globally.

5. Explanations on momentum

What we have discussed before is mainly focused on the following parts, concerning origins of factor models, the construction of momentum investment strategies and the performance of those strategies under numerous asset classes or market types. However, they are all about the descriptions or evaluations on this particular phenomenon. For a unanimous effect that exhibits across different time periods, market border as well as asset types, provides a major challenge to the basic theory of efficient market [47], it is indispensable to provide in-depth explanations as to why the serial correlation exists and perform further explorations on its sources and determinants. Therefore, we then dig into this particular strand of literature, settle them under a logical structure, and try to figure out whether those literature are solid enough or still blur to serve as the theoretical foundation on this field. And if the phenomenon of momentum is still inexplicable and under high controversy, our job could help highlight the potential research gap, which may be conducive for future research.

The explanations on momentum effect could be primarily divided into two parts: irrational (behavioral) and rational (risk) perspective. In fact, the most prosperous strand of literature is derived in the perspective of irrational theories or investor psychology in other words. Several behavioral models are introduced to interpret the coexistence of intermediate horizon momentum and long horizon reversals in individual stock returns, i.e. the underlying momentum in stock returns. Under the scope of behaviors, the momentum could be regarded as traders' slow reaction (underreaction) or overreaction to news, which results in the sequential characteristics in the process of market absorption of news.

Specifically, one of the viewpoints can be summarized as 'anchoring effect', which means traders would always refer to a specific point as an anchor and utilize it to evaluate the potential value implicit in news, although the specific point per se would be far away from the intrinsic value of a stock, and even appear as several random numbers [59]. In this respect, investors constrained by the specific point are reluctant to revise their priors until the information finally prevails, resulting in underreaction and the pronounced predictability. According to the anchors mentioned in Klein [60] and Grinblatt and Han [61], the acquisition price of shares plays an essential role in explaining price dynamics, while motivated by tax avoidance and disposition effect respectively, resulting in reverse discoveries on the relationship between demand and imbedded gains. And in George and Hwang [62], the anchor could be the 52-week high, which covers the predictability of the former anchor.

As mentioned before, the 'disposition effect' is another important explanation from the behavioral perspective, generated by the prospect theory together with mental accounting framework [63,64]. Risk attitudes held by investors toward stocks are implicated by the paper capital gain or loss, or capital gain(loss) overhang in other words. According to Grinblatt and Han [61], investors are inclined to show more risk aversion with the increase of unrealized paper capital gain, when value of stocks goes up. This would lead to investors' underreaction to public information, resulting in a

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spread between the fundamental value and market value of stocks. And this potential mispricing would be sequentially reflected afterwards, leading to return distortions and momentum.

Sentiment effect also plays an essential role in interpreting stock market anomalies [65,66]. Antoniou, Doukas, and Subrahmanyam [67] provides robust empirical evidence for the link between investor sentiment and momentum, augmenting the argument formed by Hong and Stein [68], that incremental news diffuses slowly into stock market by the underreaction from investors. Also, Antoniou, Doukas, and Subrahmanyam [67] finds that relationship significant especially when the additional information contradicts with the current sentiment, resulting in cognitive dissonance. This argument is consistent with the conservatism bias [69] that individuals exposed to new evidence are still slow to change the impression formed before.

As we mentioned before, momentum is not only presented as short-term correlation of return, but also often followed by a reversal from long-term perspectives. However, most literature focuses on the first half of it by revealing the mechanism on investors' short-term underreaction. Indeed, the subsequent reversal could be further interpreted as a modification or correction of investors' former overreaction. The identification of investors' delayed overreaction and momentum first came up by Delong, Shleifer, Summers and Waldmann [70]. Then Barberis, Shleifer and Vishny [69] referred to "representativeness heuristic" for explanations on the overreaction mechanism, which is a tendency of individuals to draw patterns of sequences, no matter how random the situation is. Therefore, investors would infer the process and jump into conclusion in haste without efficient observation periods, resulting in erroneous overshooting pricing. Although George and Hwang [62] once call for the construction of separate theories on short-term and long-term predictability in prices rather than an integrated framework containing both, we still place great emphasis on integrating the above two viewpoints, i.e. underreaction and delayed overreaction, by clarifying the boundary of those two theories at least.

In that integrated respect, Daniel, Hirshleifer and Subrahmanyam [71] takes the first attempt. They argue that those informed investors are affected by a 'self-distribution' bias, which makes them unequally and asymmetrically attribute the performance of ex-post winners to their own skills while ex-post losers to insufficient luck or noises. Therefore, the increasing overconfidence brought by investors would consecutively push up the market prices above fundamental values, and finally modify them by reversals. Additionally, Daniel, Hirshleifer and Subrahmanyam [71] also points out the effect of market states to momentum strategies, which is also the first attempt to figure out the boundaries of sources of momentum. Several following studies have also shown different momentum effect across various market conditions [67,72]. Although momentum factor and the investment strategy based on it seem like a contradiction to the efficient market hypothesis, there are still several studies provide rational explanations stemming from risk-based asset pricing models, in order to align the existence of momentum with efficient market.

From the perspective of risk, the momentum effect is regarded as compensation for risk. For instance, Hong and Stein [68] present a graceful explanation to momentum without reference to any irrational biases implicit in investors. They simply attribute it to different partial information sets available to different types of investors and integrate both short-term underreaction and long-term reversals under a certain argument, that those informed traders would take more underreaction, while those technical traders tend to overshoot the price, resulting in following reversals. Johnson [73] places the stochastic expected growth rate on the core position of the model, which provides a more direct explanation channel in comparison with that in Berk, Green and Naik [74]. Based on that, Sagi and Seasholes [75] consider firm-specific attributes in the model, which takes further steps in explaining enhanced momentum strategies including a richer set of determinants.

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Nevertheless, given the long-standing positive returns as well as the staggering Sharpe ratios, the momentum effect is both too persistent and significant to be interpreted only through the lens of risk [76,47]. Therefore, it is still more prevalent to take the irrational behaviors of investors into account in terms of explanations.

6. Future outlook on momentum

The above discussion is based on a common premise that the momentum is a distinct factor. However, Ehsani and Linnainmaa [77] think out of the box and argue that the momentum indeed aggregates all the autocorrelation found in other existing factors, and it could even be generalized across different classes of assets. This point of view provides a brand-new version of explanation on momentum factor, or even implies a potential collapse of the current shaky theoretical foundation.

7. Conclusion

The momentum effect has emerged as a significant and persistent phenomenon that challenges traditional asset pricing theories for a unified explanation and prompting extensive research across various asset classes and global markets. In this review paper, we have delineated the evolution of factor models, from the seminal CAPM to more sophisticated multi-factor models, setting out the momentum factor in explaining cross-sectional variations in asset returns. Our analysis on the past literature reveals that momentum strategies have demonstrated remarkable robustness and are consistently yielding significant abnormal returns across diverse asset classes including stocks, currencies, commodities, futures, and bonds. Moreover, the persistence of momentum effects across international markets showed its pervasive nature, transcending financial and geographical boundaries.

Despite its widespread empirical support, the underlying drivers of momentum remain a subject of vigorous academic debate. Two primary sources of thought have emerged: rational explanations rooted in risk-based models, and behavioral theories attributing momentum to cognitive biases of human and market inefficiencies. While behavioral explanations, such as investor underreaction, overconfidence, and the disposition effect, have gained considerable traction in the past academic debate, a unified theoretical framework remains elusive as claimed. As research continues to evolve, future studies may benefit from exploring the interactions between rational and behavioral (or psychological) factors, investigating the role of market conditions and investor sentiment, and examining the potential limits to arbitrage that allow momentum effects to persist. As financial markets continue to evolve, the study of momentum still awaits further academic inquiry and application in investment strategies.

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