Empirical Research on Momentum and Reversal Effects in Software Industry

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Abstract. This paper uses monthly data from Jan 2002 to Sep 2022 from fifty top Software companies of 2022 rated by the Software Report to examine the existence of momentum and reversal effects both in short term and long term in Software industry. The relationship between investment sentiment and anomalies is further explained and the robustness of FF-3F Model is tested. Based on two ways of forming portfolios, equal-weighted portfolio and value-weighted portfolio, the result shows that the software industry has stronger momentum and reversal effects in the medium term and short term. The Mkt-RF factor in CAPM and FF-3F model explain the momentum and reversal effects better for software industry in the short run, and HML factor explains better in the long term. Value weighted portfolio is better on explaining these effects. It is better not to utilize long term investment strategy and investors are preferring value stocks in Software industry.

Keywords: Momentum; reversal; behavior finance; software industry; factor models.

1. Introduction

Software development is driven by the inventiveness of a computer program in order to build the software that end-users require. The latest 20 years of this industry are hugely impacted by mobile operating system. Mobile phone programming language is a new development, which will become one of the windows for technology to lead the future. The design of smart phones has been improved to add more uses for the industry development. Since then, mobile computing systems have proliferated, paving the way for the development of new and enhanced games and other applications. In the field of operating system, Microsoft desktop operating system in the United States accounts for 73.21% of the global market share, and Android and Apple iOS systems account for 99.39% of the global market share. In the field of database, Oracle, Microsoft and other enterprises in the United States occupy more than 90% of the global market share [1].

According to the efficient market theory, the current market price accounts for all relevant data. The price of stock is subject to random walk, so no matter how investors choose their own investment strategy, they cannot obtain excess profits, so passive investment is the best investment strategy [2]. As the research goes, the financial market has emerged lots of 'anomalies' that cannot be explained by efficient market hypothesis, the discovery of these anomalies believes that investors are not completely rational, the proportion of noise traders in the market is quite large; Also, investment decisions tend to be inertial in the market, and these irrational transactions cannot be eliminated by large volumes of random transactions. Among these anomalies, the momentum and reversal effect are one of the typical representatives. Momentum effect refers to the phenomenon that the positive stock returns (the winner) tend to be positive in the future and negative stock returns (the loser) tend to be negative in the future. The opposite of momentum is the reversal. After long-term observation, people find that the stock returns will always reverse after a period. The momentum phenomenon and the reversal phenomenon occur alternately and are inseparable [3]. When compared to the existing Asset Pricing Model, such as the FF-5F model, momentum is found to be a violation. [4]. In spite of this, Fama and French maintain that the momentum effect does not contradict the efficient market hypothesis because the excess return generated by the momentum effect may be accounted by risk. When the momentum factor is added, the excess return of the momentum effect will disappear [5]. Investment sentiment plays an important role in generating anomalies. When optimism increases the stock prices, pessimism leads to a decrease in the stock prices, the stock prices are more likely to reflect the sentiment of optimistic investors due to differences in investor opinions and restrictions

on arbitrage. The momentum effect basically occurs in the period of optimism [6]. In order to better predict the market behavior by looking at historical trend, recent research has placed a greater emphasis on the empirical outcomes of time-series momentum, which is evaluated by holding assets with recent positive returns and selling assets with recent negative returns. [7-8]. Daniel, Hirshleifer and Subrahmanyam illustrate that Investors with information may have overconfidence and self-attribution when making investment decisions [9].

This paper applies different time arrangements and factor models to help examine the predictable behavior of momentum and reversal effect in different time horizons to discover time-series momentum caused by historical events. It helps evaluate whether the effect last in the long term (within 36 months), medium term (within 12 months) or short term (last month), it also explains the question "Whether CAPM and FF-3F Model can explain the effect well in different time periods and portfolio formations." This paper provides suggestions on investors to deal with the reversal phases by avoiding overconfidence and overreaction, taking advantage of upward trends or downward trends obtain risk-adjusted returns.

2. Methodology

2.1 Data Selection

This paper selects monthly data of stock price, number of outstanding shares, and return data from CRSP, which can be accessed through Wharton Research Data Service (https://wrds-www.wharton.upenn.edu). To better represent patterns of software industry, this paper picks up fifty top Software companies of 2022 rated by The Software Report, the sample companies are from including the New York Stock Exchange, the American Stock Exchange and the NASDAQ stock market. The time period ranges from Jan 2002 to Sep 2022. When evaluating past performances, this paper defines past 36 months as long term, past 12 months as medium term, and last month as short term. Factors are obtained from Kenneth R. French - Data Library, including monthly returns of a set of Fama-French 3 Factors.

2.2 Asset Pricing Models

This paper applies the OLS regression with CAPM and FF-3F Model [10]. The CAPM represents the relationship between an asset's undiversifiable risk and expected return, derived as the formula (1).

$$E(r_i) = r_f + \beta_i(E(r_i) - r_f) \quad (1)$$

Where E (r_i) represents the expected return of investment, r_f is risk-free rate, βi is the beta of the investment, E (r_i) - r_f equals to the market risk premium. CAPM can help evaluate whether a stock is fairly valued under certain amount of risks and time value of money. However, CAPM fails to capture various market anomalies of asset returns. For example, DeBondt and Thaler (1985) discover evidence on reversals in the long-term returns, Jegadeesh and Titman (1993) find the evidence on momentum that short-term returns tend to persist.

FF-3F model adds two more factors: size risk factor (SMB) and value risk factor (HML) to CAPM. The model is derived as the formula (2).

$$R_{it} - R_{ft} = \alpha_i + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \epsilon_i \quad (2)$$

Where R_i represents total return of a portfolio or stock i, R_f represents risk free rate, R_m means total market portfolio return. The three factors: (R_m-R_f) means excess return of market portfolio, SMB means size premium and HML means value premium. $\beta_{1,2,3}$ Are the coefficients of these factors? If these three factors can fully explain the abnormal return of assets, then the intercept α in

the model should tend to be 0. However, many scholars subsequently found that α in some portfolios is significant different from zero, indicating that the three factors are flawed, such as the existence of earnings anomalies. Fama and French (1996) pointed out that it fails to reflect the continuity of anomalies in short-term momentum.

2.3 Models of Momentum and Reversal

For medium term momentum strategy, the stocks are sorted in each month into deciles on the basis of prior ($t-12$ to $t-2$) returns, and then buys stocks in the top decile (winners) and sells stocks in the bottom decile (losers). In order to measure the previous performance, a variable is created to equal to the return on the stock from t-12 to t-2. The formula is calculated as follows, where variable ret refers to monthly return to holding the security in the indicated month, and ret_{t-i} variable represents a lag of variable where i indicates the number of lagged months.

$$\prod_{t=2}^{12}(ret_{t-i}+1)-1 \tag{3}$$

Then the stock is divided into 10 equal-sized groups, with group 1 being the one with the lowest prior returns and group 10 the one with highest prior returns. Decimal breakpoints are determined each month. For each month, it builds an equal weighted portfolio in each decile array to calculate the return on equal weighted portfolios. (I.e. for each month, take the average of monthly returns across stocks within each decile group). Therefore, for each month, it can have returns for 10 decile portfolios. A long position is established in the top decile (group 10) and a short position is established in the bottom decile (group 1) to evaluate the time series pattern of the momentum approach, and generate the variable $Ret_{MOM} = Ret_{Group10} - Ret_{Group1}$. $RetMOM$ is plotted against the timeline, describing some noteworthy patterns and pick up some striking points in the figures. After that, the OLS regression is run based on the functions given above, reporting the coefficient estimates, t-stats and FF-3F for the momentum strategy to test whether CAPM or FF-3F model can explain the momentum effect.

$$ret_{MOM,t} = \alpha^{CAPM} + \beta_{\text{mkt}} * mktrf \tag{4}$$

$$ret_{MOM,t} = \alpha^{FF} + \beta_{\text{mkt}} * mktrf + \beta_{\text{smb}} * smb + \beta_{\text{hml}} * \text{hml} \tag{5}$$

In order to make comparisons for different portfolio formation strategies, the value-weighted portfolios are formed based on the same methods described above. For each month, instead of taking a simple average of returns across stocks within each decile group, each stock is weighted in the decile on a firm's market capitalization, which is calculated as the stock price at the beginning of the indicated month t times the number of outstanding shares at the beginning of the indicated month t (in thousands). The regression results can help me compare alphas of the value weighted momentum strategy with alphas of the equal-weighted momentum strategy. For long term momentum strategy, the stocks are sorted in each month into deciles on the basis of prior ($t-36$ to $t-2$) returns and repeat the same steps as medium term momentum strategy.

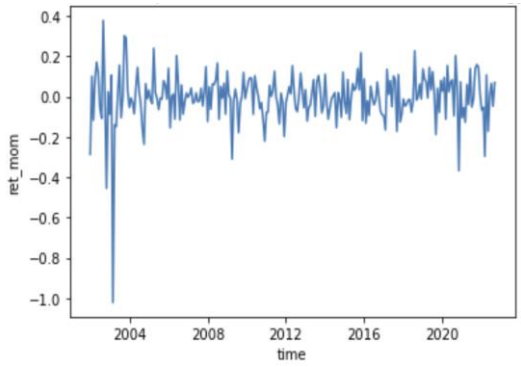
For short-term reversal, the stocks are sorted and groups are divided on previous month return (t-1) and $Ret_{str} = Ret_{Group1} - Ret_{Group10}$. For long-term reversal, the time period is adjusted as prior ($t-36$ to $t-12$) returns, which is shown as the formula (6). The 12-month momentum and the short-term reversal months are skipped to find that whether there is a significant long-term reversal effect in the corporate bond market for the long-term investment horizon.

$$\prod_{t=12}^{36}(ret_{t-i}+1)-1 \tag{6}$$

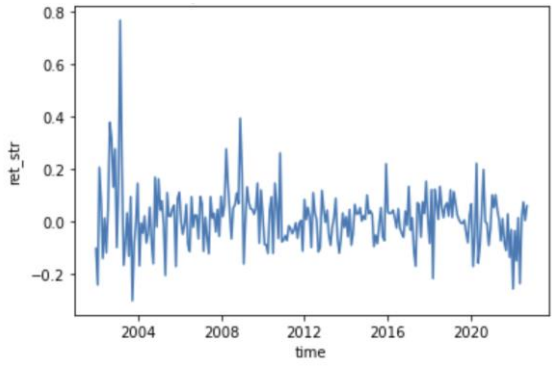
3. Empirical Results

3.1 Trend Analysis

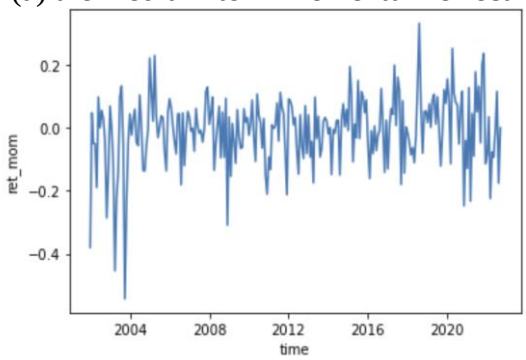
As Figure 1(a) and 1(c) shown, $ret_{MOM,t}$ is extremely striking around 2002, 2008 and 2019. Around 2002, the $ret_{MOM,t}$ first became very high, reaching 0.4 and then around 2001 $ret_{MOM,t}$became extremely low, close to -0.5. The dramatic change might be caused by the Dotcom Bubble around 2002. From 1995 to 2000, the technology-dominated NASDAQ index increased from less than 1,000 to more than 5,000, the initial increase in price drives lots of speculators, and investors attempt to capitalize on the Internet boom without noticing the traditional investment metrics. And the bubble broke between 2001 and 2002, resulting in a bear market for stocks. The dramatic change of $ret_{MOM,t}$ also happened around 2008 when the financial crisis happened. In 2019, COVID-19 had a stable but temporary impact on the financial market, so it provides a unique insight into the performance of momentum strategy at the critical moment of market pressure [11]. As Figure 1(b) and 1(d) shown, the Ret_{str} of stock returns both in short term and long term also show the dramatic changes around 2000, 2008, and 2020, which are caused by the Dotcom Bubble, financial crisis, and pandemic. In the short period, the stock return has much higher and more frequent fluctuation compared with the time series figure in 1 and 3, which shows the effect of overreaction and investors' correction of their investment behavior. These three key points in the timeline show that when significant events happen, group1 performs much better than group10, indicating that the reversal effect is stronger than usual.



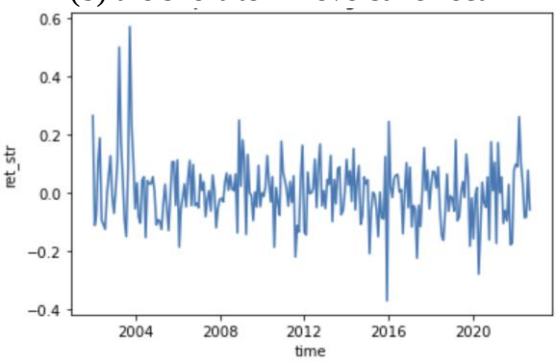
(a) the medium-term momentum effect



(b) the short-term reversal effect



(c) the long-term momentum effect



(d) the long-term reversal effect

Fig 1. Time series pattern of momentum and reversal effects.

Comparing short term, medium term and long term within each strategy, medium-term momentum effect and short-term reversal effect has more striking patterns than long term figures. Long-term strategy tend to capture the overall trend of the market, while medium-term and short-term strategy refer to the reversal effect brought by overreaction or trading problems. The performance of each factor is heavily dependent on the state of the economy as a whole. Therefore, capturing suitable market investment opportunity is an important part of implementing successful momentum and

reversal strategy generating positive returns on portfolio. Long-term and medium-term series are more correlated during financial distress, this is because the medium-term momentum also starts to capture strong and significant trends in the market.

3.2 Regression Results

3.2.1 Short-term & medium-term

In Table 1, the CAPM and FF-3F alphas are greater than 0 under value-weighted portfolio for Momentum effect, which means that the value-weighted momentum strategy can generate excess returns in medium term. For reversal effect, equal-weighted reversal strategy can generate excess returns in short term. Under FF-3F Model, the excess return factor (Mkt-RF) has more significance, which means it has more explanatory power for these two effects. The excess returns generated in short term and long term represents that the underreaction and overconfidence will cause investors to react slowly to the news at first, and then overreact in the next few days, leading to the observed medium-term momentum. Since all the stocks selected in this paper are large stocks, even after considering the transaction cost, the value weighted momentum portfolio and equal weighted reversal portfolio is still profitable. For companies that do not suffer from financial distress, the FF-3F model can partially explain the momentum and reversal effect.

Table 1. Regression results of CAPM and FF-3F factor model in the Software industry[1].

	Equal weighted		Value weighted		Equal weighted		Value weighted	
	Momentum Effect				Reversal Effect			
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.0092	-0.0102*	0.0120*	0.0117*	0.0100	0.0117*	-0.0122*	-0.0141**
	(0.005)	(0.004)	(0.005)	(0.004)	(0.006)	(0.005)	(0.006)	(0.005)
Mkt-RF	-0.0047**	-0.0046*	-0.0049**	-0.0048**	0.0003	-0.0003	-0.0046**	-0.0049**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
SMB		0.0015		0.0022		0.0037		-0.0005
		(0.003)		(0.004)		(0.003)		(0.003)
HML		-0.0040		-0.0076**		-0.0038		0.0033
		(0.003)		(0.003)		(0.002)		(0.003)

[1]From Jan 2002 to Sep 2022, made by author) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2.2 Long-term

Under long-term investment strategies, the empirical result shows that the CAPM and FF-3F model cannot explain the effect well. And for momentum strategy, since the alphas are all negative, this strategy cannot generate positive returns. The HML factor has more explanation power for momentum effect, since the beta is negative, small-cap enterprises tend to outperform large-cap firms in software industry.

Table 2. Regression results of CAPM and FF-3F factor model in the Software industry[2].

	Equal weighted		Value weighted		Equal weighted		Value weighted	
	Momentum Effect				Reversal Effect			
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.0130*	-0.0130**	-0.0161**	-0.0163**	0.0019	0.0019	0.0016	0.0013
	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)
Mkt-RF	-0.0015	0.0002	-0.0030	-0.0022	0.0011	-0.0003	-0.0020	-0.0025
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
SMB		-0.0059*		-0.0014		0.0046		0.0039
		(0.003)		(0.003)		(0.003)		(0.003)
HML		-0.0079***		-0.0082***		0.0069**		-0.0019
		(0.002)		(0.002)		(0.002)		(0.002)

[2]From Jan 2002 to Sep 2022, made by author)

4. Conclusion

This paper research on the most recent 20-year stock price and return data from CRSP, including fifty top Software companies of 2022 rated by the Software Report, to examine the momentum and reversal effect in software industry. The results shows that investors can generate positive risk-adjusted returns using value weighted momentum portfolio in the medium term and equal weighted reversal portfolio in short term; value weighted portfolio has better explanatory power and the Mkt-RF factor and HML factor explains better in the medium term and short term. It is better not to utilize long term investment strategy and investors are preferring value stocks in Software industry.

The United States and the world are experiencing an economic and social change driven by technology. In this changing world, economic growth is increasingly linked to the digital economy. The digital economy has increasingly become a key driver of employment, business creation and innovation. Today's software industry has become a global player sharing ideas, learning new skills and acquiring human knowledge. The domain of Information technology has always been an important driving force for the development of the digital economy. Bubbles and distress are often accompanied by narratives in the new era, which reasonably explain why the old investment rules no longer apply. This seems to be happening again nowadays, because people believe that the pandemic will bring a new economy dominated by technology companies.

References

[1] China Industrial Technology Software Alliance: Industrial Software White Book [R].

[2] Fama, Eugene F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work, Journal of Finance, American Finance Association, 1970, 25(2): 383-417.

[3] Jegadeesh, N. & Titman, S. Returns to Buying Winners and Selling Losers [J]. Journal of Finance, 1993, 48(1): 65-91.

[4] Fama, F. & French, R. A five-factor asset pricing model. Journal of Financial Economics 2015, 116: 1–22.

[5] Fama, E. F., French, K. R. Multifactor Explanations of Asset Pricing Anomalies [J]. Journal of Finance, 1996, 51(1): 55-84.

[6] Antoniou, C., Doukas, A. & Subrahmanyam, A. Cognitive Dissonance, Sentiment and Momentum [J]. Journal of Financial and Quantitative Analysis, 2013, 48(1): 245-275.

[7] Moskowitz, J., Ooi, H. & Pedersen H. Time-series momentum, Journal of Financial Economics, 2012, 104(2): 228–250.

[8] He X Z and Li K. Profitability of time-series momentum, Journal of Banking and Finance, 2015, 53: 140–157.

[9] Kent, D., Hirshleifer D. & Subrahmanyam A. Investor Psychology and Security Market Under-and Overreaction, 1998, 53: 1839-1886.

[10] Fama, F., & French, R. The Cross-Section of Expected Stock Returns. The Journal of Finance, 1992, 47: 427-465.

[11] Guobuzaite R. & Teresiene D. Can Economic Factors Improve Momentum Trading Strategies? The Case of Managed Futures during the COVID-19 Pandemic. Economies, 2021: 9(2), 86.