



# Forecasting Monthly Average of Taiwan Stock Exchange Index

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**Abstract.** Futures market has high leverage and the characteristics of over-performing returns. Hence, it always attracts lots of investors. However, three major kinds of institutional traders are more influential than individual investors in Taiwan. In this paper, a monthly predicting model for the weighted price index of the Taiwan Stock Exchange (TAIEX) was built based on correlation and regression analysis by using the following parameters: Dow Jones industrial index, NASDAQ index, M1A, M1B, M2 annual growth rate, US dollar exchange rate, economic monitoring indicator and global oil prices. Then, based on the prediction results, we define two trading strategies and apply them in trading MTX (mini Taiwan index futures). The evaluation result shows that both the two trading strategies have good returns.

**Keywords:** Correlation analysis · Regression analysis · Stock

## 1 Introduction

Taiwan stock futures (TX) were launched by the Taiwan Futures Exchange in 1998, and the trading target was the Taiwan weighted stock index. The mini Taiwan index futures (MTX) was launched in 2001, and the transaction target is the same as Taiwan stock futures [1, 2]. The difference between TX and MTX lies in the contract value and the required security deposit. In the past 10 years, the trading volume of both TX and MTX has been increasing year by year. In particular, the trading volume of MTX in 2016 was 8 times that of 2007, which represents the increasingly hot trading in the futures market. Stock futures provide investors with an investment approach other than stocks, which has high market liquidity, and transaction costs are much lower than stocks. Therefore, stock futures have the functions of hedging, price discovery and speculation. However, because the required minimum deposit is much lower than the contract value, stock futures are highly leveraged, high-risk investment tools.

Moreover, because the three major kinds of institutional traders have the advantages of capital size and better information sources, they usually outweigh many individual investors in profitability.

Since the trading targets of Taiwan stock futures and mini Taiwan index futures are all Taiwan weighted stock indices, the linkage between futures and stocks must be highly correlated. Therefore, the purposes of this paper are:

- To identify the factors that affected the weighted stock index of Taiwan in recent years.
- To predict the monthly average of the Taiwan weighted stock index by analyzing factors in historical data.
- To use the monthly average to judge the trend of the Taiwan stock market, and provide trading strategies on investing in mini Taiwan index futures.

We first refer to the literature on the stock market and futures market to find out the factors that may affect the stock price, such as: Dow Jones industrial index, NASDAQ index, monetary aggregates (M2, M1A, M1B), gold price, economic monitoring indicator, US dollar exchange rate, the balance of margin loan and stock loan, various international crude oil prices [3], etc. Then, we use correlation analysis and p-value approach to filter out factors that are more relevant to Taiwan weighted stock index. Then, we will find variables with better predictive power by using simple linear regression and here only one factor is considered as an independent variable at a time in simple linear regression. Finally, multiple linear regressions are used to combine multiple factors [4] and we will use the results of regression analysis to predict the monthly average of Taiwan weighted stock index. The reason for using the monthly average is to spread short-term risks, like the 9/11 attacks. If the forecast period is extended to the monthly interval, the impact of these short-term factors can be reduced.

Finally, we propose two trading strategies for mini Taiwan index futures. Through the tests based on historical data, we found that our prediction model can achieve the highest average accuracy by using the combination of the following three factors: the monthly average of Dow Jones industrial index, the monthly average of NASDAQ index, and the M2 annual growth rate. Therefore, the prediction model in this paper mainly uses these three factors to do forecast. In the evaluation section, we will show the investment performances of these two proposed strategies and both of them have good investment returns.

## 2 Related Works

After analyzing the related literature, we did not find any related works for predicting the monthly average of the weighted stock index of Taiwan. Chuang in [5] mentioned that the public information of the three major kinds of institutional traders has considerable explanatory power on Taiwan index futures, and among which foreign investment institutes have the greatest influence. Since the futures market is still dominated by institutional traders, individual investors need to track the public information of the institutional traders to adjust the trading strategy to achieve higher profit. Hsieh [6] pointed out that the exchange rate has a certain degree of relationship and

influence with the stock market, and analyzed the impact of exchange rate on Taiwan weighted stock price index, including the exchange rate changes between the New Taiwan dollar against the US dollar, the Chinese yuan, the Hong Kong dollar and the euro. Liu [7] explored the timing relationship among Taiwan weighted stock index, Taiwan stock index futures and Taiwan stock index options. It was observed that the futures price discovery ability was 30 min ahead of the option and 45 min ahead of the stock spot. Chang [8] studies the impact of the following three factors on the rise and fall of Taiwan stock index futures: the open interest of Taiwan stock index futures, the trading volume of Taiwan stock index futures and the net foreign investment of Taiwan stock index futures. Lu [9] attempted to use time series, regression analysis, and neural network to predict the next day closing index of Taiwan stock futures. Six variables were selected by stepwise regression analysis, including the 10-day moving average, the 10-day BIAS, the basis difference, the 9 days K, the open interest, and the Shanghai composite index. Wang [10] explored the linkages among the international oil price, change rate of currency exchange and the Taiwan stock price index, based on the historical data since January 2000 to September 2008. Wu [11] analyzed the market capital flow through the self-organizing map network and the reverse-transfer neural network in the Taiwan stock and futures market in order to identify potential behaviors of market capital flows as an investment aid for investors. Yang [12] made an empirical study on whether the daily close-to-close rate of return of the NASDAQ index has spillover effect on both investment reward and volatility of Taiwan stock market. According to the empirical results, NASDAQ has a statistically significant reward spillover effect for Taiwan stock index. The most significant impact is on the daily return of the Taiwan stock market. Hsieh [13] used a variety of time series methods to explore the linkage between Taiwan weighted stock price index, crude oil spot, crude oil futures, gold spot and gold futures. Using the nonparametric co-integration method, it is found that there is a long-term stable equilibrium relationship between the stock price index, crude oil and gold price. The analysis results show that the price of crude oil has the greatest influence. Therefore, when investing in the stock market, investors have to pay attention to the impact of oil price fluctuations. Sou [14] used an empirical research method to establish a trading strategy for Taiwan stock price index futures by additionally referencing the KD value of the day as well as the positive and negative price difference between Taiwan stock index futures.

### 3 TAIEX Index Prediction

In this paper, we have to collect the required historical data for prediction model creation and model performance evaluation. Table 1 shows the types, the sampling intervals and the data sources (web sites) of these historical data. The data are gathered either by a Java language crawler or manual downloading from the web sites listed in Table 1. For some types of data (whose Avg field is Y) in Table 1, we will calculate their respective monthly averages, and use their monthly averages in the subsequent data analysis process.

We calculate the correlation coefficient and p-value for each data type in Table 1 and the monthly average of the Taiwan weighted stock price index. Then we can

**Table 1.** Types, sampling intervals and data sources of historical data

Data type	Avg	Sampling interval	Data sources
Taiwan weighted stock index	Y	2010.01–2016.12	TWSE homepage [1]
The balance of margin loan	Y	2010.01–2016.12	TWSE homepage [1]
The balance of stock loan	Y	2010.01–2016.12	TWSE homepage [1]
Dow Jones industrial index	Y	2010.01–2016.12	Quandl homepage [15]
NASDAQ index	Y	2010.01–2016.12	Quandl homepage [15]
Gold price	Y	2010.01–2016.12	Quandl homepage [15]
M1A annual growth rate	N	2010.01–2016.12	TW central bank [16]
M1B annual growth rate	N	2010.01–2016.12	TW central bank [16]
M2 annual growth rate	N	2010.01–2016.12	TW central bank [16]
MTX index	N	2014.01–2016.12	TAIFEX homepage [2]
Economic monitoring indicator	N	2010.01–2016.12	TW NDC homepage [17]
US dollar exchange rate	Y	2010.01–2014.12	TPEFX homepage [18]
NYMEX crude oil	Y	2010.01–2014.12	Anue homepage [19]
WTI crude oil	Y	2010.01–2014.12	Anue homepage [19]
Brent crude oil	Y	2010.01–2014.12	Anue homepage [19]
RBOB gas	Y	2010.01–2014.12	Anue homepage [19]

observe that between 2010 and 2014, the following variables whose correlation coefficient with Taiwan weighted stock price index are more than 0.3: the Dow Jones industrial index, the NASDAQ index, the annual growth rate of M2, the economic monitoring indicator, and the NYMEX crude oil. From 2010 to 2014, the three variables of Dow Jones industrial index, NASDAQ index and M2 annual growth rate are all of moderately positive correlation, and even highly positive correlation can be achieved in a single year. In addition, similar results can also be observed by using the P-value approach. The following variables have a p-value of less than 0.05 (which means that the correlation is significant) with the Taiwan weighted stock price index: the Dow Jones industrial index, the NASDAQ index, the annual growth rate of M2, the economic monitoring indicator, the NYMEX crude oil, the balance of margin loan, and the gold price.

Therefore, we select to use each of the above-mentioned variables whose p-value is less than 0.05 as the independent variable to perform simple linear regression with the dependent variable, Taiwan weighted stock price index. Here we take the historical data of 60 months (from January 2010 to November 2014) as the training set for simple linear regression, and we will use the trained linear model to predict the Taiwan weighted stock price index for one month later (i.e., the monthly average of January 2015). Then, we will use the same simple linear regression training method based on the historical training data of the previous 60 month to predict the monthly average Taiwan weighted stock price index from February 2015 to December 2016. From the results of simple linear regression, it is found that the variables with better predictive ability are the Dow Jones industrial index, the NASDAQ index, the annual growth rate of M2, the gold price, and economic monitoring indicator.

We then can produce various variable combinations based on the variables selected by the procedure of simple linear regression. Using multiple linear regressions, a linear prediction model with multiple variables is generated for each of the above-mentioned variable combinations. For evaluating each prediction model, we use the historical data of the previous 22 months as the training set to predict the month average of Taiwan weighted stock price index from January 2015 to December 2016. However, since to choose a model is actually related to the profitability of trading and the prediction accuracy of the stock price trend, we will return to this issue after introducing our proposed trading strategies.

## 4 Trading Strategies

In this paper, we propose two trading strategies. In trading strategy 1, in the first MTX trading day of each month in the experimental interval, we enter into the arena. If the forecasted index is higher than the index of the last month, we buy one MTX LOT of the month. In contrast, if the forecasted index is lower than the index of the last month, we sell one LOT MTX. Here the contract value of one MTX LOT is the MTX index multiplied by 50 New Taiwan dollars. If the MTX index reaches the forecasted value before the clearance day, we will perform liquidation directly in advance. In contrast, if it does not, we will perform liquidation at the clearance day. In trading strategy 2, we also enter into the arena in the first trading day of each month in the experimental interval. If the forecasted index is higher than index of the last month, we buy one MTX LOT of that month. However, if the forecast index is lower than the index of the last month, we sell one LOT MTX. Here we always perform liquidation at the clearance day.

After we describe the proposed trading strategies, we can go back to discuss the issue of selecting which variables to form the best prediction model by using multiple linear regressions. We first use the method defined in the second trading strategy to generate the data of investment profit points and profit accuracy ratio, which shows how well the model can correctly predict the index in a coming month to go up or go down so that positive profit is generated or not. Each point in MTX is 50 New Taiwan dollars. Here we select the profit accuracy ratio as our main filtering factor. For predicting the index from 2015 to 2016, if we set the criteria that the average profit accuracy ratio within two years needs to be at least 58.3%, and the average annual profit accuracy ratio is not less than 50%, there are only nine variable combinations remain. Table 2 shows these variable combinations as well as the profit points and the profit accuracy ratio of each variable combination. We find that the combination of the monthly average of the Dow Jones industrial index, the monthly average of NASDAQ index, and the annual growth rate of M2 can achieve the highest average accuracy ratio and the second highest profitability. Therefore, we chose them as the independent variables of the prediction model based on multiple linear regressions in this paper.

**Table 2.** Accuracy and profit points of various variable combinations

Variable combinations	Year	Accuracy	Profit points
NASDAQ, M2	2015	66.7	764
	2016	66.7	1442
Dow Jones, NASDAQ, gold price	2015	58.3	376
	2016	58.3	1294
Dow Jones, NASDAQ, M2	2015	66.7	911
	2016	66.7	1350
NASDAQ, M2, economic indicator	2015	50	408
	2016	83.3	2166
Dow Jones, gold price, economic indicator	2015	66.7	912
	2016	66.7	1180
NASDAQ, M2, gold price, economic indicator	2015	50	408
	2016	83.3	2166
Dow Jones, NASDAQ, M2, economic indicator	2015	50	474
	2016	75	1510
Dow Jones, NASDAQ, gold price, economic indicator	2015	58.3	868
	2016	66.7	394
Dow Jones, NASDAQ, M2, gold price, economic indicator	2015	50	474
	2016	75	1510

## 5 Evaluation

Table 3 shows the investment profit in 2014 and 2015 of the prediction model that uses the Dow Jones industrial index, the NASDAQ index, and the annual growth rate of M2 as independent variables. The principal used in this experiment is 100,000 New Taiwan dollars, and the trading volume is one LOT. The administration fee of Taiwan Futures Exchange is 17.5 New Taiwan dollars and the Futures trading tax rate is 0.002%.

**Table 3.** The profit table of the two trading strategies

Strategies	Year	Monthly maximum profit (NTD)	Monthly maximum loss (NTD)	Annual profit (NTD)	Annual net profit (NTD)	Profit accuracy rate	Return rate
Strategy 1	2015	27350	20550	39350	38715	75	38.7
	2016	27900	16400	47150	46521	66.7	46.5
Strategy 2	2015	27350	21850	45550	44914	66.7	44.9
	2016	27900	16400	67500	66871	66.7	66.9

As shown in Table 3, both trading strategies have good investment performance. The reason why the profit accuracy rate of trading strategy 1 in 2015 is higher than that of trading strategy 2 is described in detailed below. For October 2015, the trading

strategy 1 predicts that the index is going downward. Since the MTX index reaches the forecast point of 8162 on October 1, 2015, the trading strategy 1 will not wait until the clearance day and performs liquidation immediately. Hence, the profit is 18 points. On the contrary, since the trading strategy 2 needs to perform liquidation until the clearance day in October 2015, it lost 437 points.

In terms of net profit, since the operations of the trading strategy 1 make the decision of liquidation based on the forecasted points, the date for performing liquidation may be earlier than the clearance day. This may result in that the profit and loss are different from the trading strategy 2. The trading strategy 1 performs liquidation early in March, May, June, October and July 2016. Although the maximum loss in a single month is smaller than that of the trading strategy 2, the maximum profit in a single month is also smaller than that of the trading strategy 2. Therefore, the return rate of the trading strategy 2 is higher than that of the trading strategy 1.

## 6 Conclusions

In this paper, we used literature analysis to identify a variety of factors that might affect Taiwan stock market in the past. Then, by using correlation analysis and p-value approach analysis, we found out the most important factors related to Taiwan stock price index, including: US Dow Jones industrial index, US NASDAQ index and M2 annual growth rate. We also use these parameters to create a prediction model to forecast the monthly average index through multiple linear regressions. Finally, we propose two trading strategies based on the prediction model. The first strategy takes the day achieving the predicted index as the day to exit positions, and the second one takes the clearance day as the day to exit positions. The evaluation results showed that the first strategy has higher trend prediction accuracy, while the second strategy has a higher rate of return. Therefore, if an investor wants to pursue higher returns and can withstand higher investment risks, the second trading strategy is recommended. In contrast, conservative investors can choose the first trading strategy. Moreover, based on the historical data from 2014 to 2016, the simulation results showed that both of the two trading strategies yield good investment returns.

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