

Vol 22 No. 13, September 2020

ISSN : 0975-1386

Wesleyan Journal of Research

An International Research Journal
HUMANITIES & SOCIAL SCIENCE SECTION

Multidisciplinary | Peer Reviewed | Referred
UGC Care Listed



Bankura Christian College
Bankura-722 101
WEST BENGAL, INDIA

Wesleyan Journal of Research

Vol.22 No.13, September 2020

Published by

Principal

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Print at :

A.T. Press,

Bankura, India



Predictability of MACD Index: Evidence from Indian Stock Market

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Abstract: MACD is one of the widely reported technical indicators used in stock market to trigger 'buy' and 'sell' based on the position of 'current close' near 'upper end' or 'lower end' of the 'price range' for certain periods back. But controversy over its futurity and futility for stock price prediction still remains unsettled in various markets. This paper examines its predictive validity and concludes absence of profitability and consistency.

Key Words: Moving Average Convergence Divergence Index, Superior wealth, signal strategies, long cash, short cash, buy and hold, Terminal and daily deals, technical analysis, stock market.

Article History

Received: 24/09/2020; Accepted: 29/09/2020

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INTRODUCTION

Price prediction is the most interesting and important thing in the success of stock market investment. Technical Indicators form a prediction-kit category and numerous tips based on it are flooding the media. Number of interested people asking for and commenting them also increase with growth in demat accounts and day trade. Moving Average Convergence Divergence Index (MACD Index) or Indicator is one of the widely reported indicators that trigger 'buy' and 'sell' based on the momentum. But controversy over its futurity and futility for stock price prediction still remains unsettled in various markets. This paper examines its predictive validity for consistent profitability.

Problem

Though MACD is widely used, it is not a tool tested for its validity in Indian stock market. The problem is the practice of MACD Index paradoxical to the holding of its futility.

Objectives of the study

The objective is to ascertain the 'consistent superiority', if any, of MACD index over non-signal strategies in return generation and wealth creation.

2. Long-Cash Position- It is a signal strategy. In this study these terms refer to deals by an investor using signals from analysis. He buys the stock on the day next following the day of 'buy signal', from MACD. From the day of purchase to the day sale, he holds the stock and is in 'long position'. From the day of sale to the day of next buy signal he keeps cash and is out of the market and is in cash position.
3. Short Cash position- It is a signal strategy. Here, the investor sells the security on the day next following the day of 'sell signal' from MACD. He buys back the stock when the next signal to buy is triggered. From the day of sale to the day of buy back, he is in short position. From the day of purchase (cover) to the day of sale, he is 'out of the market'.
4. Long-short position- It is a signal strategy. In this case, the investor combines the long position and short position without any cash position. He is always 'in the market' He buys and also covers his short position, if he has any, on buy signals and on sell signals he not only sells and but also sells short. Here he expects to make profit both the ways- from the rise in price during long signal days and from the fall in prices during short signal days.
5. Daily long - It is a signal strategy where the trader first buys and then sells every day during the period from the day next following the day of 'signal to buy' to the day of 'signal to sell'. He buys at the opening price and sells at the closing price of the same day. He expects a price rise for the day. For the period from the next day following the 'sell signal day' to the 'buy signal day', he is out of the market. It is a bull strategy using signals.
6. Daily short- It is a signal strategy where the trader first sells and later buys back every day during the period from the day of 'signal to sell' to the day of 'signal to buy'. It is just the opposite of the 'Daily long' strategy. He sells at the opening price and buys back at the closing price of the same day. He expects a fall in price for the day. For the period from the next day following the 'buy signal day' to the 'sell signal day', he is out of the market. It is a bear strategy using signals.
7. Daily long-short- It is a signal strategy. It is a combination of the daily short position and daily long position, without keeping any cash position. In this case the trader is always in the market. Here he expects to make profit both the ways- from the rise in price during 'buy signal days' and from the fall in prices during 'sell signal days'.
8. Long only- It is a non-signal strategy where the trader buys at opening price and sells at the closing price both on the same day. He does it every day without reference to any signal or analysis. Bulls do it. It differs from the Daily long policy as the latter uses

Hypothesis

“Signal strategies using ‘MACD index’ generates a return consistently greater than that from non-signal strategies.”

Methodology

The study analyses the historical data of selected shares listed on the BSE for a period of fourteen years beginning with 1st January 1990.

1. Calculation of MACD Index Value

As the name implies, Moving Average Convergence Divergence (herein after referred as MACD) Index signals buy and sell by measuring the convergence and divergence between two moving averages -a Short-term Moving Average (SMA) and a Long-term Moving Average (LMA). The latter is deducted from the former to get the MACD Index value. Closing prices of the day are used to calculate the moving averages. Convergence shows continuation and divergence hints reversal.

Signals to act are further stabilised, as a second method, using cross-over of a very short term moving average of MACDs by the MACD itself. It is the second method that is used in this study.

2. Consideration of two different MACDs

To ascertain the influence of ‘number of periods’ (Term), two MACD Indices were constructed with two different durations as follows. The ‘combinations of periods’ that gave best result for two different durations –a short period’ and a ‘long period’ - during experimental period are as follows :

1. Combination consisting of:

1. A Long Term Moving Average (LTMA) of twenty eight (28) days,

2. Short Term Moving Average (STMA) of twelve (12) days and

3. A three (3) days moving average of MACD cross over of which by the MACD triggers the signal.

Equation for the construction of 28 Day MACD

$$\text{MACD Index} = (12\text{DMA} - 28\text{DMA})$$

$$\text{Trigger} = 3\text{DMA of MACD cross over of MACD}$$

2 Combination consisting of:

1. A Long Term Moving Average (LTMA) of fifty six (56) days,

2. Short Term Moving Average (STMA) of twelve (12) days and

3. A three (3) days moving average of MACD cross over of which by the MACD triggers the signal.

Equation for the construction of 56 Day MACD

$$\text{MACD Index} = (12\text{DMA} - 56\text{DMA})$$

$$\text{Trigger} = 3\text{DMA of MACD cross over of MACD}$$

Both these combinations were applied to the data.

3. Sample Design

All the stocks as were listed on Bombay stock exchange as on 31st December 1996 form the broad universe of the study. The data on 3400 companies were screened for regularity of trading and it reduced the number of stocks to two hundred and seventy (270) which was further screened to select the most actively traded fifty (50) stocks. Form this list ten stocks were selected at random for analysis which were: (1) Associated Cement Companies Limited, (2) Bajaj Automobiles Limited, (3) Century Textiles and Industries Limited, (4) Escorts India Limited, (5) Great Eastern Shipping Company Limited, (6) Glaxo India Limited, (7) Grasim Industries limited, (8) Hindustan Liver Limited, (9) Indian Tobacco Company Limited and (10) VIP industries Limited.

4. Analysis of MACD Index or Indicator

Analysis involved the following steps:

(i) Simulation process for the calculation of return

To ascertain the return generating capacity, purchases and sales were simulated on signals given by the MACD indicator. The return is calculated by comparing the net proceeds and purchase cost. Commission is charged at half a percentage on both ends but other transaction costs, dividends and taxes are ignored while computing the return.

The simulation process involves the following: the stock is purchased or sold on the day following the day of 'buy signal' and 'sell signal' respectively in case of terminal deals . However, daily deals involve: (1) 'buy in the morning and sell in the evening' during all the 'buy signal days ' and (2) 'sell in the morning and buy in the evening during all the 'sell signal days '. Morning deals are assumed to be made at the 'opening price' and evening deals at 'closing price'.

(ii) Strategies tested

The study examines the investment performance in all the nine different trading strategies possible for a trader as mentioned below.

1. Buy-and-hold position- It is a non-signal strategy. In this case the investor firstly buys a stock and holds it and sells later only at the end of his investment period that is decided by him. He does not care for any analysis and there are no intervening trades. This is usually resorted by an investor-for long term.

signals from analysis.

9. Short only- It is a non-signal strategy where the trader sells at opening price and buys at the closing price both on the same day. He does it every day without reference to any signal or analysis. Bears do it. It differs from the Daily short policy as the latter uses signals from analysis

(iii) Prices used for calculation of return

For all terminal deals under signal strategies and for 'buy-and -hold' non-signal strategy, average of highest and lowest prices is used. All daily deals are, however, made at opening prices and closing prices depending on the short or long position assumed. The net capital gain, as a percentage of cost of initial deal (buy or sell), is cumulated on an assumed initial investment of Rs.100. The initial investment therefore grows with positive net return and declines with negative net return.

(iv) Evaluating the performance and its consistency

If 'signal strategies using MACD outperform 'non-signal strategies', the MACD indicator can be taken as a useful tool for improving investment performance. The consistency of the superior return generating capacity is established by evaluating the result of experimental period against the testing period.

The consistency of superiority of return revealed by the Test of significance for difference between means. The standard error of difference between means is obtained by the following equation: $S.E. \text{ of Means} = \text{square root}(s_1^2/n_1 + s_2^2/n_2)$

Where, s_1 = Standard deviation of the first group, s_2 = Standard deviation of the second group

n_1 = Number of observation in the first group n_2 = Number of observation in the second group

(v) Prices Used for Calculation

For deals in the first four (1-4) positions, the prices used are the average of the 'highest price' and the 'lowest price' on the day of trade for purchase and sale as the case may be. For deals in the next five (5-9) positions, the 'opening price' and 'closing price' of the day of trade are used. The positions -short or long- with some holding period -of a day or more- are termed as 'Terminal' deals. If positions are closed every day, that is, without any holding period or carry forward, such deals are termed as 'Daily' deals.

vi Calculation of Rate of Return (r) for each completed deal

The calculation of return in long and short positions differs slightly as summarised in the following equations.

For long positions: $r = .995s - 1.005b / 1.005b$

For Short positions: $r = .995s - 1.005b / 1.005s$

Where, r = Rate of Return, s = Selling Rate, b = Buying Rate

For Long-Short combination positions, the return on investment is calculated by sequential merging of both the returns

(vii) Computation of Quarterly Wealth

To find the changing position of wealth, the wealth at the period of origin, which is assumed to be Rs.100/- is compounded at the 'r' as obtained above.

The investment values at the end of all the quarters during the data-period are averaged to obtain the average quarterly wealth. In this respect longitudinal approach is applied in finding the wealth position.

Limitations

The study did not take into account transaction costs other than commission (@0.5%) and also ignored dividend, as the primary aim is to study dependencies of past and future prices. Result would have been better if commission was lower. Optimum duration found for MACD - 28 days 56 days – can differ for different periods and consequently in results.

Findings

The results of analysis are presented in tables 1-6. In each table, the stock-wise and strategy-wise summary results (average across 28 quarters) are presented.

The change in wealth in all the nine strategies of trade (six using signals from shorter period (28 days) MACD and three non-signals) are shown in Table 1 for experimental period and in Table 2 for testing period. The test of significance for the difference between the means of the wealth of the two periods-experimental period and testing period are shown in Table 3. The same for longer period combination of 56 day MACD are shown respectively in tables 1, 2 and 3.

All signal strategies show lower average wealth in both the above 'long term' and 'short term' combinations compared to average wealth by 'buy and hold policy'. No specific exception found for even to any one of the individual stocks. This means, when judged by wealth, superiority of signal strategy is not found for both 'average across stocks' and for every individual stock. The relative superior position of buy and hold does not change in the testing period also.

Average wealth in both the combinations across stocks support buy and hold policy rather than signal strategies.

Table 1 Quarterly Wealth from 28 Day MACD									
Average across all 28 Quarters (LTMA 28, STMA 12 and Trigger 3DMA)									
For Experimental Period									
Stock Serial Number	Using Signal from MACD						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
1	107.5873	99.0657	105.3189	65.9325	78.6383	83.0036	58.7406	61.5866	108.7367
2	101.3241	92.3210	93.3111	61.7535	84.2367	71.0856	74.8774	49.5135	108.9667
3	98.3794	96.0946	94.6209	61.9155	94.4483	65.3897	94.3287	41.6158	102.0875
4	102.9503	94.7847	99.7440	78.3904	92.8625	90.7741	88.8714	29.2294	116.5052
5	97.8574	93.9233	92.3590	64.2331	77.3221	79.3919	60.8014	59.8921	100.8535
6	98.6925	90.9108	89.8122	61.0410	81.5899	72.3061	69.0268	51.3199	107.1210
7	100.9061	98.7430	99.1463	61.3288	72.5084	81.9392	55.5369	68.0652	99.9955
8	102.6427	96.6026	99.0227	60.3983	81.1795	72.9199	69.1147	49.3999	107.6246
9	102.1366	92.1686	93.6920	60.0479	79.9026	73.6323	67.8440	51.7863	111.2584
10	99.3523	95.2337	95.4144	103.9703	103.1613	90.2278	98.8178	88.1475	106.9453
Average	101.1829	94.9848	96.2441	67.9011	84.5850	78.0670	73.7960	55.0556	107.0094
Standard Deviation	2.9011	2.7382	4.5417	13.7848	9.3539	8.4280	15.2211	15.8652	5.0194

Table 2 Quarterly Wealth from 28 Day MACD									
Average across all 28 Quarters (LTMA 28, STMA 12 and Trigger 3DMA)									
For Testing Period									
Stock Serial Number	Using Signal from MACD						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
1	104.5064	98.6158	102.9798	57.5466	69.0103	81.9824	46.6160	62.1211	106.1659
2	98.7685	95.3478	94.0044	56.1738	74.3335	74.7567	53.3890	55.5907	104.1714
3	98.7596	93.7204	91.6623	59.2172	62.8028	85.4398	41.8433	72.0421	107.9050
4	98.1471	95.6887	93.8353	55.7442	72.8611	76.4787	56.2752	56.9635	102.5704
5	102.5145	96.2860	97.8172	57.9546	69.7551	79.0924	49.3969	60.9980	109.2066
6	98.7294	94.3008	93.2549	54.3574	68.3539	76.5205	49.6694	59.4700	105.4297
7	101.7000	94.1515	96.5962	61.2681	84.7525	72.1755	71.2513	49.1482	108.6790
8	96.5195	89.9317	86.4286	51.6783	69.3984	70.9225	54.7060	56.0346	106.5846
9	96.8648	93.0688	90.5168	51.1423	69.5979	74.4119	50.3471	57.6379	104.5526
10	98.0690	94.5272	91.7568	53.3923	70.9749	75.0247	55.1449	55.9651	103.3203
Average	99.4579	94.5639	93.8852	55.8475	71.1840	76.6805	52.8639	58.5971	105.8586
Standard Deviation	2.5896	2.2585	4.5013	3.2652	5.6530	4.4191	7.8007	5.9172	2.2599

Table 3 Test of Significance for difference between Means of Wealths									
Results of 28 Day MACD									
Statistic	Using Signal						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
Experimental Mean.	101.1829	94.9848	96.2441	67.9011	84.5850	78.0670	73.7960	55.0556	107.0094
Experimental Std. Dev.	2.9011	2.7382	4.5417	13.7848	9.3539	8.4280	15.2211	15.8652	5.0194
Test Period Mean	99.4579	94.5639	93.8852	55.8475	71.1840	76.6805	52.8639	58.5971	105.8586
Test Period Std. Dev.	2.5896	2.2585	4.5013	3.2652	5.6530	4.4191	7.8007	5.9172	2.2599
Standard Error of Means	1.2298	1.1224	2.0221	4.4797	3.4562	3.0093	5.4086	5.3546	1.7407
Difference between Means	1.7250	0.4209	2.3589	12.0536	13.4009	1.3865	20.9320	3.5415	1.1509
Difference/S.E.	1.4027	0.3750	1.1666	2.6907	3.8774	0.4607	3.8701	0.6614	0.6611

Table 4 Quarterly Wealth from 56 Day MACD
Average across all 28 Quarters (LTMA 56, STMA 12 and Trigger 3DMA)
For Experimental Period

Stock Serial Number	Using Signal from MACD						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
1	109.1123	100.0844	108.0582	67.0845	79.8893	83.3606	58.7406	61.5866	108.7367
2	105.4695	96.0491	100.9699	62.3526	84.8673	71.7583	74.8774	49.5135	108.9667
3	101.3615	99.4626	100.5140	64.4958	95.7293	66.3432	94.3287	41.6158	102.0875
4	98.6561	92.7383	91.8662	77.1924	85.6523	88.5248	88.8714	29.2294	116.5052
5	99.8598	96.9812	96.4171	64.6708	78.3164	78.6683	60.8014	59.8921	100.8535
6	103.6283	96.2951	100.0695	65.2985	84.0929	74.7724	69.0268	51.3199	107.1210
7	98.5480	98.3128	97.2688	59.8599	71.8200	80.9441	55.5369	68.0652	99.9956
8	103.4587	98.2996	101.3371	61.4860	83.1673	73.5666	69.1147	49.3999	107.6246
9	101.5969	92.1123	93.3922	59.6827	81.0432	71.6919	67.8440	51.7863	111.2584
10	99.7033	95.7622	95.9386	81.9397	103.8252	83.0105	98.8178	88.1475	106.9453
Average	102.1394	96.6098	98.5832	66.4063	84.8403	77.2641	73.7960	55.0556	107.0094
Standard Deviation	3.3455	2.6342	4.6484	7.4138	9.0310	6.7743	15.2211	15.8652	5.0194

Table 5 Quarterly Wealth from 56 Day MACD
Average across all 28 Quarters (LTMA 56, STMA 12 and Trigger 3DMA)
For Testing Period

Stock Serial Number	Using Signal from MACD						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
1	103.2830	97.5026	100.7029	59.4193	68.3611	82.4703	46.6160	62.1211	106.1659
2	99.4684	96.4300	95.4477	58.3897	75.0466	76.1248	53.3890	55.5907	104.1714
3	104.8228	99.0906	101.9851	58.4048	65.2933	88.9497	41.8433	72.0421	107.9050
4	98.1169	95.2517	93.9762	57.8842	74.4270	77.7840	56.2752	56.9635	102.5704
5	102.8685	95.9675	98.4141	55.3034	69.4224	78.8280	49.3969	60.9980	109.2056
6	97.1699	93.7042	90.8396	54.7945	68.5813	77.5404	49.6694	59.4700	105.4297
7	105.0154	98.0524	103.5974	64.0629	85.8758	74.4919	71.2513	49.1482	108.6790
8	97.2627	91.6810	88.9701	52.3962	70.2026	72.3310	54.7060	56.0346	106.5846
9	96.8881	94.0953	91.5463	54.4215	70.7795	75.3951	50.3471	57.6379	104.5526
10	96.8944	94.9139	90.8791	53.4575	70.2693	75.4594	55.1449	55.9651	103.3203
Average	100.1790	95.6689	95.6358	56.8534	71.8259	77.9375	52.8639	58.5971	105.8586
Standard Deviation	3.4280	2.2212	5.2353	3.4696	5.6928	4.7374	7.8007	5.9172	2.2599

Table 6 Test of Significance for difference between Means of Wealths
Results of 56 Day MACD

Statistic	Using Signal						Without Signal		
	Terminal			Daily			Daily		Terminal
	Long-Cash	Short-Cash	Long-Short	Long-Cash	Short-Cash	Long-Short	Long only	Short only	Buy and Hold
Experimental Mean.	102.1394	96.6098	98.5832	66.4063	84.8403	77.2641	73.7960	55.0556	107.0094
Experimental Std. Dev.	3.3455	2.6342	4.6484	7.4138	9.0310	6.7743	15.2211	15.8652	5.0194
Test Period Mean	100.1790	95.6689	95.6358	56.8534	71.8259	77.9375	52.8639	58.5971	105.8586
Test Period Std. Dev.	3.4280	2.2212	5.2353	3.4696	5.6928	4.7374	7.8007	5.9172	2.2599
Standard Error of Means	1.5147	1.0896	2.2140	2.5885	3.3759	2.6141	5.4086	5.3546	1.7407
Difference between Means	1.9604	0.9408	2.9473	9.5529	13.0144	0.6734	20.9320	3.5415	1.1509
Difference/ S.E.	1.2943	0.8635	1.3312	3.6905	3.8551	0.2576	3.8701	0.6614	0.6611

Summary of Findings

1. There is period –specific difference in wealth creation under some of the strategies tested using either shorter period MACD or longer period MACD (bold figures in bottom line of tables 3 and 6).

2. MACD index could not establish its ‘superiority in ether experimental period or testing period – although used shorter period or longer period. Experimental period result was supported by testing period results for either combinations.

3. In all cases, average result favours buy and hold policy.

The results of the test of significance (for difference between wealth of the two different periods) are shown in tables 3 and 6 also recognise the continuing inferior performance of signal strategies and supports that persistence of superiority of buy and hold policy in both the experimental and testing period. Therefore, the hypothesis that “signal strategies using MACD generates a return consistently greater than that from non-signal strategies” is rejected.

So the study does not find any evidence supporting the holding that MACD index can give consistently superior return in the Indian stock market.

Conclusion

Signal strategies using MACD index does not generate wealth superior to that from buy and hold policy.

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