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ARTICLE

An Empirical Research of Futures Program Trading Based on RSI And CCI Indicators

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ABSTRACT

Over the years, many scholars have conducted a wealth of empirical research on the effectiveness of technical indicator analysis in the financial market, and the conclusions are obviously different. Among them, two program trading models based on RSI and CCI indicators achieve an annual return rate of more than 180% in the empirical research of palm oil futures program trading, but the amount of data used in this study is too small, and the transaction cost is not considered. As the actual trading process has the characteristics that investors pay more attention to the sustainability of the model's profitability, and that investors' trading varieties are diverse and with high transaction cost, this paper further verifies the sustainability and general applicability of these two models: using the closing price of 1-day and 30-minute K-line of 18 kinds of commodity futures in recent 10 years to investigate the changes of annual return rate, maximum withdrawal ratio etc. under different transaction costs and K-line cycles. The results show that the model's profitability is time-varying, and the transaction cost has a greater influence on the rate of return of 30-minute K-lines than that of 1-day K-lines.

1. Introduction

With the rapid development of the financial market, the trading mode which relies on the experience of investment managers to carry out manual operation is confronted with practical challenges such as the aggravation of market risks and frequent changes, so it is necessary to introduce program trading to automatically place orders, improve efficiency and control risks. Nowadays, the proportion of program trading in the stock, bond, option, futures and other markets is increasing. Financial institutions such as Morgan Stanley,

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Deutsche Bank and Goldman Sachs are the most active participants in program trading.

Transaction cost can be divided into explicit transaction cost and implicit transaction cost [1]. Among them, the explicit transaction cost includes transaction fee, stamp tax, etc.; the implicit transaction cost mainly includes market impact cost, opportunity cost, etc. Market impact refers to the change of transaction price caused by the submission of an order to the market, which often leads to transaction slippage. Theoretically, the size of market impact is the difference between the price when the order is executed and the price when the order does not exist in the market. Opportunity cost refers to the part of profit lost caused by the order execution failure. Due to the limited liquidity and rapid price changes in the market, the limited price orders submitted by investors may not be able to be executed completely, resulting in opportunity cost. In fact, by analyzing the data of Tel Aviv Stock Exchange, Alam and Ttkatch[2] found that only about 48% of orders could be completely closed. If investors try their best to push orders to be fully executed to reduce the opportunity cost, this will then undoubtedly increase the market impact cost. Compared with the explicit cost, implicit cost is not easy to be observed and measured directly, but it accounts for a large proportion in the total transaction cost.

Technical indicators are divided into trend indicators and swing indicators. Trend indicators include Moving Average (MA) and Moving Average Convergence and Divergence (MACD), swing indicators include Relative Strength Index (RSI), Commodity Channel Index (CCI), William Index (WMS), KDJ Index (KDJ), On Balance Volume (OBV) and Psychological Line (PSY), etc. Many scholars have done a lot of empirical research on the predictability of technical indicator analysis in financial market, the empirical conclusions are obviously different. For example, park and Irwin (2007)[3] found in the literature review that 56 of the 95 empirical literature conclusions support that the technical analysis method can obtain excess earnings, and 20 of them believe that the technical analysis method cannot obtain excess earnings. Baetje et al. (2016)[4] pointed out that the prediction effect of technical indicators is stable. Lin Jie et al. (2018)[5] constructed two models based on the RSI and CCI indicators respectively. When assuming the margin ratio equals 8% and considering neither transaction cost nor slippage, the back testing results of six-month trading data of palm oil futures show that both models can achieve an annual return rate of more than 180%. Different from the previous studies, Chong (2008)[6] found that both MACD and RSI analysis can obtain excess return, but the excess return decreased after 2000. In recent years, with the development of computer and artificial intelligence, some scholars combine multiple technical indicators, or combine technical indicators with SVM (support vector machine), RRL (recurrent reinforcement learning), ANN (artificial neural network) or other methods to build a new transaction model. For example, Wu et al. (2015)[7] verified that the combination of MACD, RSI and KDJ indicators can accurately predict the short-term price change trend of the stock market. Kim (2003)[8] used 12 technical indicators as the initial parameters of SVM to predict the daily change direction of Korean stock composite index. Dempster and Leemans (2006)[9] found that when using RRL model to predict, the method of adding technical indicators to the input data is not better than the method of using only lagged return as input. Zhang and Maringer used genetic algorithm to select the best subset of input parameters of RRL model from many indicators including lagged return, technical indicators, fundamental indicators and econometric indicators. Their experimental results using data of 238 (2013)[10] and 180 constituent stocks (2015)[11] of S&P 500 index show that the optimization model of genetic algorithm is better than that using only closing price lagged return as input, which shows that the joint information found in the combination of technical indicators, fundamental indicators and economic indicators is conducive to the performance of RRL model.

In many of the above studies, Lin's two models[5], based on the RSI and CCI indicators ,achieved an annual return rate of more than 180%, which is the highest in many models. Then, when considering the transaction cost, can these models still bring stable benefits to futures trading? In order to answer this question, this paper will further verify the two models for the following reasons: firstly, compared with the short-term profit level of the trading model, investors pay more attention to the sustainability of the model's profitability in actual trading. Besides, investors' trading varieties are diversified, while Lin's study only used the closing price of palm oil futures for six months, the number of futures varieties and the amount of data tested are too small. So, the sustainability and universal applicability of these two models have not been fully verified in Lin's study; secondly, the transaction cost is high in the actual transaction. Usually, traders in the market are mainly divided into individual traders and institutional traders. The amount of funds of individual traders is small, so the transaction fee rate is high; institutional investors can enjoy a lower transaction fee rate because of their capital advantages, but their transaction volume is large, resulting in higher market impact cost and opportunity cost, so the total transaction cost is not less than that of individual investors. Thirdly, a verification

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deducting the transaction cost can better reflect the profitability and risk level of a model in the actual investment. Based on this, this paper mainly studies the changes of investment income and risk of 18 kinds of commodity futures when trading with the two models based on RSI and CCI indicators under the consumption that the transaction cost is the normal commission of futures companies.

2. Trading Models

2.1 RSI Indicator Model

RSI indicator was proposed by Welles Wilder in his book "new ideas of technical trading system" in 1978. It is calculated and plotted according to the ratio of the sum of price rise and the sum of price change in a certain period of time to measure the relationship between market supply and demand. The calculation method of RSI is: the commonly used parameters of RSI are 5, 9 and 14. When selecting 14 as the parameter, 15 closing prices of the previous 14 K-lines and the current K-line are obtained, then for each of the last 14 K-lines subtract its closing price from the closing price of its previous K-line to obtain 14 numbers. The calculation formula of RSI is as follows:

$$M = \sum_{n=1}^{14} a_n (an \geq 0) \tag{1}$$

$$N = -\sum_{n=1}^{14} a_n (an < 0) \tag{2}$$

$$RSI_{14} = \frac{M}{M+N} \times 100 \tag{3}$$

The above formula uses 14 as parameter, M represents the sum of price increases in 14 K lines, N represents the sum of price decreases, and M+N represents the sum of overall price changes. The value of RSI is between 0-100, which is larger when the market is strong and smaller when the market is weak. RSI indicator can use different period parameters. RSI of different periods can be used in a comprehensive way. In Lin's study, two RSIs with different parameters were used. The RSI with smaller parameter is called short-term SRI1, the RSI with bigger parameter is called long-term SRI2.Based on this, the trading strategy adopted by Lin is: buy long when RSI1 goes up through RSI2 and sell short when RSI1 goes down through RSI2.

2.2 CCI Indicator Model

The CCI indicator created by Donald Lambert in the 1980s is widely used in the stock and futures markets. Different from most technical indicators that use opening-, closing-, highest- or lowest-price separately, CCI introduces the concept of deviation level between price and average interval of fixed period price according to the statistical principle, especially emphasizes the importance of the average absolute deviation of price.

The value of CCI indicator is calculated as follows: first calculate the average value D of the closing-, the highest- and the lowest-price of the current K-line, then calculate the difference value E between D and the moving average of D in N-cycles, finally divide E by 0.015 times of the average absolute deviation of D in N-cycles to get the CCI value, where the average absolute deviation is a statistical function. CCI takes 100 as the reference standard. When CCI goes up through 100, it means that the market becomes strong, vice versa. Accordingly, the trading strategy adopted by Lin is: buy long when CCI goes up through 100 and sell short when CCI goes down through 100.

3. Empirical Results and Analysis of the Model Considering Transaction Costs

3.1 Test Varieties, Test Data and Transaction Costs

In this paper, we use the software Tradeblazer v5.5.2.0 to write and simulate the futures program trading based on RSI and CCI indicators. The details and results of the back testing are as follows:

For back testing, the closing price of 1-day and 30-minute K-line of 18 kinds of commodity futures with the largest trading volume in China's futures market were measured. The data measurement period is from January 1, 2008 to July 20, 2019. Due to different starting date of futures on the market, the data amount of each futures variety may diverse.

Most individual investors have a small amount of capital and transaction volume, so their implicit transaction cost can be ignored, and their total transaction cost is about the regular transaction fee. Although institutional investors can enjoy a lower transaction fee rate, the implicit transaction cost increases significantly with the increase of capital volume, so the total transaction cost is not necessarily lower than that of individual investors. In order to simplify the analysis, this paper assumes that the total transaction cost of both individual investors and institutional investors is the transaction amount multiplied by the normal transaction fee rate. Although the conventional fee rate varies with the futures companies, futures varieties and trading time, it usually fluctuates from 0.00006 to

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0.00016. For simplicity, this paper tests RSI and CCI indicator models only under these two boundary rates.

Generally, the margin ratio paid by individual investors is between 10% and 16%. However, in order to compare with the empirical results of Lin, this paper assumes that the margin ratio of all varieties is also 8%, and uses the same inspection indicators: annual return rate, maximum withdrawal ratio, sharp ratio, winning ratio and average profit loss ratio. In addition, in order to more accurately measure the risk of the model in extreme cases, i.e. the

Table 1. Back testing results of RSI indicator model for 1-day data

	Transaction fee rate=0.00006					Transaction fee rate=0.00016				
	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio
PTA	134.78	337.60	0.98	33.26	3.10	129.47	346.49	0.93	33.26	3.04
SR	27.48	570.91	0.34	28.13	2.79	19.97	637.10	0.28	27.71	2.78
C	21.65	167.02	0.24	33.91	2.19	13.62	174.86	0.15	33.91	2.10
M	52.70	547.09	0.37	30.91	2.58	45.13	574.86	0.31	30.91	2.52
FU	20.21	599.24	0.11	26.63	2.94	14.88	651.18	0.07	26.63	2.89
P	65.67	285.80	0.50	34.82	2.38	60.48	300.07	0.24	34.82	2.33
ZN	-36.78	960.26	-0.17	28.00	2.33	-44.24	1029.61	-0.22	27.43	2.35
CU	8.51	418.85	0.04	28.46	2.57	0.84	427.19	-0.01	28.27	2.54
RB	142.85	338.22	0.97	32.24	3.12	136.27	347.67	0.92	32.24	3.06
J	187.64	279.21	1.10	32.25	3.30	182.19	281.98	1.06	31.92	3.30
RM	-62.06	547.75	-0.40	25.67	2.48	-70.99	594.14	-0.46	25.67	2.43
BU	23.14	407.72	0.13	29.13	2.57	16.12	416.60	0.09	29.13	2.52
I	188.94	286.29	1.20	32.12	3.20	184.17	288.05	1.18	32.12	3.16
JD	-4.80	470.35	0.03	26.43	2.75	-12.46	481.85	-0.02	26.43	2.70
PP	118.33	300.01	0.82	31.94	2.92	111.58	304.07	0.78	31.94	2.86
HC	20.41	696.81	0.31	27.32	2.78	13.84	708.00	0.27	27.32	2.74
MA	49.10	483.30	0.26	31.50	2.44	42.06	495.08	0.21	31.50	2.40
AP	264.08	277.95	1.67	36.17	3.10	257.81	280.10	1.64	36.17	3.05

Table 2. Back-testing results of RSI indicator model for 30-minute data

	Transaction fee rate=0.00006					Transaction fee rate=0.00016				
	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio
PTA	30.0	528.32	0.23	26.50	2.88	23.1	726.82	-0.24	26.06	2.76
SR	-10.21	640.53	-0.02	26.91	2.68	-63.11	1091.74	-0.45	26.16	2.62
C	-12.99	521.88	-0.13	25.79	2.80	-77.89	1052.28	-0.91	25.79	2.46
M	-73.60	1080.59	-0.47	27.38	2.45	-141.23	1715.65	-0.95	27.05	2.33
FU	-241.50	2962.04	-1.45	25.25	2.12	-276.23	3268.70	-1.65	24.44	2.11
P	-33.74	659.14	-0.28	26.77	2.62	-82.59	1136.79	-0.75	26.57	2.48
ZN	41.02	547.74	0.34	28.71	2.58	-36.62	1041.64	-0.16	27.89	2.50
CU	82.76	327.90	0.75	29.74	2.57	10.62	423.93	0.24	28.41	2.55
RB	107.42	262.04	0.81	28.81	2.76	41.37	375.01	0.31	28.00	2.68
J	207.75	419.67	1.22	27.55	3.13	141.40	505.31	0.77	27.24	3.00
RM	-22.27	756.92	-0.15	26.78	2.68	-112.34	1200.48	-0.74	26.78	2.50
BU	-130.57	988.86	-0.64	24.50	2.78	-208.90	1333.16	-1.09	24.50	2.62
I	112.50	392.62	0.51	25.65	3.13	45.15	539.29	0.13	25.65	2.99
JD	-31.39	440.53	-0.17	26.47	2.68	-93.72	737.69	-0.62	25.19	2.68
PP	72.41	528.28	0.40	29.03	2.62	11.25	634.36	0.02	28.40	2.55
HC	11.43	611.72	0.15	27.70	2.63	-78.43	719.15	-0.38	27.18	2.53
MA	45.74	767.25	0.18	27.99	2.66	-46.57	1053.83	-0.37	27.87	2.51
AP	213.74	171.98	1.18	28.29	3.01	155.83	198.29	0.89	27.86	2.93

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maximum withdrawal has occurred at the very beginning, when no profit has been made, the calculation formula of the maximum withdrawal ratio in this paper is as formula 4.In addition, it is assumed that the initial funds are sufficient and can be traded continuously.

maximum withdrawal ratio = maximum reversion value / maximum funds used * 100% (4)

3.2 Empirical Results and Comparative Analysis

3.2.1 RSI Indicator Model

For the verification of RSI indicator model, 9 and 14 have been chosen as the parameters of RSI1 and RSI2 correspondingly. The back-testing results of 1-day and 30-minute data of 18 commodity futures are shown in Table 1 and Table 2.

In the empirical analysis of RSI indicator model, Lin took the trading data of main palm oil futures contracts from May 4, 2015 to November 27, 2015 for back testing, and the results are shown in Table 5. Comparing table 1 and table 2 with table 5 separately, it is found that the value of profit relative indicators such as annual return rate, winning rate in both table 1 and table 2 are lower than that in table 5, while the value of risk relative indicators such as maximum withdrawal ratio is higher than that in table 5. The results of our study are much worse than that of Lin. In addition, it is found that the results in 30-minute data are worse than that in 1-day data by comparing table 1 with table 2, that's because the increase of transaction frequency leads to a substantial increase in transaction fees, while the winning rate and average profit loss ratio are almost unchanged, which resulting in a decrease in return and an increase in risk. It can be sure that transaction cost has a great impact on model revenue.

3.2.2 CCI Indicator Model

14 is selected as the parameter value in the verification of CCI indicator model. The back-testing results of 1-day and 30-minute K-line data of 18 kinds of commodity futures are shown in Table 3 and Table 4.

In Lin's study, the empirical analysis of CCI indicator

Table 3. Back testing results of CCI index model for 1-day data

	Transaction fee rate=0.00006					Transaction fee rate=0.00016				
	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio
PTA	131.81	362.36	0.77	34.37	3.07	127.94	370.91	0.74	34.06	3.06
SR	23.99	368.57	0.08	31.09	2.44	19.10	381.92	0.04	30.77	2.42
C	15.94	430.57	0.14	35.31	2.03	10.38	474.37	0.07	35.31	1.96
M	19.69	405.04	0.07	32.67	3.73	14.18	429.20	0.04	31.82	2.24
FU	-18.07	797.42	-0.40	25.17	2.79	-22.79	843.17	-0.43	24.83	2.79
P	45.98	700.00	0.23	35.06	2.25	42.22	712.77	0.20	34.76	2.25
ZN	-6.92	707.71	-0.12	30.81	2.19	-11.77	748.30	-0.15	29.94	2.24
CU	71.99	574.15	0.39	35.50	2.35	67.44	586.61	0.36	35.50	2.31
RB	44.28	746.89	0.15	33.68	2.27	39.41	763.27	0.12	33.33	2.27
J	150.32	339.47	0.84	33.94	2.99	146.33	341.97	0.81	33.94	2.95
RM	34.48	463.05	0.13	36.20	1.97	29.51	472.08	0.10	36.20	1.94
BU	-46.16	860.96	-0.44	27.89	2.27	-51.57	875.90	-0.47	27.89	2.24
I	100.73	481.13	0.36	31.01	2.82	96.97	485.61	0.33	31.01	2.80
JD	76.12	248.95	0.50	33.95	2.48	70.52	250.44	0.46	32.72	2.57
PP	110.14	267.80	0.67	37.50	2.34	104.97	271.22	0.63	36.81	2.37
HC	-15.74	824.80	-0.07	35.17	1.77	-20.79	840.92	-0.10	35.17	1.74
MA	18.99	669.94	-0.01	31.08	2.33	13.75	681.20	-0.04	31.08	2.30
AP	72.53	354.20	0.48	46.88	1.35	68.39	357.37	0.46	43.75	1.52

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Table 4. Back testing results of CCI indicator model for 30-minute data

	Transaction fee rate=0.00006					Transaction fee rate=0.00016				
	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio	annual return rate (%)	maximum withdrawal ratio (%)	sharp ratio	winning ratio (%)	profit loss ratio
PTA	65.80	543.10	0.30	31.01	2.44	29.27	661.55	-0.02	30.28	2.40
SR	45.85	241.72	0.40	32.78	2.20	9.95	453.70	0.11	32.11	2.15
C	-2.37	376.10	-0.07	29.01	2.43	-46.86	716.93	-0.60	29.01	2.17
M	8.67	549.38	-0.03	31.72	2.18	-37.99	860.93	-0.36	30.78	2.15
FU	-78.32	1322.57	-0.58	29.17	2.11	-102.79	1539.13	-0.74	28.09	2.13
P	24.83	412.52	0.19	30.62	2.36	-8.90	456.72	-0.14	30.35	2.26
ZN	47.47	394.97	0.22	32.35	2.21	-4.41	703.03	-0.11	31.36	2.18
CU	113.57	260.22	0.81	33.55	2.30	63.18	386.07	0.43	31.78	2.33
RB	147.67	303.56	0.95	33.48	2.38	103.22	362.09	0.62	32.14	2.39
J	107.92	683.22	0.32	31.10	2.47	63.96	770.99	0.04	30.71	2.40
RM	-70.04	955.76	-0.52	29.46	2.23	-130.16	1222.50	-0.90	29.46	2.11
BU	-5.34	554.33	-0.19	28.65	2.48	-57.28	693.20	-0.50	28.65	2.35
I	111.40	606.46	0.38	31.57	2.38	67.81	664.00	0.13	31.57	2.29
JD	56.14	237.00	0.41	33.09	2.19	14.94	259.52	0.10	31.45	2.22
PP	52.06	716.47	0.24	32.72	2.18	9.95	806.12	-0.02	31.97	2.15
HC	32.43	549.23	0.25	32.78	2.11	25.80	702.18	-0.09	32.04	2.07
MA	-36.48	1133.82	-0.33	30.70	2.19	-98.11	1317.40	-0.69	30.70	2.08
AP	325.88	214.44	1.81	36.39	2.45	287.36	224.53	1.60	35.41	2.45

model is based on 1-day data of palm oil futures from June 1, 2015 to December 11, 2015. The results are shown in table 6. From table 3, it can be seen that the winning rate of CCI is only about 30% after increasing the number of varieties and the amount of back testing data, which is much lower than 50% as listed in table 6. In addition, although 14 of 18 varieties making profits, the maximum withdrawing ratio of all varieties exceeds 100%, which indicates that the varieties have lost all the principal during the trading period. Compared table 3 with table 4, it is found that the income and risk index values of CCI model in 30-minute data are worse than those of 1-day data, that's because the high transaction frequency leads to a substantial increase in transaction fees, while in the case of low winning rate and average profit loss ratio, the profit cannot fill the handling fees, resulting in a decrease in income and an increase in risk. In addition, table 3 and table 4 show that the annual return rate, maximum withdrawal ratio and other data of CCI model are significantly lower than listed in table 6 under the circumstance of increasing the back-testing futures varieties, data volume and deducting transaction cost.

Table 5. Test results of RSI model in palm oil futures

RSI indicator model	test result
Annual return rate (%)	184.61
maximum withdrawal ratio (%)	38.91
sharp ratio	7.74
winning ratio (%)	45
Average profit loss ratio	2.67

Table 6. Test results of CCI model in palm oil futures

CCI indicator model	test result
Annual return rate (%)	215.61
maximum withdrawal ratio (%)	42.18
sharp ratio	5.03
winning ratio (%)	50
Average profit loss ratio	3.01

4. Conclusion and Enlightenment

4.1 Main Conclusions

In this paper, data of 18 futures with the largest trading volume in Chinese futures market in recent 10 years are tested. Trading strategy writing and simulating are carried

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out through the software trade blazer v5.5.2 to further verify the sustainability of profitability and general applicability of the RSI and CCI indicator models under the consideration of transaction cost. The RSI model parameters are 9 and 14, and the CCI model parameter is 14. The conclusions are as follows:

(1) When deducting the transaction cost and increasing the amount of test data, both income index and risk index are worse than that in the research conclusion of Lin.

(2) The average winning rate of the two models in both 1-day and 30-minute data is just about 30%, which means that the prediction accuracy is not high.

(3) In terms of income and risk indexes, the results of 1-day data is better than that of 30-minute data. Because the high transaction frequency leads to a substantial increase in transaction fees, but due to the low winning rate and average profit loss ratio, profits do not increase correspondingly, resulting in a lower income and a higher risk.

(4) The back-testing results of 1-day data shows that most of the varieties can obtain profits, but the maximum withdrawal ratio is too large, there is a risk of exposure, indicating that the profitability of the model is time-varying, it's sustainability and general applicability is not good. In order to spread the risk, it is better to build a multi variety trading portfolio when using the RSI or CCI indicator model for trading.

4.2 Enlightenment

Over the years, many scholars have done a lot of empirical research on the predictability of technical indicator analysis in the financial market, the conclusions are obviously different. One reason for that maybe the non-uniform of test data. If the data used in the industry can be studied uniformly, it should be able to make a better and more accurate comparison of the benefits and risks level of different trade models and methods.

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