Comparison of the Performances for Mean Reversion Strategy for DDAIF, Ford and VWAGY

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Abstract. The mean reversion strategy argues that investors should buy low and sell high, for there is an average line for the stock prices. The price will always meet the average line of it. When the price is higher than the average line, it will drop. When the price is lower, it will increase. To test and validate the effectiveness of this strategy, this study chose three stocks in auto industry to comparison the performance of this strategy on them. According to the analysis, when it is in volatility market, the strategy performances good in auto industry, but in unilateral tendency market, it may get a bad profit. This paper gives an exact way to calculate the buy and sell method point, which can make direction for people to trade. Besides, it makes comparison for the strategy in 3 different stocks in same field. Therefore, one can learn the performance of it on different shape of stocks. These results shed light on guiding further exploration of mean reversion strategy on auto industry.

Keywords: mean reversion; volatility market; unilateral tendency market; method points.

1. Introduction

Contemporarily, with the development of technology, the new energy vehicle has become a important part of the auto industry. The company like Tesla entered the market and made some impact on the ancient auto industry company. Besides, the COVID-19 made a great damage on the auto industry, for instance, many companies need to reduce the staff to make sure their finance on a health level. Hence, nowadays the auto industry is still face difficulties. Debondt and Taylor are the scholars who found the return of stocks follows the mean reversion phenomenon early than other scholar [1]. They found the price of the always move near its average line. There does not have a stock can go up forever or fall forever. In equity market, the stock price recent higher than average level will move lower [2]. Balvers et al. has made research on mean reversion on National Stock Market, and most countries followed this phenomenon [3]. For the U.S. stock, Kim found the mean reversion return was weak here [4]. However, Lo and Mackinlay found the evidence to argue the mean reversion in stock market [5]. For the mean reversion strategy, Poterba and Summers thinks there are several factors are the resons for mean reversion phenomenon [6].

Daimler AG and Volkswagen are German companies and Ford is a USA company. Due to the COVID 19, the world stock market was badly hurt. In 2020, most countries' central bank took a loose monetary policy, and in 2021,with the global supply chains disrupt, inflation risk were moving higher, FED and Bank of England had become more hawkish in tightening monetary policy. Therefore, this research did not chose recent time as the research period.

The motivation of the essay is to comparison the performance of mean reversion strategy on the three stocks in auto industry company, for it is too difficult to see it performance in all field. The research started with the linear regression of the stocks price. Then, price is utilize to set the trade signals to finish the strategy. Finally, this study calculates the return of it and use some method the measure the risk of this strategy.

2. Data & Method

2.1 Data

The data of DDAIF, Ford and VWAGY was found on Yahoo Finance. In order to look this strategy in a long period, the date was chosen from 20 October 2010 to 1 January 2017. The data from Yahoo

finance has many factors, but during the research, Adj Close column was used as the price of the stocks. The Adj close is the close price after adjusting, and for the data, the adj close keep 4 decimal places and the others keep 2 decimal places, which is more accurate.

2.2 Models & Strategy

This study starts from a simple linear time-series model used on the price of stocks, and the model of the linear regression is of the form:

$$P_{t+1} = P_t + \lambda(\bar{P} - P_t) + \varepsilon_t \quad (1)$$

where P_t is the price of the asset, $\bar{P}$ is the mean-reversion level, λ is the mean-reversion speed and ϵ_t is unpredictable noise. In this procedure, one sets a lookback period to calculate the simple moving average (SMA) [7] of the asset, and this research set this to be the mean-reversion level. The SMA follows the equations below [8]:

$$\text{SMA} = \frac{\sum_{i=1}^{k} P_k}{k} \quad (2)$$

In linear equation based on the given arrays. The research changed the linear regression form into:

$$P_{t+1} - P_t = \lambda(\bar{P} - P_t) + \varepsilon_t \quad (3)$$

In this section, one put the equation above into the ordinary least squares (OLS) model. It can get the exact number of the parameters (λ and ε_t) in the equations (1) and (3). For the OLS model, it is used to figure out the unknown coefficient in the linear equation. In these illustrations, the coefficients there are the λ in linear regression.

$$\begin{cases} \lambda_{DDAIF} = 0.000335 \\ \lambda_{Ford} = 0.001655 \\ \lambda_{VWAGY} = 0.001701 \end{cases} \quad (4)$$

After calculating the exact λ, one takes each λ into the correct linear equation, and the ϵ_t for each stocks follow the equation below:

$$\varepsilon_t = (P_{t+1} - P_t) - \lambda(\bar{P} - P_t) \quad (5)$$

As for the trading signal, the strategy needs to give an exact trade signal for buyer to choose when to buy and when to sell. Here, a factor is needed to be mentioned. The ratio shows the relationship between the price and the average price, which follows the equation:

$$\text{ratio} = \text{P}_\text{t}/\bar{p} \quad (6)$$

After getting the data of ratio, there is a comparison which is made with 1 to judge the level of the prices of the stock:

- If the ratio > 1, that means the price is in a high level, and there may have a sell signal
- If the ratio < 1, that means the price is in a low level, and there may have a buy signal

Next procedure is to set the percentile and make comparison with the upper quartile and the lower quartile, where ere the percentile is $[15,20,50,80,85]$. Then, one sets the three lines in the illustrations of ratio, which are at the percentile of 15% 50% and 85%:

- If the ratio is above the 85% percentile line, it is at the sell signal
- If the ratio is at the 50% percentile line, it is at the average level
- If the ratio is under the 15% percentile line, it is at the buy signal

Subsequently, there are some positions need to be set in order to get the return of the strategy. Put -1 at where the ration is greater than percentile to sell and nan otherwise, then put 1 at where the ratio is less than the percentile to buy and put the current value otherwise. At last, one uses ffile to fill the missing values in the data frame, the ffill stands for forward fill. After getting the signals, one put the signals on the price illustrations, the green points are the buying signals and the red points are the sell signals.

2.3 Backtesting evaluation

After making the strategy, there are some factors need to be calculated. First was the return, the return shows the profit or lost in a stock, it can reflect the investment performance. The simple returns follow the equation:

$$\text{simple return} = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{7}$$

During the research, the Log return was used more compared with the simple return, because the Log return follows the logarithmic operation rule. The Log return follow the equation below:

$$\text{Log return} = \ln(1 + \text{simple return}) \tag{8}$$

Based on these two factors and the positions which was set before, the return of strategy can be calculated. The strategy return follows the equation below:

$$\text{strategy return} = P_t \cdot \text{position}_{t-1},\ \text{position} \in \{1, -1\} \tag{9}$$

There is also a factor named Sharpe ratio, which is a measure of excess return of a portfolio relative to the total variability of the portfolio. And the calculating of Sharpe ratio follows the equation [9]:

$$\text{Sharpe ratio} = \overline{\text{strategy return}} / \text{std. strategy return} \tag{10}$$

$$\text{monthly Sharpe ratio} = \sqrt{22} \cdot \text{daily Sharpe ratio} \tag{11}$$

and the Sharpe ratio for each stock are

$$\text{Sharpe ratio} = \begin{cases} DDAIF = -0.00754 \\ Ford = 0.00155 \\ VWAGY = 0.00870 \end{cases} \tag{12}$$

$$\text{monthly Sharpe ratio} = \begin{cases} DDAIF = -0.03539 \\ Ford = 0.00727 \\ VWAGY = 0.04081 \end{cases} \tag{13}$$

Drawdown is a measure of downside of volatility. This study considered the maximum drawdown during the research. Maximum drawdown can be defined as the largest drop from a peak to a bottom in a certain time period [10]. To ensure the calculate procedure would be more easier, the paper supposed the asset of me is 1 dollar. According to the definition given before, the max drawdown(MDD) and max drawdown rate(mdd) follows the formula:

$$\text{MDD(T)} = \max_{t\in(0,T)}\left\{0, \max_{t\in(0,\tau)} \prod_{k=1}^{t}(1 + R_k) - \prod_{k=1}^{\tau}(1 + R_k)\right\} \tag{14}$$

$$\text{mdd(T)} = \frac{\text{MDD(T)}}{\max_{t\in(0,\tau)} \prod_{k=1}^{t}(1+R_k)} \tag{15}$$

and the max drawdown and max drawdown rate is

$$\text{DDAIF} \begin{cases} MDD = 0.7827 \\ mdd = 0.6214 \end{cases} \tag{16}$$

$$\text{Ford} \begin{cases} MDD = 0.6347 \\ mdd = 0.6369 \end{cases} \tag{17}$$

$$\text{VWAGY} \begin{cases} MDD = 0.7225 \\ mdd = 0.5228 \end{cases} \tag{18}$$

3. Results & Discussion

3.1 Correlation and regression analysis

The parameter λ in linear regression is shown in Table. 1, and the ε_t is shown in Fig. 1. The research found for all the three stocks, their linear regression equation all has a positive λ. The stock of Volkswagen company has the highest λ (0.001701) and the Daimler AG has the lowest λ (0.000335).

TABLE.1 parameters in linear regression equation

OLS Regression Return				
company	coef	std err	t	kurtosis
DDAIF	0.0003	0.009	-0.672	13.164
Ford	0.0017	0.009	0.2	5.806
VWAGY	0.0017	0.009	0.193	7.811

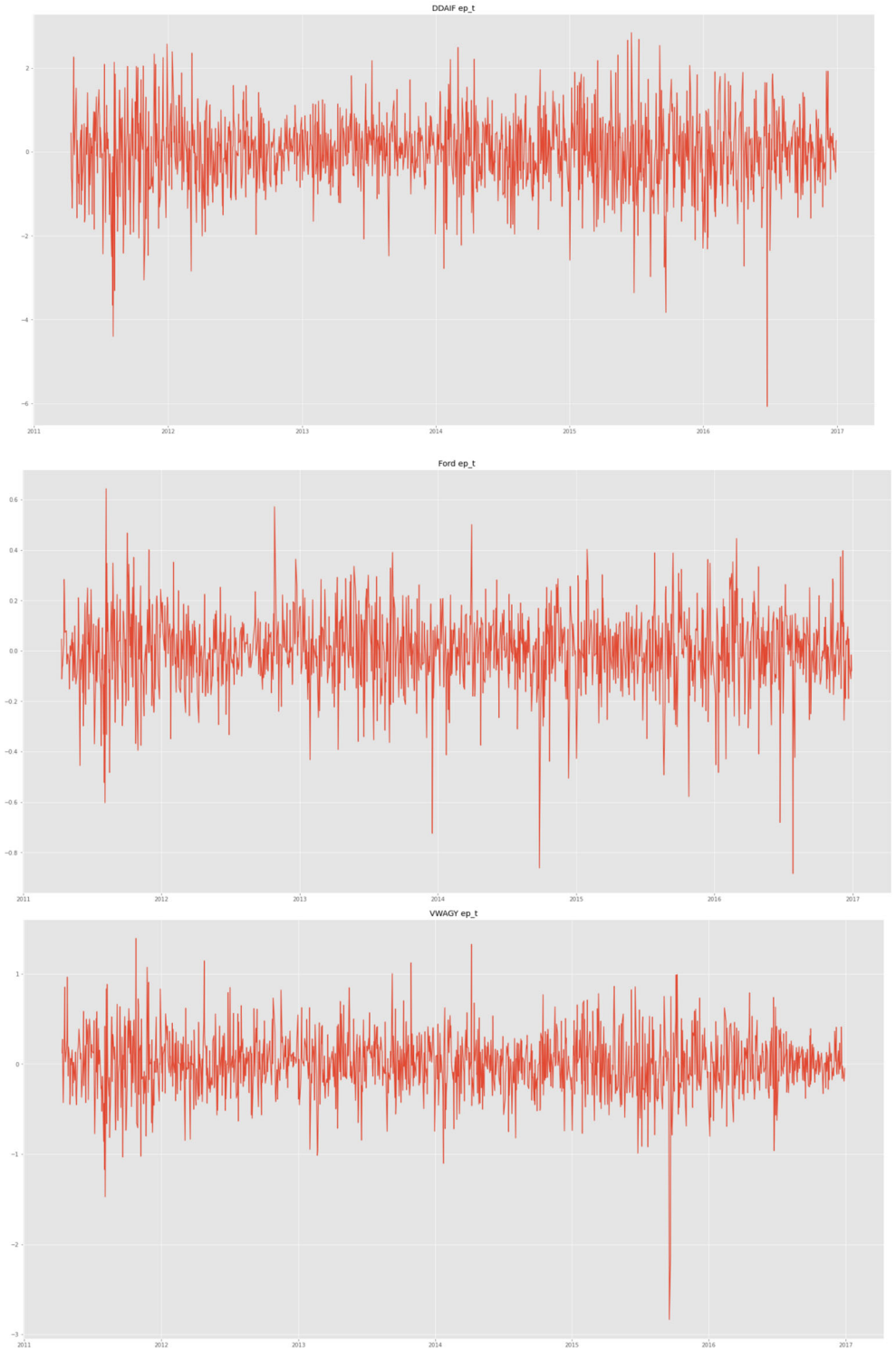

Fig. 1 The parameter of ε_t in linear regression

3.2 Strategy performances

The 3 percentile lines (15%, 50% and 85%) used to find buy and sell signals for stocks are illustrated in Fig. 2. The ratio under green line means the price there is a good time to buy it, and the ratio above the red line means the price is higher enough for people to sell it. The exact signal for buy and sell are shown in Fig. 3. Seen from the results, the sell and buy signals are designed based on the analysis before. The green points are the buying signals and the red points are the selling signals. With the given signals, the holder of these stocks can limit the amount of trade to reduce the cost of transaction cost.

Fig. 2 The [15%,50%,85%] percentile line for ratio.

The cumulative strategy return of 3 stocks are shown in Fig. 4. According to the illustrations, the stock of Volkswagen company and Ford has the positive cumulative return, but the stock of Daimler AG has a negative cumulative return. Similarly, the cumulative returns of stock of Volkswagen are the highest among all the three stocks. Looking back at the 3.1.1 linear regression parameter, the stock of Daimler AG has the lowest λ and the stock of Volkswagen company has the highest λ.

Fig. 3 The buy & sell signals for stocks

Fig. 4 Strategy return.

3.3 Evaluation and comparison

After making the strategy, the research made a comparison with buy and hold strategy. To make the calculate easier, a consumption is made that the asset is one dollar, and the return of Buy and Hold strategy is the simple return (seen in Fig. 5). With the information and assumption before, the research draws 3 illustrations reflect the growth of one dollar in each strategy on three stocks. At last, one uses the data above to calculate ethe exact return for both strategies in these three stocks:

$$\text{DDAIF}\begin{cases} mean\_reversion: -0.1980 \\ buy\_and\_hold: 0.1324 \end{cases} \tag{19}$$

$$\text{Ford}\begin{cases} mean\_reversion: 0.0370 \\ buy\_and\_hold: -0.0142 \end{cases} \tag{20}$$

$$\text{VWAGY}\begin{cases} mean\_reversion: 0.3139 \\ buy\_and\_hold: \quad -0.0230 \end{cases} \tag{21}$$

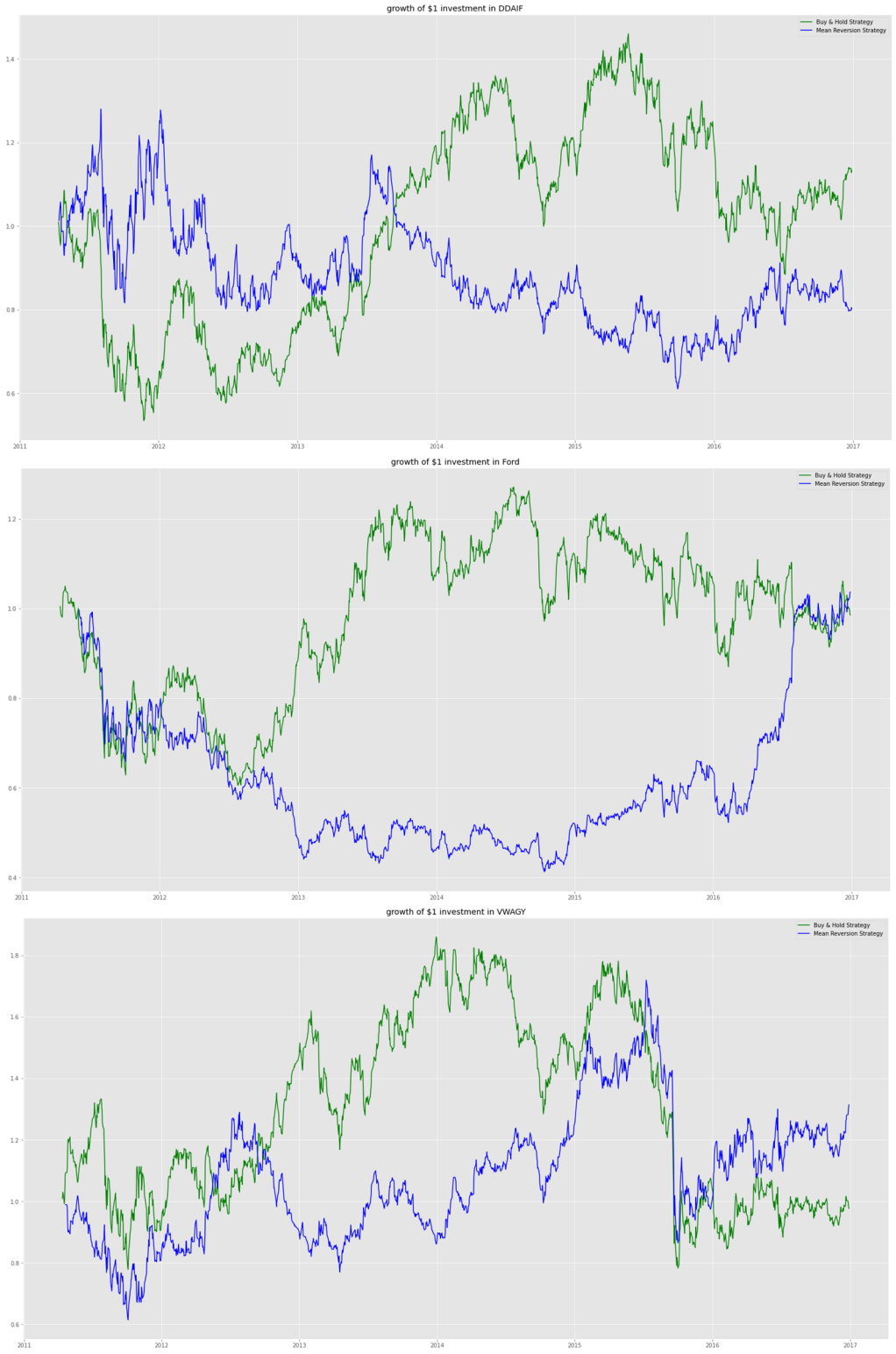

Fig. 5 Growth of one dollar in each strategy.

3.4 Limitations & Prospects

Nevertheless, in the real market, there is a factor named transaction cost, and it must be considered when making a portfolio for stock. Transaction cost is the total cost of a security transaction after commissions. Thus, it means every time people make a trade on the stock, it will cost some money from the asset. it is obviously that the return will decrease because of that. The research just considers the transaction cost, but did not set an exact number of it to calculate the impact of it. To be specific, after consider the exact number of transaction cost, return of the strategy and the Sharpe ratio will

change. Besides, there are more method are needed to measure the risk of this strategy. The study used the Sharpe ratio, max drawdown to judge the risk of it. Nevertheless, there are still one indicator, i.e., volatility. Because of the time limitation, the research did not figure it out. In the future study, after learning more professional knowledge about the mean reversion strategy, further researches will calculate the impact of transaction cost based on the real data and use more factors to measure the risk of this strategy, so as to make the model more real and useful.

4. Conclusion

In conclusion, this study shows the mean reversion strategy uses on three different stocks in Auto industry company. The mean reversion strategy has a good performance when the stock market has a high volatility. However, when the market is in a unilateral tendency, the mean reversion strategy might not fit the market and cannot get a good profit compared to the buy and hold strategy. It should be noted that the research did not consider the exact number of transaction cost, and did not calculate the exact and accurate impact of transaction cost reflect on Sharpe ratio and strategy returns. It means that the model is an ideal model. In the future, this part will be added in discussion. Overall, these results offer a guideline for how to operate in auto stoke market with mean reversion strategy.

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