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How Investors Survive in Crony Capitalism: A Case Study of OBI Pharma Inc. in Taiwan

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Abstract

The development of big data research methods and the information asymmetry problems in the financial market lead to the new issue of homo sociologicus, which has become a new way of thinking and has hoped to find the cause of asset pricing problem in the market. Crony capitalism is prevalent in the emerging and developing countries. It leads to wealth inequalities. Therefore, behavioral finance theory can help individual investors make investment decisions and help stock prices to reflect their true values. This study finds that the biotechnology industry does not exist an efficient market based on two OTC biotech companies, OBI Pharma and TaiMed Biologics, for the period 2015.11.23~2016.6.7. The results show that the technical analysis tested in this study can lead to trading profits and investors can increase their trading profits based on the mean reversion characteristic of company price differences.

Keywords: mean reversion, program trading, Granger causality test, crony capitalism, biotech industry, efficient market

1. Introduction

On 7 May 2016, the Economist published the crony capitalism index which measured the easiness that people can make money based on relations. Taiwan which had billionaire wealth representing 3.2% of GDP was ranked number 10 around the world. Crony capitalism is referred to the close political connection between business people and the government. Under crony capitalism, the success to fortune depends on "who" the businesses have close relations to rather than business skills. The crony capitalism index also showed that Taiwan had more serious collusion problem than China and United states, which was ranked number 11 and 16, respectively, in 2016.

OBI Pharma Inc. was established in 2002 and was a 100% re-investment by Optimer Phamaceuticals (short for, OPTR) founded in 1998 by the former chair of Academia Sinica, Chi-Huey Wong[1], who was an authority on carbohydrates field, and by the current board of director, Michael Chang. In September 2012, Samuel Yin, the chairman of Ruentex Financial Group bought the shares of OBI Pharma held by OPTR at $31 for a total of US$ 60 million. In December, OBI Pharma was listed in the emerging stock market at $90 which was the triple of the original cost. In March 2015, OBI Pharma was traded at the OTC market at $310[2], which was ten times higher than the original cost. In 2006, Chi-Huey Wong was the first person with dual nationality to serve as the chair of Academia Sinica. In June 2007, Ing-Wen Tsai[3] who was the Vice Premier of Executive Yuan, and Jin-Pyng Wang, who was the President of Legislative Yuan, successfully pushed the "Biotech and New Pharmaceutical Development Act" to be passed. The Act[4] allowed governmental researchers to participate in new pharmaceutical development and be distributed a maximum of 40% technology stocks. With funding from the government, the biotechnology and new pharmaceutical were hoped to become a cash cow industry. However, as many new drugs are under development, there was a large difference between the production value and market value. There was no operating income or P/E ratio for evaluating the company. All companies relied on the "dream ratio". According to the Q4 financial report of OBI Pharma, the company's capital was approximately 1.5 billion while the market value was as high as 112 billion. The operating income was -1,063 million, and non-operating income was only 123 million. As a result, when the blind experiment of a breast cancer drug (OBI-822) failed on 19 February 2016, the stock price dropped sharply from $718 to $321 on 25 April 2016; that is, a drop of 55.2%. At the same time period, the Taiwan stock market increased by 3.6%. As the biotech and new pharmaceutical industry was highly technology intensive, this caused company information asymmetry problem and

allowed for speculation by government officers and businesses. (Please refer to the Appendix for the political ties of OBI Pharma and TaiMed Biologics.) The top management of OBI Pharma even intensively sold their holdings in the fourth quarter of 2015 before the results of blind experiment. The security lending also rocketed to 7,219,000 shares, and amounted to $40 billion. In contrast, the investors lost their savings.

According to the reports by FSC, by the end of May 2016, the individual traders in the market had dropped to 47%, compared to a high of 70% in the past. The financed trading volume also reduced from 207.3 billion to 135.2 billion (-34.8%). The Taiwan stock market showed an escaping sign by individual investors. Due to the lack of information, individual investors often engaged in short-term trading, tracing highs and selling at lows. Therefore, this study aims to use behavioral finance theory to help individual investors develop appropriate investment strategies. At the same time, the stock market can reflect its real value. The Taiwan stock market can change from a highly turnover market and become a mature stable market.

This study aims to propose investment strategies for investors based on the case study of a failed blind experiment of OBI Pharma. The organization of this paper is as follows. Section 2 provides the literature review. Section 3 discusses the event study method, Granger causality model and program trading. Section 4 provides the data source. Section 5 provides the empirical results and analysis. Lastly, a conclusion is provided in Section 6.

2. Literature Review

Fama (1970) proposes the efficient market hypothesis and suggests that all investors in the market are "rational". However, since1980, more and more evidence points to anomalies in the market due to investors' perception bias. Therefore, there occurs some typical investment behavior. For example, Tversky and Kahneman (1973) propose the "availability heuristics" and suggest that people are not able to extract all related information from past memory. People tend to believe in events that they can easily think of or remember as events that happen often. Tversky and Kahneman (1982) suggest the "representativeness heuristics" and argue that when people evaluate the possibility of an event, they often over rely on past experience of a similar event. In addition, Shefrin and Statman (1994) suggest that people are often overconfident and believe that their judgements are correct. Tversky and Shafir (1992) suggest that people have "qusi-magical thinking" and believe that they can change something that is already a fact. People also dislike losses and regrets, and have disposition effect. As a result, the behavioral finance argues that investors are "bounded rational". Cohen, Frazzini and Malloy (2008) use social connection (also referred to as social networks or social ties) to test the information flow in the securities market. Their results show that investment performance of asset management that has social networks is significantly higher than that does not have social networks. The difference in yearly return between the two is 7.8%. Private information can pass between fund managers, CEO and financial analysts through alumni relations. This affects the asset pricing, asset allocation and investment returns. Therefore, they are referred to as "homo sociologicus".

Examples of social relations include alumni relations, colleague relations, peer relations, business relations, geographic position relations and military colleagues. Hong et al. (2005) find that the American people's participation in the market is affected by social interactions. The more people interact with their neighbors, the higher the degree of socialization, and therefore, the more participation in the stock markets. Kuhnen (2009) examines the open fund managers (or directors) and consulting firms between 1993 and 2002 and finds that the employment relationship between the two is based on past interaction experience. Their business relations can help improve information efficiency. However, due to the inefficient favoritism restriction in corporate governance, investors do not benefit from such social ties. Hwang et al. (2009) follow Fortune 100 companies between 1996 and 2005 and find that among the 87% of traditional independent directors, only 62% are real independent directors and the average annual remuneration dropped by US$1.2 million after considering social relation networks. Fracassi et al. (2012) use S&P 1500 panel company data to examine the external social relations of directors and CEO. Their results show that dominant CEOs will appoint directors whom they have strong social ties. When the corporate governance mechanisms are absent, external social ties of CEO and directors will reduce company value. In particular, when the ties are strong, they are likely to engage in value-decreasing acquisitions. In other words, social networks will weaken the monitoring function of directors. In addition, Fracassi (2014) finds that when making company decisions, CEOs are likely to be affected by their peer CEOs. That is, the more strong the ties between companies, the more alike the capital investment. Therefore, in this study, we adopt two brother companies, OBI Pharma and TaiMed Biologics, as the case study to examine the appropriate investment strategies when investors are facing with crony capitalism. The chairman of OBI Pharma and the chair of Academia Sinica have alumni relations at MIT. Engelberg (2013) uses the US data between 2000 and 2007 and finds that when the CEO of listed companies have alumni relations with other CEOs, their compensations are positively related; adding one alumni relation will increase compensation by US$ 17,000. Early studies, including Shiller (1979) and LeRoy and Porter (1981), have found overreactions in speculative asset pricing. This phenomenon is inconsistent with the efficient market hypothesis. Investors often make investment strategies based on noise trading and positive

feedback trading. DeBondt and Thaler (1985, 1987) use NYSE listed company data from 1926 and 1982 and find that overreactions exist in the market. The return of "losing group" (which consists of 35 worst performing stocks in past three years) is 8% higher in yearly average than that of "winning group" (which consists of 35 best performing stocks in the past three years) and is 25% higher in three-year returns. Fama and French (1988) also find that three to five year stock market returns are negatively autocorrelated. The result suggests that price overreaction will recover in the long-run. Poterba and Summers (1988) also use variance ratio test to examine the US market between 1871 and 1986 and 17 other countries between 1957 and 1985. The evidence also shows that stock market returns are positive correlated in the short term and negative autocorrelated in the long term.

Moreover, De Long et al. (1990) argue that noise trading will cause overreactions. When the asset price is too high or too low, an inverse correction is likely. Therefore, autocorrelation is observed in the long-run returns. Cutler, Poterba and Summers (1991) find that negative autocorrelations exist in three to five year stock market returns. The evidence suggests that price under-reacts initially and corrects gradually. Daniel, Hirsheifer and Subrahmanyam (1998) develop a model for describing investor behavior (referred to as DHS model). The DHS model divides investors into two groups, informed and uninformed investors. Uninformed investors disobey judgment bias. The stock prices are set by informed investors who suffer from over-confidence and over self-preference. Due to over-confidence, investors exaggerate the precision of price related private information. On the other hand, over self-preference causes continuous short-term and long-term conversions in stock returns. Barberis, Shleifer and Vishney (1998) argue that as investors do not realize that the real returns of risky assets follow random walk, they may overreact or under-react.

Thaler (1992) develops a method for measuring short-term price reversion of losers and risk volatility. If the stock price rises or falls by 10%, the objective risk is unlikely to have such a large volatility. Thus, in a very short period of time, we can observe the phenomenon of mean reversion. The phenomenon is likely to be caused by reasons other than size or objective risk. In addition, Bremer and Sweeney (1988) test the short-term price changes of Fortune 500 companies between July 1962 and December 1986 and find similar daily return patterns reported by Brown and Van Harlow (1988) on long-term winners and losers.

Event studies can be used to test how corporate environmental changes affect finance and examine the changes in stock prices before and after the event. Daily and Johnson (1997) use LISREL analysis and find out the authority of CEOs is related to corporate performance. Mazur (1999) adopts 2500 survey data of Burson-Marsteller and finds that the image of CEOs will affect the evaluation of stock analysts on companies. This will then affect investors' viewpoint on companies. During the 1997 stock market depression, stock prices of companies with top 10 best image CEOs recover four times faster than other companies. 77% of respondents are willing to invest in companies with better CEO images. Rozeff and Zaman (1998) also find that the trading behavior of corporate insiders is not random. When the stock returns are low, insiders purchase more stocks and vice versa. Bergman and Roychowhury (2008) find that managers will strategically adjust earnings disclosure policy based on investors' sentiment. When investors' sentiment is low, they will increase the prediction for future earnings growth. In addition, Shleifer (1986) finds that since September 1976, while the basic values of newly added S&P 500 composite companies do not vary, their stock prices increase by about 3% when they are added to the index. The abnormal returns usually last for at least one month. In this study, the OBI Pharma initially (2015.8.31) planned to reveal the results of blind experiment on March 2016. On 12 November 2015, the company announced to forward the date to February 2016; on that day, the stock price was $439.5. On the next day (13 November 2015), the company was included in the MSCI index. One month later (18 December 2015), the stock price of OBI Pharma reached its highest of $755 (i.e., an increase of 72%).

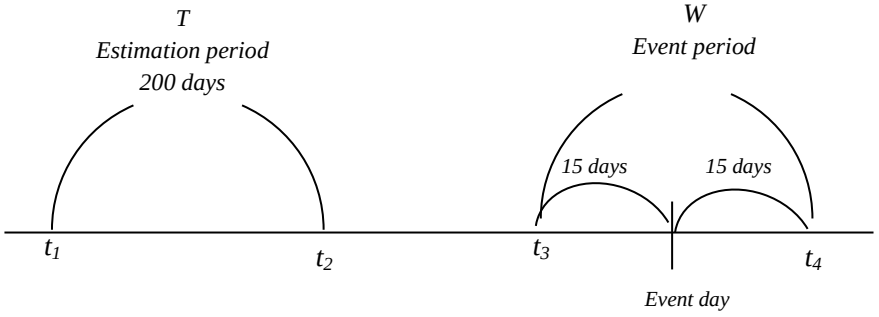
Thaler (1992) argues that fundamental changes will cause changes in market value. For instance, when company X acquires company Y, the market increases by 10%. To test if this is an unbiased estimate, we can examine the price five years later. However, prices often have large variations, and there is no one correct method for testing this hypothesis. The relations in this study are even more complex[5], including teacher-student relations (i.e., Samuel Yin was the student of Jin-Pyng Wang at a naughty students training class at junior high school), alumni relations (i.e., Chi-Huey Wong and Michael Chang both studied at MIT), political relations (i.e., Jin-Pyng Wang and Ing-Wen Tsai served different political parties but they both supported the enactment of the new biotech Act), business relations (i.e., Ing-Wen Tsai, the chairman of Yu Chang Biotech, transferred her shares to Samuel Yin), father-daughter relations (i.e., Chi-Huey Wong and Yu-Siou Wong), public servant relations (i.e., Shih-Jen Li and Chi-Huey Wong had monitoring relations), tax matters (i.e., Chi-Huey Wong's gift tax), stockholding matters (i.e., Chi-Huey Wong did not declare changes in stockholdings). In short, the case company in this study has the following issues: conflict of interest avoidance issue, tax matters, omission of disclosing stockholdings, and prior short-selling.These relations cannot be modeled using economic or financial models. Therefore, this study develops a new testing method by using a quantitative model and optimized program trading. Specifically, the event study method and a two-stage test are adopted to seek for a stable investment strategy. This study aims to find an investment strategy that improves investors' investment efficiency using

the mean reversion feature in stock prices. That is, if the diversion in stock price and index exists as shown by technical analyses and investors are able to improve their trading profits based on positive feedback trading model, then there is evidence that stock prices are featured by mean reversion.

3. Methods

3.1 Event Study Model and Estimation Methods

Based on Fama, Fisher, Jensen and Roll (1969), this study adopts the event study method to test the effect on stock prices when OBI Pharma announced a failure in blind experiment. Using the data obtained from Taiwan Economic Journal (TEJ), GARCH model is applied to test abnormal returns. The event study model is defined below:



t：time T：Estimation period W：Event period

Estimated return based on the market model is as follows:

$$R_t = \alpha + \beta R_{mt} + \varepsilon_t$$

where R_t is stock return at time t; R_{mt} is market return on day t.

$$\hat{\varepsilon}_t \left| \Omega_{t-1} \sim N(0, h_t) \right.$$

Expected value of the error term, ε_t, is zero.

$$h_t = d_0 + d_1 \varepsilon_{t-1}^2 + d_2 h_{t-1}$$

Average abnormal return (AR) during the event period is:

$$AR_{it} = 1/N(\sum_{i=1}^{N}(R_{it} - \hat{R}_{mt}))$$

Where $R_t = \ln P_t - \ln P_{t-1}$; *i* is individual company; P is the stock price.

Average cumulative abnormal return (CAR) is calculated as follows：

$$CAR = 1/N(\sum_{t=t_3}^{t_4} AR_{it})$$

Due to the trading restriction after the announcement, the event period is 30 days, including 15 days before the announcement of blind experiment failure on 21 February 2016, which is the event date, (i.e., the estimation window) and 15 days after the event date (i.e., the event window). That is, a total of 61 days for testing if AR and CAR are significantly different from zero. Also, TAIEX is used as the benchmark for the 200-day estimation period.

3.2 Vector Autoregression (VAR) and Granger Causality Model and Estimation Methods

The theoretical models and estimation methods in this study follows Lan et al.'s (2014) method and uses vector autoregression model as proposed by Sims (1980). By including lagged estimates of the variables in the model, we are able to predict a relevant time series system and the dynamic impact of random noises on this system. This study uses OBI Pharma (stock ID 4174) as the base variable and TaiMed Biologics (stock ID 4147) as its brother company. There exists a causal relationship within variables. Hence, in the following sections, OBI Pharma is the base variable. The two variables in the model are A4174 (OBI Pharma) and A7447 (price difference between OBI Pharma and TaiMed Biologics). The variables y_{1t}, y_{2t} at time t are composed of variables in the prior time k and error term. Taking VAR(1) (i.e., k = 1) as an example:

$$A4174_t = \alpha_1 + a_{11}A4174_{t-1} + a_{12}A7447_{t-1} + \varepsilon_{1t}$$
$$A7447_t = \alpha_2 + a_{21}A4174_{t-1} + a_{22}A7447_{t-1} + \varepsilon_{2t}$$

where $E(\varepsilon_t) = 0, \forall t, E(\varepsilon_t \varepsilon_s') = \begin{cases} \Omega, s = t \\ 0, s \neq t \end{cases}, \Omega = E(\varepsilon_t \varepsilon_t')$, the error term ε_t is white noise; α is the constant, a is the coefficient and Ω is the positive definite variable and covariance matrix.

The error term ε_t can be same period correlated but cannot be correlated with its lagged estimates or variables on the right-hand side of the function. From here, we can test the causality relationship. Moreover, as the economic theory has no definite conclusion on the relationship between stock price and price difference, the causality analysis developed by Granger (1969, 1988) can used to examine the relation between two. That is, by examining whether a causal relationship exists between current period price differences (A7447) and A4174 (past stock price of OBI Pharma), we can determine the degree to which the past value of A4174 can be used to predict the value of A7447. If adding the lagged value of A4174 can increase the explainability or the correlation coefficient of A4174 and A7447 is statistically significant, the result suggests that A7447 is the Granger cause of A4174.

3.3 Experimental Design and Estimation Methods

The experiment used in this study includes two models. Model 1 includes only one set of data (data1). Model 2 is based on program trading design concept of Williams (1999). In order to enhance the trading performance, one more set of data (apart from data1) is included in the model. We use the price difference of corresponding company as the filter. Therefore, the following trading strategies are adopted. We use the base company (data1, OBI Pharma) and the price difference of data2 (OBI Pharma) and data3 (TaiMed Biologics) as the benchmark. The diversion trading[6] based on technical analysis in program trading is designed as follows:

1. The benchmark uses RSI as oscillators. Data1 is the stock price of the base company, OBI Pharma.
2. The price difference of two companies is calculated and used as the benchmark. Specifically, the stock price of data2 (OBI Pharma) is deducted from the stock price of data3 (TaiMed Biologics) and times 100.
3. If within nine K bars, the RSI is above 70 (or below 30) for at least twice, this can be included. In addition, if the closing price is at its new high (or low) within nine K bars while RSI does not reach its new high (or low) at the same time, we note down the value of K bar at that point. In the future, if the stock price touches this low (or high) point of the K bar, the strategy is to sell (or buy).

Moreover, in this study MultiCharts program trading is used to do back-testing of the first stage (2015.11.23~2016.02.21) and to compare the trading performance at optimal conditions. The optimal coefficient is obtained when we have up to nine K bars and RSI that is above 70 (or below 30). It is then used in the second stage (2015.11.23~2016.06.07) to estimate the Taiwan stock market. By doing so, we can determine if trading performance can be enhanced by using the price difference between two companies.

4. Data

This study examines whether including the price difference of OBI Pharma and TaiMed Biologics can improve the stock market trading performance. The daily price data used in this study includes the stock price (30m) of OBI Pharma and TaiMed Biologics obtained from XQ database. To ensure the benchmarks are comparable, the stock prices of TaiMed Biologics are obtained from the time it listed on the OTC market. For the experimental design, the data period for the first stage covers from 2015.11.23 to 2016.02.21 (i.e., 522 sample points) and the second stage covers from 2015.11.23 to 2016.06.07 (i.e., 1197 sample points). The experimental method is to use the optimized simulated parameters obtained from the first stage in the second stage. All data mentioned above are calculated at level except for those original data that is I(1). These need to be differentiated and symbolized by D. Also, a transaction cost of 1% of the price of OBI Pharma (i.e., $5) is assumed for all models.

5. Results

5.1 Abnormal Returns around the Announcement of Blind Experiment Failure

5.1.1 OBI Pharma's Abnormal Returns

Figure 1 shows the AR/CAR line chart of GARCH model. Twenty days before the announcement of blind experiment failure by OBI Pharma on 21 February 2016, the average abnormal return is -4.6235%. This is possibly related to the advanced reaction of experimental failure. Twenty days after the announcement, the average cumulated abnormal return reaches -68.9988%. The average abnormal return is significantly negative at -10.90775% on the announcement day. The

stock price of OBI Pharma falls continuously for four days from $681 to $447.5, showing a drop of 34%. In comparison, another company, Medigen Biotechnology (stock ID 3176), announced a failure in blind experiment in 2014, its stock prices fell for 19 days continuously. The price of OBI Pharma does not fall as sharply as Medigen Biotechnology. This is possibly due to the positive speech by the former chair of Academia Sinica, Chi-Huey Wong, who suggests that the resulting data from the experiment is nice and it is an excitement from the vaccine point of view. As a result, the stock prices climb up slowly to the current price of $477 on 13 June 2016.

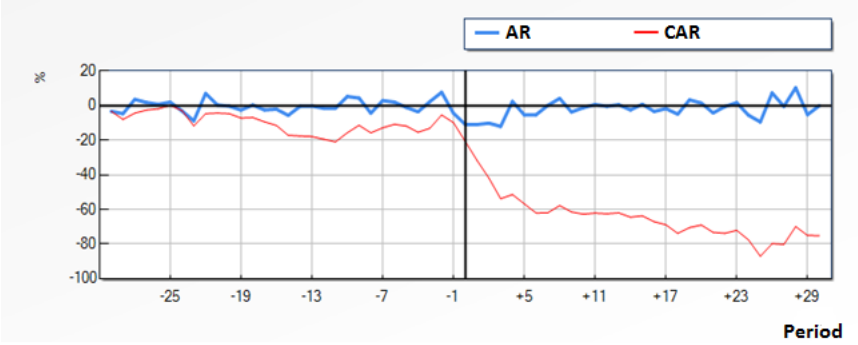


Figure 1. AR and CAR of OBI Pharma around blind experiment failure announcement

5.1.2 TaiMed Biologics' Abnormal Returns

Figure 2 shows the AR/CAR line chart of GARCH model for TaiMed Biologics. Twenty days before the announcement of blind experiment failure by OBI Pharma on 21 February 2016, the average abnormal return is -2.0313%. Again, it is possibly due to the advanced reaction of experimental failure. The average abnormal return on the announcement day is significantly negative at -11.2103%. On the next day, the average abnormal return rises to 3.0353%.

Twenty days after the announcement, the average cumulated abnormal return is -58.8066%. The stock prices of TaiMed Biologics fall from $238 on 18 February 2016 to $183 on 23 February 2016; that is, a decrease of 23%. It is obvious that the price over-react to the experimental failure announcement. Not until three months later, the stock prices climb back to $224.

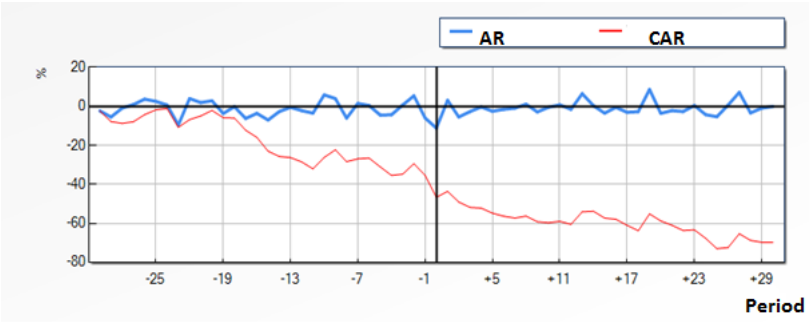


Figure 2. AR and CAR of TaiMed Biologics around blind experiment failure announcement

5.2 Unit Root Test of Sample Data

To ensure the validity of empirical results, when testing the causality relationships, we need to ensure their cointegration relationship and the ranks of two variables' time series are the same. That is, when there is I(D), a cointegration relationship is possible. Accordingly, the following uses ADF unit root test to examine the stationary feature of OBI Pharma's price, TaiMed Biologics' price and their price difference. The test results are shown in Table 1.

Table 1. Unit root test of price difference between stock price of OBI Pharma and TaiMed Biologics

Variables / Model	Constant (C)	Trend (T) and Constant (C)	No time trend (T) and constant (C)
A4174	-1.1158(0)	-1.9915(0)	-0.4009(0)
D(A4174)	-34.4905(0)***	-34.4775(0)***	-34.5036(0) ***
7447	-1.1761(0)	-1.6696(0)***	-0.8812(0)
D(A7447)	-36.2009(0)***	-36.1874(0)***	-36.2046(0)***
A4147	-3.0050(0)**	-3.7362(0)**	-0.4073(0)
D(A4147)	-34.7563(0)***	-34.7832(0)***	-34.7548(0)***

Note: According to Mackinnon (1991), *, **, and *** represent significance at 10%, 5% and 1% level, respectively. C,

T, and L are the constant, time trend and lagged period. A4174 and A7447 are the stock price of OBI Pharma and the price difference of OBI Pharma and TaiMed Biologics. D denotes differentiated data.

At the original level, the variables include the stock price of OBI Pharma, price of TaiMed Biologics and their price differences. According to the test of lagged period with minimum SIC, most results cannot reject the null hypothesis (as shown in Table 1). That is, most variables are not stationary. This is probably because of the fat-tail characteristic of financial data and the autocorrelation in time series data. Hence, after taking the first difference, the series are stationary and satisfy the condition of cointegration. That is, we have obtained an I(1) stationary series which can then be proceeded with Granger causality test.

5.3 Determination of Lagged Period

First, we need to determine the lagged period of VAR model. The lagged period need be large enough to reflect its dynamics. However, this can reduce the degree of freedom. The most commonly used test include AIC, SC, and HQ, which looks for lower values. Based on the results presented in Table 2, the best lagged period is 2.

Table 2. Lagged period test of OBI Pharma

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-12372.27	NA	3626882.	20.77964	20.78817	20.78285
1	-6807.542	11101.43	319.2458	11.44172	11.46732*	11.45136
2	-6798.919	17.17354	316.7771*	11.43395*	11.47663	11.45003*
3	-6797.612	2.597137	318.2133	11.43848	11.49822	11.46099
4	-6795.345	4.500528	319.1406	11.44139	11.51820	11.47033

Note: The sample includes OBI Pharma, and the price difference of OBI Pharma and TaiMed Biologics. The sample period is 2015.11.23~2016.6.7. Based on the minimum AIC, this study uses two lagged periods.

5.4 Estimation Results of VAR Model

This section analyzes the causality relationship between OBI Pharma and the price difference between OBI Pharma and TaiMed Biologics based on VAR model. The results in Table 3 show that the stock price of OBI Pharma and the price difference lead each other by two periods.

Table 3. Estimation results of VAR model on OBI Pharma and the price difference

	A4174	A7447
A4174(-1)	1.206313	0.238115
	(0.08134)	(0.06661)
	[14.8306]	[3.57468]
A4174(-2)	-0.211092	-0.226314
	(0.08071)	(0.06609)
	[-2.61559]	[-3.42422]
A7447(-1)	-0.266174	0.682311
	(0.09898)	(0.08106)
	[-2.68914]	[8.41749]
A7447(-2)	0.269360	0.301582
	(0.09816)	(0.08039)
	[2.74402]	[3.75156]
C	1.489531	-1.475929
	(2.12594)	(1.74100)
	[0.70065]	[-0.84775]

5.5 Granger Causality Test of OBI Pharma's Price and the Price Difference

This section analyzes Granger causality relationship between the stock price of OBI Pharma and the price difference of OBI Pharma and TaiMed Biologics. The results show that when lagging two periods, the two variables are Granger cause of each other. That is, there is a two-way relationship. In the next section, these two variables will be included in the program trading model to conduct back-testing and we will examine their effects on trading performance.

Table 4. Granger causality relationship between OBI Pharma's stock price and price difference

Dependent variable: A4174			
Excluded	Chi-sq	df	Prob.
A7447	7.569756	2	0.0227
All	7.569756	2	0.0227
Dependent variable: A7447			
Excluded	Chi-sq	df	Prob.
A4174	13.41376	2	0.0012
All	13.41376	2	0.0012

5.6 Evaluation on the Inclusion of OBI Pharma's Price and the Price Difference on Trading Performance

In this section, we first examine Model 1 which assumes that investors have OBI Pharma's stock market price and investors trade only based on RSI's price volume diversion technical analysis. The second stage simulation is based on data for the period 2015.11.23~2016.2.21~2016.6.7. Based on the optimal simulated parameter from the first stage (2015.11.23~2015.2.21), we apply it to the second stage (2007.1.1~2016.6.7). The profit in the first stage is $161 while in the second stage, the profit drops to $13. The results suggest that investors cannot make profit based on past information and that efficient market exists (as shown in Table 5).

Table 5. Total trading analysis of Model 1 at the first and second stage

Unit: $

	Period	2015.11.23~2015.2.21~2016.6.7	
	Stage	First stage	Second stage
OBI Pharma	Winning probability (Trading No. / Failing No.)	100%(3/3)	66%(6/4)
	Net profit	161	13

Note: First stage covers 2015.11.23~2015.2.21. Second stage covers 2015.11.23~2016.6.7.

The results from Model 2 which includes the price difference between the two companies show that the profits of base company (OBI Pharma) and its corresponding company (TaiMed Biologics) significantly increase in the second stage (2015.11.23~2016.2.21~2016.6.7). Specifically, the profits increase from $147 to $520, showing an increase of 253%. Similarly, when using OBI Pharma as the base company and the corresponding company , Pharmally International Holding Company, the trading profits increase from $200 in the first stage to $562 in the second stage; that is, an increase of 181%. When OBI Pharma is paired with Grape King Bio, the trading profits increase from $215 in the first stage to $428 in the second stage (i.e., an increase of 99%). The pair of OBI Pharma and Chlitina shows a trading profit of $143 in the first stage and $173.5 in the second stage (i.e., a 21%). When OBI Pharma is paired with TTY Biopharm, the trading profit in the first stage is $137 and $142 in the second stage (i.e., a 3% increase). When OBI Pharma is paired with Ginko, the trading profit in the first stage is $129 and $487 in the second stage (i.e., a 277% increase). When OBI Pharma is paired with St.Shine, the trading profit in the first stage is $175 and $431 in the second stage (i.e., a 146% increase). The increase in trading profits differs in different pairing companies. This is likely to be due to different company properties in the corresponding company.

In contrast, when the base company, OBI Pharma, is paired with ScinoPharm Taiwan, the trading profit in the first stage is $85, and $74 in the second stage, showing a decrease of 12%. When OBI Pharma is paired with PharmaEngine, the profit is $126 in the first stage and -$146 in the second stage. Therefore, including the price difference information and using the mean reversion characteristic, this trading strategy can lead to trading profits and the pair of OBI Pharma and

TaiMed Biologics gives best trading profits and highest winning probability as shown in Table 6.

Table 6. Total trading analysis of Model 2 at the first and second stage

Unit: $

Base company	Corresponding company (Company property)	Period / Stage	2015.11.23~2015.2.21~2016.6.7 First stage	Second stage
OBI Pharma (New drug)	TaiMed Biologics (New drug)	Winning probability (Trading No./Failing No.)	100%(2/0)	66%(6/2)
		Net profit	147	520
	ScinoPharm Taiwan (Pharmaceutical Ingredients)	Winning probability (Trading No./Failing No.)	50%(4/2)	45%(11/6)
		Net profit	85	74
	Ginko (Medical equipment)	Winning probability (Trading No./Failing No.)	44%(9/5)	47%(19/10)
		Net profit	129	487
	St.Shine Optical (Medical equipment)	Winning probability (Trading No./Failing No.)	75%(4/1)	50%(10/5)
		Net profit	175	431
	Pharmally International Holding Company (Generics)	Winning probability (Trading No./Failing No.)	50%(4/2)	50%(10/5)
		Net profit	200	562
	Grape King Bio (Healthy diet)	Winning probability (Trading No./Failing No.)	71%(7/2)	52%(17/9)
		Net profit	215	428
	Chlitina (Aesthetic medicine)	Winning probability (Trading No./Failing No.)	50%(4/2)	21%(14/11)
		Net profit	143	173.5
	PharmaEngine (New drug)	Winning probability (Trading No./Failing No.)	100%(2/0)	50%(6/3)
		Net profit	126	-146
	TTY Biopharm (Generics)	Winning probability (Trading No./Failing No.)	80%(5/1)	33%(21/14)
		Net profit	137	142

6. Conclusion

According to Nature Biotechnology's research report in 2014, the success of new drugs to finally being able to be sold in the market is only 10%. The success of cancer related medications is even lower with only 6% chance. The new drug of OBI Pharma has been supported by industrial, governmental and academic experts. Because of the weaknesses of investor behavior as pointed out by the behavioral finance theory (i.e., availability bias and representative bias), investors blindly believe in the support by Princo Corp.[7] and government policy support[8]. In addition, investors are over-confident and have "qusi-magical thinking". They believe that the price of OBI Pharma is likely to rise to at least a thousand dollar. However, in actual fact, investors are facing extreme risks.

In recent times, the problem of information asymmetry is becoming more severe. Homo sociologicus has become a new thinking in current finance field. Crony capitalism becomes prevalent in emerging countries, causing an inequality in wealth. Therefore, this study uses two OTC market companies (OBI Pharma and TaiMed Biologics) as the case study companies. Using the mean reversion theory suggested by behavioral finance and program trading simulations, the results show that during 2015.11.23~2016.06.07, the biotechnological industry in Taiwan is not market efficient. The technical analysis shows that investors can make profits in the financial market using the price difference data which have mean reversion property. Due to the space and time limit, future research could use other bio-tech cases in Taiwan to conduct optimal back-testing and run the simulation.

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Notes

Note 1. Chi-Huey Wong and Michael Chang were classmates at MIT and the former was elected as a member of US National Academy of Sciences in 2006. He became the chair of NAS in 2006, and won the Wolf Prize in 2014.

Note 2. The 2014 annual report of Cubist (which was merged by Merck & Co.) revealed that Optimer is suspected of violating FCPA. Interestingly, while the company was still under investigation by the US Justice Department and SEC, the company was able to be listed in Taiwan. (Wealth Magazine 2016/3/10, 2016/4/1, 2016/4/21 www.wealth.com.tw; CommonWealth 2012/3/30). On 4 September 2012, the IPO price at emerging stock market was $45. Chi-Huey Wong did not hold any stocks. However, his daughter, Yu-Siou Wong, got 3,000,000 shares from Ruentex Financial Group at a price of $31, lower than the IPO price of $45.

Note 3. After retiring from the public servant, Ing-Wen Tsai served as the chairman on the board of directors of Yu Chang Biotech in August 2007. In May 2008, the holdings of Yu Chang Biotech were transferred to Samuel Yin, the chairman of Ruentex Financial Group. In April 2009, the company was renamed as TaiMed Biologics. In May 2016, Ing-Wen Tsai was elected as the President of Taiwan and her shareholdings are now under trust.

Note 4. The Act allows government researchers to hold the shares of biotech and new pharmaceutical companies, and to be funders, directors or R&D consultants. They are not regulated by Civil Servant Work Act. The Act also allows these types of companies to carry IPO to obtain funds even when they have no operating income.

Note 5. As this study focuses on the price differences between the two companies, please refer to Wealth Magazine (2016/3/24, 2013/3/14,) for a discussion on their interlocking relationship in prices.

Note 6. When the stock price reaches a new high (or low), the indicator does not.

Note 7. Samuel Yin is ranked the 7th richest person in Taiwan and 452 in the world by Forbes 2015.

Note 8. Biotechnological industry was the focus of government development plan. When Ing-Wen Tsai was elected as the Taiwan President, she and the biotechnological policy team leader, Chi-Huey Wong, visited the Nan-Kang Biotech Park on 24 February 2016 and President Tsai said to continue with biotechnological industry development.

Note 9. According to latest stockholder report on 27 June 2016, Shih-Jen Li is no longer in the director list. Ruentex Financial Group holds 37.73% of shares. Michael Chang became the representative director of Ruentex Financial Group on the board of OBI Pharma. Fu Tai Investment became the 7th largest stockholder and held 1.66% of shares.

Appendix

Appendix. Social and political ties in OBI Pharma and TaiMed Biologics

Company	OBI Pharma (Breast cancer new drugs)	TaiMed Biologics (AIDS new drugs)
Open market	IPO at $335 in the OTC market (2015.3)	IPO at $115 in the OTC market (2015.11.23). Company name changed from Yu Chang Biotech to TaiMed Biologics
Stock price range	$250~$755	$146~$303
Management team	Michael Chang (Chair of the board of directors)	Nien-Yuan Chang (Director and CEO, brother of Michael Chang)
Main stockholder	Samuel Yin (Ruentex Financial Group) holds 33.21% of shares.	Samuel Yin (Ruentex Financial Group) holds 16.34% of share. Development fund of Executive Yuan holds 32.24% of shares.
Political ties	1. The daughter of Chi-Huey Wong holds 3,000,000 shares (which was transferred from Ruentex Financial Group at $31). 2. The fifth largest stockholder is Fu Tai Investment which is related to Ing-Wen Tsai's family and holds 3,249,000 shares. 3. OBI Pharma co-operated with Academia Sinica and Chi-Huey Wong since 2007. In 2014, they signed a technical skill transfer of carbohydrates in 2014. 4. The third largest stockholder is Shih-Jen Li[9] (of British Virgin Islands). He is a research managing member of Academia Sinica and is related to the brother of current Minister of Economic Affairs and sister of Michael Chang.	1. Ing-Wen Tsai was the chairman of Yu Chang Biotech, whose stockholdings was transferred to Ruentex Financial Group. 2. The chairman, Chih-Chuan Chen, is the director of OBI Pharma.

Data source: Wealth Magazine (2016.4.21), TEJ and this study.