THE RELATIONSHIP BETWEEN THE BIO-ENERGY CONCEPT STOCKS IN TAIWAN AND THE INTERNATIONAL STOCK MARKETS

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Abstract

This research explores the relationship among the bio-energy company stock index in Taiwan, TAIEX, DJI, Nikkei 225 and SSE composite index for a period from January 1, 2005 to March 11, 2008. Test results indicate two things are noteworthy: 1. Granger causality tests show that the interaction between the bio-energy company stock index in Taiwan and TAIEX is one-way only; however, that between the bio-energy company stock index in Taiwan and DJI is two-way. 2. According to the results of variance decompositions, though TAIEX has the highest explanation power; nevertheless, the explanation strength tends to decrease. On the contrary, DJI and Nikkei 225 manifest constantly increasing strength in explanation. Accordingly, the influence of DJI upon the bio-energy company stock index in Taiwan keeps rising and can't be ignored.

Keywords: bio-energy concept stocks, international stock markets

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1. Introduction

Alternative energies are quite diversified, including solar power, water, wind and bio-energy companies. Development varies with each country due to geographical differences. For example, water power is emphasized in Iceland and Norway, wind is stressed in Holland and Taiwan, and bio-energy is primary in Brazil. As far as the energy required for transportation, bio-energy is the best choice everywhere at present.

The Brazilian government announced they had bio-energy they produced themselves without depending on the oil imported in 2006. 27 countries of European Union (EU) signed a co-energy program in 2007, in which the bio-energy consumption is required to account for 10% of vehicle energy by 2020. In 2007, President Bush of the United States signed the Energy Independence and Security Act that bio-energy had to be added into petroleum at a certain proportion. The government in Taiwan planned to achieve the goal of creating an output value of 1,590 thousand billion of bio-energy in two years, which is 2010.

Thanks to familiarity with companies, emphasis on developing and training agricultural professionals and accumulation of considerable strength, the technologies related to agricultural development and application in Taiwan are highly developed. Research and production of bio-energy has rooted here in Taiwan. Currently, there are five listed and over-the-counter companies that are active in mass producing bio-energy.

This research is centered on the bio-energy company stock index in Taiwan for an in-depth exploration of the joint movements among the bio-energy company stock index in Taiwan, DJI, Nikkei 225, SSE composite index and TAIEX. The literature on energy researches is plenty; however, most of the studies focus on petroleum. Researches on alternative energies are scarce, let alone studies related to bio-energy. Therefore, this study is a trailblazer in examining the relationship between bio-energy company stock index and the international stock markets.

In previous literature, discussions based on global or district scope are like: Nandha and Faff (2008) analyzed 35 DataStream global industry indices for the period from April 1983 to September 2005 to examine whether and to what extent the adverse effect of oil price shocks impacts stock market returns. The results: 1. Oil price rises have a negative impact on equity returns for all sectors except mining, oil and gas industries. 2. Little evidence of and asymmetry is detected in the oil price sensitivities. 3. The recommending is that the international portfolio investors consider hedging oil price risk. Jim'enez-Rodr'iguez and S'anchez (2005) used multivariate VAR to study the effects of oil price shocks on the real economic activity of the main industrialized countries. The results: 1. Oil price increases are found to have an impact on GDP growth of a larger magnitude than that of oil price declines. 2. Among oil importing countries, oil price increases are found to have a negative impact on economic activity in all cases but Japan. 3. The effect of oil shocks on GDP growth differs between the two oil exporting countries in the sample, with the UK being negatively affected by an oil price increase and Norway benefiting from it.

Discussions based on the scope of single countries are like: Boyer and Filion (2008) found that the return of Canadian energy stock in positively associated with the Canadian stock market return, with appreciations of crude oil and natural gas prices, with growth in internal cash flows and proven reserves, and negatively with interest rates. Chen, Finney and Lai (2005) used Threshold cointegration and error – correction model to provide evidence for asymmetric adjustment in U.S retail gasoline price from January 1991 to March 2003. The results are the asymmetric transmission is found to occur not just through the spot markets of crude oil and refinery gasoline but also through their future markets, and asymmetry in price transmission primarily occurs downstream, not upstream of the transmission process. Goto (2005) examined whether the temporary protection policy for the Japanese oil industry provided by the Provisional Law on Importation of Specific Petroleum Products (Tokusekiho) between 1986 and 1996 was a credible policy. The effectiveness of the law is by measuring changes in the cost structure of four oil firms in the oil industry before, during and after the period of protection, and is found that the cost function of each firm shifted upwards during the period of protection, suggesting that the incentives did not work effectively. Liang (2004) studied the effect of Taiwan entering the WTO, according to the data of Chinese Petroleum Corporation in 1997. The refining cost of fuel oil and jet fuel oil was lower than that of corresponding imports, but gasoline, LPG and diesel was higher than that of corresponding imports.

As far as literature related to joint movements among the global stock markets is concerned, most of them center on the relationships between stock markets. Lee (2006) adopted the structural-form GJR model to examine the interactions among the stock markets in America, Japan and Hong Kong. The results indicated the stock returns in Hong Kong affected the stock market in Japan. Chen, Firth and Rui (2002) explored the integrated relations of stock markets in six Latin American countries. The empirical results showed significant correlations existed among them. Dekker, Sen and Young (2001) investigated joint movements of the stock markets in Pacific Asia area. The results revealed markets that were more open to foreign capital were more influenced by the stock market in the U.S.

A majority of the previous researches focus on the correlations between stock markets. As bio-energy is a sunrise industry, it is critically important either for the management of bio-energy companies or the investors such as stockholders and creditors to be aware of the relationship between their stock prices and the global stock markets. As a result, the relationship between the bio-energy company stock index and the international stock markets is discussed in this study.

2. Data

The data for the samples of this research were based on the daily closing prices for the period from January 1, 2005 to March 11, 2008.

The bio-energy company stock index in Taiwan refers to companies that are engaged in R&D and manufacturing bio-energy registered in the securities market in Taiwan for transactions. There are five of them currently, including Ve Wong (1203), AGV (1217), Tai Roun (1220), LCY (1704) and NPC (9937). The weighted average stock index of the research is calculated by equation (1). The daily closing prices of Ve Wong, AGV, Tai Roun, LCY and NPC stocks are obtained from the database of Taiwan Economic Journal (TEJ).

The bio-energy company stock index

$$= \left(\sum_{i=1}^{n} P_{it} \times Q_{it}\right) / \left(\sum_{i=1}^{n} Q_{it}\right) \qquad (1)$$

P_{it} : daily closing price of stock i at time t

Q_{it} : number of shares of stock i at time t

TAIEX, DJI, Nikkei 225 and SSE composite index are obtained from the database of Taiwan Economic Journal (TEJ).

3. Methodology

Long-run Equilibrium Relationship: Unit Root Test and Johansen Cointegration Test

There are three different unit root tests taken in this paper, namely ADF (Augmented Dickey -Fuller), PP (Phillips - Perron) and KPSS (Kwiatkowski – Phillips – Schmidt - Shin). Most of the studies in the literature use ADF and PP, but ADF and PP tests are criticized due to their low power properties (Sims, 1988). In order to have robust results, three different unit root tests are adopted.

ADF tests have a null hypothesis stating that the series in question has a unit root against the alternative that it does not. The null hypothesis of KPSS, on the other hand, states that the variable is stationary. In the literature, KPSS is sometimes used to verify the results of commonly used ADF and PP tests although it also suffers from the same low power problems (Soytsa and Sari, 2007).

There are many possible tests for cointegration, and the most commonly used test is the multivariate test based on the autoregressive representation discussed in Johansen (1991, 1992) , Johansen and Juselius (1990), namely Johansen cointegration tests. The Johansen cointegration tests provide two different likelihood ratio tests, the trace test and the maximum eigenvalue test to determine the number of cointegration vectors (Hammoudeh and Li, 2004). When the number of cointergration vectors is more, the long-run equilibrium relationship among variables is more stable.

Short-run Interactions: VEC model

The short-run relations among the variables are examined by the vector error correction (VEC) model in this paper. If the variables in concern are cointegrated, a VEC model is more appropriate than a VAR model as in a standard Granger Causality test (Granger 1988). The VEC model representation is as follows:

$$\Delta Y1_t = \nu_1 + \beta_{1,1}Y1_{1,t-1} + \beta_{1,2}Y1_{2,t-1} + --- + \beta_{1,i}Y1i_{,t-1} + \sum_{s=1}^{m}\lambda 1_{1,s}\Delta Y1_{t-s} + \sum_{s=1}^{m}\lambda 1_{2,s}\Delta T2_{t-s}$$
$$+ \sum_{s=1}^{m}\lambda 1_{3,s}\Delta D3_{t-s} + \sum_{s=1}^{m}\lambda 1_{4,s}\Delta N4_{t-s} + \sum_{s=1}^{m}\lambda 1_{5,s}\Delta C5_{t-s} + \varepsilon_{1,t} \quad (2)$$

$$\Delta T2_t = \nu_2 + \beta_{2,1}Y1_{1,t-1} + \beta_{2,2}Y1_{2,t-1} + --- + \beta_{2,i}Y1i_{,t-1} + \sum_{s=1}^{n}\lambda 2_{1,s}\Delta Y1_{t-s} + \sum_{s=1}^{n}\lambda 2_{2,s}\Delta T2_{t-s}$$
$$+ \sum_{s=1}^{n}\lambda 2_{3,s}\Delta D3_{t-s} + \sum_{s=1}^{n}\lambda 2_{4,s}\Delta N4_{t-s} + \sum_{s=1}^{n}\lambda 2_{5,s}\Delta C5_{t-s} + \varepsilon_{2,t} \quad (3)$$

$$\Delta D3_t = \nu_3 + \beta_{3,1}Y1_{1,t-1} + \beta_{3,2}Y1_{2,t-1} + --- + \beta_{3,i}Y1i_{,t-1} + \sum_{s=1}^{o}\lambda 3_{1,s}\Delta Y1_{t-s} + \sum_{s=1}^{o}\lambda 3_{2,s}\Delta T2_{t-s}$$
$$+ \sum_{s=1}^{o}\lambda 3_{3,s}\Delta D3_{t-s} + \sum_{s=1}^{o}\lambda 3_{4,s}\Delta N4_{t-s} + \sum_{s=1}^{o}\lambda 3_{5,s}\Delta C5_{t-s} + \varepsilon_{3,t} \quad (4)$$

$$\Delta N4_t = \nu_4 + \beta_{4,1}Y1_{1,t-1} + \beta_{4,2}Y1_{2,t-1} + --- + \beta_{4,i}Y1i_{,t-1} + \sum_{s=1}^{x}\lambda 4_{1,s}\Delta Y1_{t-s} + \sum_{s=1}^{x}\lambda 4_{2,s}\Delta T2_{t-s}$$
$$+ \sum_{s=1}^{x}\lambda 4_{3,s}\Delta D3_{t-s} + \sum_{s=1}^{x}\lambda 4_{4,s}\Delta N4_{t-s} + \sum_{s=1}^{x}\lambda 4_{5,s}\Delta C5_{t-s} + \varepsilon_{4,t} \quad (5)$$

$$\Delta C5_t = \nu_5 + \beta 5_{,1}Y1_{1,t-1} + \beta 5_{,2}Y1_{2,t-1} + --- + \beta 5_{,i}Y1i_{,t-1} + \sum_{s=1}^{z}\lambda 5_{1,s}\Delta Y1_{t-s} + \sum_{s=1}^{z}\lambda 5_{2,s}\Delta T2_{t-s}$$
$$+ \sum_{s=1}^{z}\lambda 5_{3,s}\Delta D3_{t-s} + \sum_{s=1}^{z}\lambda 5_{4,s}\Delta N4_{t-s} + \sum_{s=1}^{z}\lambda 5_{5,s}\Delta C5_{t-s} + \varepsilon 5_{,t} \quad (6)$$

In the formula above, Y1 represents the bio-energy company stock index, T2 stands for TAIEX, D3 means DJI, N4 stands for Nikkei 225, C5 means SSE composite index, and p, q, g, l, h, k and j stand for lag length.

4. The results

Daily Stock returns (first difference of daily closing price) are analyzed, except the Unit Root Test is conducted in compliance with the natural logarithm of daily closing price, including Johansen cointegration test, Granger causality test, impulse responses and variance decompositions. The period commenced on January 1, 2005 and ended on March 11, 2008.

Unit Root Test

The results of the unit root tests are reported in Table 1. From Table 1, we know all the series are non-stationary. That is, the results of ADF and PP tests are insignificant, which means the null hypothesis can't be rejected at 5% significant level. The results of KPSS test are significant and contrary to those of ADF and PP tests. However, all the series are stationary after first difference; i.e., the results of ADF and PP tests are significant, and that of KPSS test is not.

Table 1. Unit root tests results

Panel A: Level		bio-energy companies	TAIEX	DJI	Nikkei225	SSE composite index
Intercept	ADF	-0.937962 (0.7761)	-1.229314 (0.6634)	-1.288083 (0.6368)	-1.496637 (0.5350)	-0.294765 (0.9230)
	PP	-1.021105 (0.7473)	-1.061319 (0.7325)	-1.202897 (0.6750)	-1.465834 (0.5506)	-0.019758 (0.9555)
	KPSS	2.844138*	2.871529*	2.923874*	1.895896*	3.004109*
Intercept And Trend	ADF	-2.79164 (0.2008)	-2.776830 (0.2064)	-2.042888 (0.5762)	0.127702 (0.9975)	-2.060308 (0.5665)
	PP	-3.137959 (0.0983)	-2.736045 (0.2223)	-2.113217 (0.5370)	0.064799 (0.9969)	-1.954078 (0.6247)
	KPSS	0.207550*	0.219267*	0.272665*	0.584541*	0.572884*
Panel B. First difference		bio-energy companies	TAIEX	DJI	Nikkei225	SSE composite index
Intercept	ADF	-23.49404* (0.0000)	-10.14612* (0.0000)	-29.01185* (0.0000)	-29.13163* (0.0000)	-6.189496* (0.0000)
	PP	-23.82693* (0.0000)	-27.08870* (0.0000)	-29.35006* (0.00000	-29.18279* (0.0000)	-27.73723* (0.0000)
	KPSS	0.037734	0.053577	0.135795	0.600516*	0.355959
Intercept And Trend	ADF	-23.47936* (0.0000)	-10.13947* (0.0000)	-29.00071* (0.0000)	-29.31167* (0.0000)	-6.194380* (0.0000)
	PP	-23.81269* (0.0000)	-27.06925* (0.0000)	-29.37997* (0.0000)	-29.31365* (0.0000)	-27.73299* (0.0000)
	KPSS	0.030694	0.053264	0.121224	0.091258	0.275630

1. T-Statistic
2. ( ): MacKinnon (1996) one-sided p-values.
3. *: significant at 5% level

Cointegration Tests

The results of the cointegration tests are reported in Table 2. Both the maximum eigenvalue (Max-Eigen) and the trace statistics (Trace) are significant rejecting the null hypothesis. It means cointegration vectors exist. In other words, long-run equilibrium relationships exist between bio-energy company stock index and international stock markets.

Besides, at 5% significant level, both the maximum eigenvalue and the trace statistics have five cointegration vectors resulting in the series with common stochastic trends in the data and in the cointegration equation. That is, the long-run equilibrium relationship is stationary among bio-energy company stock index, TAIEX, DJI, Nikkei 225 and SSE composite index.

Table 2. Johansen cointegration tests results

H_0: No. of CE(s)	Eigen value	Trace	5% level	p-value
None *	0.292446	867.5028	69.81889	0.0001
At most 1 *	0.230717	619.8089	47.85613	0.0001
At most 2 *	0.197792	432.0050	29.79707	0.0001
At most 3 *	0.179444	274.2078	15.49471	0.0001
At most 4 *	0.169061	132.6022	3.841466	0.0000
H_0: No. of CE(s)	Eigen value	Max-Eigen	5% level	p-value
None *	0.292446	247.6939	33.87687	0.0001
At most 1 *	0.230717	187.8038	27.58434	0.0001
At most 2 *	0.197792	157.7972	21.13162	0.0001

At most 3 *	0.179444	141.6057	14.26460	0.0001
At most 4 *	0.169061	132.6022	3.841466	0.0000

1. MacKinnon-Haug-Michelis (1999) p-values
2. *: significant at 5% level

Granger Causality Test

The result of the Granger causality test shows that the null hypothesis is rejected at 10% significant level as shown in Table 3. It indicates DJI can explain the fluctuations of SSE composite index and explanation power exists between Nikkei 225 and DJI, TAIEX and DJI, bio-energy company stock index in Taiwan and DJI to explain the changes for each other. Besides, TAIEX is also capable of explaining the fluctuations of the bio-energy company stock index in Taiwan.

From the perspective of the bio-energy company stock index in Taiwan, TAIEX changes may affect the bio-energy company stock index in Taiwan and the latter and DJI influence each other. It is noteworthy that the interactive influence between bio-energy company stock index in Taiwan and TAIEX is one-way; however, that between bio-energy company stock index in Taiwan and DJI is two-way.

Table 3. Granger Causality Test

Null Hypothesis:	F-Statistic	Prob.
DJI does not Granger Cause SSE composite index	7.62716	5.E-05
Nikkei225 does not Granger Cause DJI	2.76993	0.0408
DJI does not Granger Cause Nikkei225	55.7646	2.E-32
TAIEX does not Granger Cause DJI	3.59946	0.0133
DJI does not Granger Cause TAIEX	53.4991	3.E-31
Bio-energy company stock index does not Granger Cause DJI	2.57930	0.0526
DJI does not Granger Cause Bio-energy company stock index	10.9976	5.E-07
TAIEX does not Granger Cause Bio-energy company stock index	5.43381	0.0011

Impulse Responses

Only the impulse responses of the bio-energy company stock index in Taiwan are listed in Table 4. It indicates bio-energy company stock index in Taiwan give the strongest response to TAIEX, followed by DJI; nevertheless, the impact imposed by DJI fluctuations becomes more significant on the second day than on the first day. Responses to Nikkei 225 and SSE composite index are weaker.

All impulse responses of the bio-energy company stock index in Taiwan to other variables are positive and become level with time.

Table 4. Response of bio-energy company stock index

Period	SSE composite index	DJI	Nikkei225	TAIEX
1	0.002857	0.001269	0.003297	0.007901
2	0.000765	0.004086	0.000998	0.004221
3	0.001613	0.002062	0.000107	0.002357
4	0.001085	0.002666	0.000723	0.004790
5	0.001438	0.002579	0.001351	0.004428
6	0.001482	0.002459	0.000712	0.003600
7	0.001216	0.002544	0.000857	0.004218
8	0.001379	0.002625	0.000943	0.004181
9	0.001406	0.002502	0.000854	0.003950
10	0.001304	0.002543	0.000885	0.004114

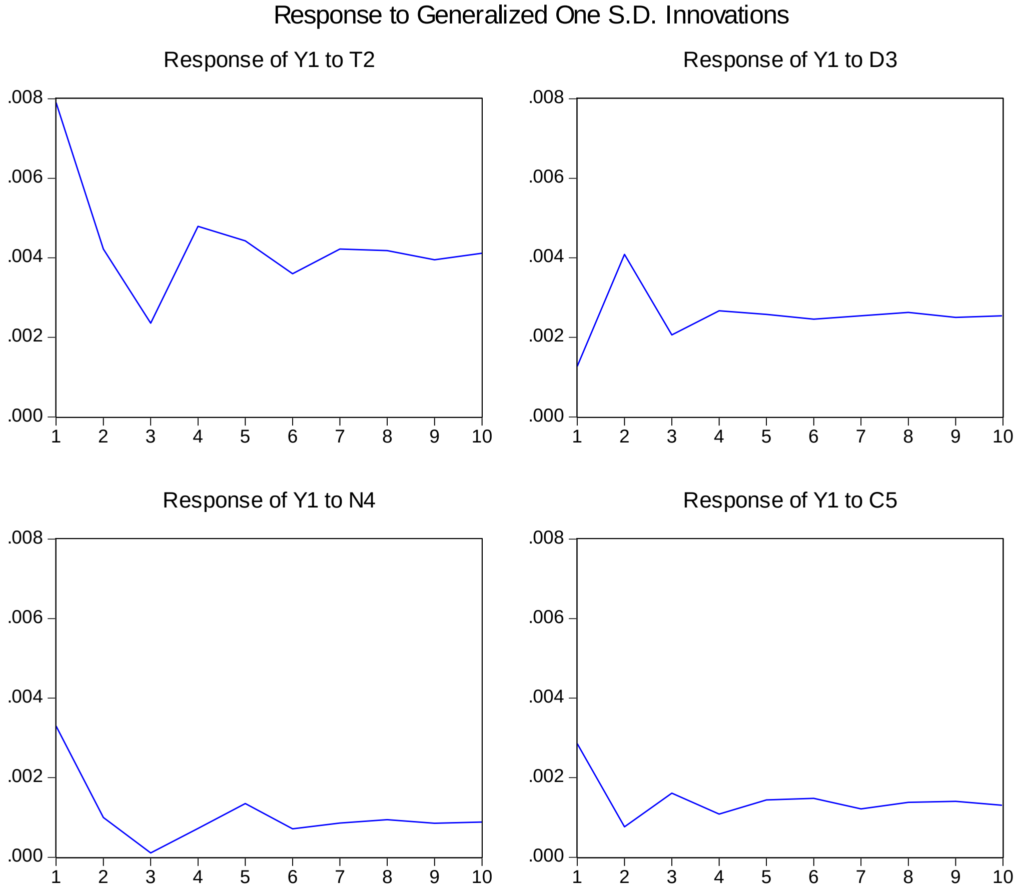

Figure1. Response of bio-energy company stock index

Variance Decompositions

Only the sources of prediction variances of the bio-energy company stock index in Taiwan are listed in Table 5. It is obvious to know from Table 5 that TAIEX has the highest explanation power (20.06763) and takes the lead all the way, which remains unchanged when prediction is made till the 10th length. Furthermore, it is observed from the data listed in Table 5 that the explanation percentages of other variables are trivial compared with the explanation percentage of TAIEX when prediction is made till the 10th length.

In sum, the interactions between the bio-energy company stock index in Taiwan and other variables come from the domestic market mainly during the process. Nevertheless, there is one thing that needs our attention; i.e., though TAIEX has the highest explanation power even when prediction is made till the 10th length, it tends to decrease. In contrast with it, the explanation power of DJI and Nikkei 225 continues increasing.

Table 5. Variance Decomposition of bio-energy company stock index

Period	SSE composite index	DJI	Nikkei225	TAIEX
1	0.955680	0.015005	0.032788	20.06763
2	0.796014	2.956716	1.009096	21.00061
3	1.112771	3.073270	1.371028	18.80893
4	0.939702	2.996256	1.899663	18.87658
5	0.928481	3.068453	1.873929	19.27678
6	0.976661	3.142278	1.970154	18.71353
7	0.929142	3.154220	2.082790	18.64585
8	0.922048	3.210607	2.146885	18.63241
9	0.928683	3.233290	2.190796	18.46985
10	0.912946	3.249609	2.238157	18.41593

5. Conclusion

This research makes an in-depth study on the relationship between the bio-energy company stock index and international stock markets.

For long-run equilibrium relationships, the results of unit root and cointegration tests indicate that the bio-energy company stock index in Taiwan, TAIEX, DJI, Nikkei 225 and SSE composite index are stationary and co-moving significantly long-run equilibrium relations..

Two things are noteworthy in the short-run test results: 1. Granger causality tests show that the interaction between the bio-energy company stock index in Taiwan and TAIEX is one-way only; however, that between the bio-energy company stock index in Taiwan and DJI is two-way. 2. According to the results of variance decompositions, though TAIEX has the highest explanation power even when prediction is made till the 10^{th} length; nevertheless, the explanation power tends to decrease. On the contrary, DJI and Nikkei 225 manifest constantly increasing power in explanation. Accordingly, the influence of DJI upon the bio-energy company stock index in Taiwan keeps rising and can't be ignored.

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