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Physical approach to price momentum and its application to momentum strategy

Jaehyung Choi *

Department of Physics and Astronomy, SUNY Stony Brook, NY 11794-3800, USA

HIGHLIGHTS

- We introduce the physical momentum concept to price momentum in finance.
- Using the physical momentum, the weekly contrarian strategies are implemented in KOSPI 200 and S&P 500.
- The alternative portfolios outperform the traditional contrarian strategy.
- The alternative portfolios are less riskier in VaR, CVaR, Sharpe ratio, and maximum drawdown.

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ABSTRACT

We introduce various quantitative and mathematical definitions for price momentum of financial instruments. The price momentum is quantified with velocity and mass concepts originated from the momentum in physics. By using the physical momentum of price as a selection criterion, the weekly contrarian strategies are implemented in South Korea KOSPI 200 and US S&P 500 universes. The alternative strategies constructed by the physical momentum achieve the better expected returns and reward–risk measures than those of the traditional contrarian strategy in weekly scale. The portfolio performance is not understood by the Fama–French three-factor model.

1. Introduction

Searching for the existence of arbitrage is an important task in finance. In the case of the statistical arbitrages, regardless of their origins such as market microstructure, firm-specific news/events, and macroeconomic factors, it is possible to exploit arbitrage opportunities via trading strategies in order to take consistent profits. Among such kinds of the statistical arbitrage chances, they are also called as market anomalies, if their origins are not well-explained or understood quantitatively and qualitatively [1,2]. To academic researchers in finance, it is very useful for testing the robustness of the efficient market hypothesis [3,4] and no-arbitrage theorem. Although they had played the keystone roles in asset pricing theory and general finance, their statuses recently have been changed as alternative theories that intrinsically allow the pricing anomalies have appeared in financial markets, as instances, the adaptive market hypothesis [5–7] and behavioral finance [8–11]. Hunting for the systematic arbitrage opportunities is also crucial to market practitioners such as traders and portfolio managers on Wall street because it is the core of money-making process that is their most important role.

Among these market anomalies, price momentum has been the most well-known example to both groups. Since Jegadeesh and Titman's seminal paper [12], it has been reported that the prices of financial instruments exhibit the momentum effect that the future price movement tends to keep the same direction along which it has moved during a given past

* Tel.: +1 631 921 4389; fax: +1 631 632 8176.
E-mail addresses: jj.jaehyung.choi@gmail.com, jaehyung.choi@sunysb.edu.

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period. It is also realized that the momentum strategy, a long–short portfolio based on the momentum effect, has been a profitable trading strategy in the stock markets of numerous developed and emerging countries during a few decades even after its discovery [13,14]. In addition to the existence in equity markets, the momentum effect large enough to implement as the trading strategy is also found in other asset classes such as foreign currency exchange [15], bond [16], futures [16,17], and commodities markets [18].

In spite of its success in profitability over diverse asset classes and markets, its origin has not been fully understood in the frame of traditional mainstream finance. This is why the momentum effect is one of the most famous market anomalies. Attempts to explain the momentum effect with factor analysis have failed [19] and the reason the momentum effect has persisted over decades still remains mysterious. The Fama–French three factor model is able to explain small portions of the momentum return [19]. The lead–lag effect or auto-/cross-sectional correlation between equities are one of the possible answers to the momentum effect [20,21]. The sector momentum is another partial interpretation on the anomaly [22]. Additionally, the behavioral aspects of investors such as collective response to financial news and events have broadened the landscape of understanding on the momentum effect [23–26]. Transaction cost is also considered a factor which caused the momentum effect [27]. Unfortunately, none of these explanations are capable of providing the entire framework for explaining why the momentum of price dynamics exists in many financial markets.

Not only demystification on the origins of the price momentum, but also pursuit on the profitability and implementability of the momentum effect in financial markets have been interesting to academia and practitioners. For example, although several studies [28–32] found that the momentum strategies in some Asian markets such as Japanese stock market are not profitable, Asness et al. [16] discovered that the momentum strategy in Japan becomes lucrative, when it is combined with other negatively correlated strategies such as value investment. Not limited to several stock markets, the hybrid portfolio of value and momentum also outperforms each of the value and momentum portfolios across the asset classes.

Their study paid attention to the implementation of the momentum strategy combined with fundamental value investment factors such as book–market (BM) ratio[1] which also has been used to unveil the origins of the momentum effect in Fama–French three factor analysis. In other words, their work can be understood as the construction of the hybrid portfolio to increase the profitability and stability of the portfolios based on the momentum strategy. Moreover, the selection criteria for the hybrid portfolio are considered as the multiple factors related to the momentum returns whether they are positively correlated or negatively correlated. Academically, this observation imposes the important meaning in the sense that these multiple filters can explain their contributions to the momentum returns. In practical viewpoint, it is obviously the procedure for generating trading profits in the markets.

Another method for improving the profitability of the momentum strategy is introducing various selection rules for the construction of the momentum portfolio. First of all, simple variations in the original momentum selection rule can be made. Moskowitz et al. [17] suggested new trading strategies based on time series momentum which constructs the momentum portfolios by time series regression theory. It is not simply from cumulative return during a lookback period as a sorting variable but from an autoregressive model of order one which can forecast the future returns under given conditions such as the past returns and volatilities. The predicted return is used as the selection criterion for the time series momentum strategy. The time series momentum portfolio performs very well even during market crisis. It also shares the common component which drives the momentum return with the cross-sectional momentum strategy across many asset classes. This fact imposes that the momentum strategy is improved by the modified cumulative return criterion and there is a possibility to find the better momentum strategies in performance and risk.

Besides only considering the cumulative return, the introduction of alternative proxies for the portfolio selection rules has been also worth getting attention. George and Hwang [33] used 52-week high price[2] as a selection criterion and the momentum portfolio based on the 52-week high price generated stronger returns. Additionally, the tests on the momentum portfolios, which are doubly-sorted by the cumulative return or sector momentum and the 52-week high price, exhibit the superiority of the 52-week high price criterion. The factor analysis also shows that the return from the 52-week high price factor is not only stronger than the traditional and sector momentum factors but also statistically more significant and important in the momentum return modeling. The dominance of the 52-week high momentum criterion is also observed in the various international stock markets [32].

Reward–risk measures are also able to serve as the ranking criteria. Rachev et al. [34] used the reward–risk measures as the sorting criteria for their momentum portfolios instead of the cumulative return over the estimation period. In their work, Value-at-Risk (VaR), Sharpe ratio, *R*-ratio, and STARR were used as alternative ranking rules. In the S&P 500 universe from 1996 to 2003, their momentum portfolios constructed by the reward–risk measures provided the better risk-adjusted returns than the traditional momentum strategy. In addition to that, the new momentum portfolios had lower tail indexes for winner and loser baskets. In other words, these momentum strategies based on the reward–risk measures obtained the better risk-adjusted returns with acceptance of the lower tail risk.

Back to physics, the momentum in price dynamics of a financial instrument is also an intriguing phenomenon because the persistent price dynamics and its reversion can be understood in terms of inertia and force. The selection rules of the

[1] It is also related to price–book (PB) ratio inversely. Many literature on momentum mostly use BM ratio as a momentum-driven factor and PB ratio also known as PBR is frequently mentioned in fundamental analysis of stocks.

[2] The 52-week high price is the highest price during last 52 weeks, i.e. 1 year.