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Identifying Factors Affecting Palm Oil Prices Based On Grey Incidence Analysis

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Abstract

Palm oil industry is an industry that supports Malaysian economy. It triggers economic activities, but due to the uncertainty in the world of economic force, the palm oil prices in Malaysia have a high volatility movement. The volatility movement of palm oil prices is due to many factors such as the prices of other vegetables oil and crude oil. The purpose of this research is to find the main factors that affecting crude palm oil price quantitatively and to overcome the problem by providing an early warning signal in order to prevent huge losses in the future. By employing absolute grey incidence analysis and also correlation, this study calculates the grey incidence degree to determine the co-integration of palm oil prices with other factors which are soybean oil, rapeseed oil, palm kernel oil, coconut oil and crude oil prices towards palm oil prices. It demonstrates that palm kernel oil price has a high relationship between the palm oil prices.

Keywords: Grey Incidence Analysis, Palm Oil Prices, Soybean Oil, Commodity.

Introduction

Oil palm plays an important role in supporting Malaysia's economy. On top of that, Malaysia has gained position as the world leading palm oil producer (Goniur,2011). The palm oil industry formed the economic backbone of Malaysia with the total export of palm oil in Malaysia until the end of year 2010 was 2,064, 247 Millions/Tonne (M/T). It was increased from the previous year, 2009 which was 1,892,099 M/T.

Currently Malaysia accounts for 39% of world palm oil production and 44% of world exports. Edward, Hondgon, Hamer, Mitchell, Ahmad, Cornel and Wilcove (2010) state that there are countries those believe and prefer to use palm oil amongst the vegetable oil because it is healthier. As a result, they increase consumption of palm oil in food products. Palm oil is the most popular agricultural commodity in many countries. This industry makes significant contributions in the Malaysian economic growth and development. Palm oil also is commonly used in food industry in Malaysia. According to Shakila, Noryati and Maheran (2017) food industry has low stock volatility that benefits

the Malaysia's economy. As emphasized by Nordin and Ismail (2014) the stock market index in Malaysia is influenced by the prices of palm oil. Other than that, the widely used of palm oil made researchers interested to explore more on oil palm (Syamsiah et al., 2011; Roseleena et al., 2011).

Other considered factors in this study are soybean oil prices, rapeseed oil prices, palm kernel oil prices, coconut oil prices and Brent crude oil prices. In this research, Grey incidence analysis is selected as a method to evaluate the correlation or interaction degree with other variables in the system. Deng Ju-long is the first person that proposed the concepts and establishes the grey system in 1982. More specifically, in 1982, Deng Ju-Long published the first research paper in the area of grey systems in the international journal entitled *Systems and Control Letters*, published by North-Holland Co. His paper was titled "Control problems of Grey Systems".

The publication of this paper signaled the birth of grey systems theory after many years of effective research of the founding father (Liu, Fang, & Lin, 2006). According to Deng the output of the system is more important compared to the input and in addition both grey quantity and grey relationship within the systems are also important (Ping & Keija, 2005). The fundamental idea of grey incidence analysis is that the closeness of a relationship is judged based on the similarity level of the geometric patterns of sequences curves (Liu et al., 2006). There are many incidence models such as Deng's degree of grey incidence, absolute degree of grey incidence, relative degree of grey incidence, grey incidence of B-model, grey incidence of entropy and many more models afterwards (Liu, Forrest & Yang, 2012).

Literature Review

Palm Oil Prices

There are many studies proposed in analyzing the factors affecting palm oil prices. Different study conducted to attest the factors contribute to the movement of palm oil prices. In examining the correlation of crude palm oil and other factors, Chuangchid, Wiboonpongse, Sriboonchitta and Chaiboonsri (2012) discovered that there is co-integration relationship between palm oil prices with soybean oil prices and crude oil prices. The soybean oil prices are found to have some dependence with the growth rate of palm oil, while crude oil has a fairly weak dependence. They use the bivariate extreme value in investigating the relationship between prices of palm oil and crude oil.

In a different study, Sanders, Balagtas and Gruere (2012) conduct a study to investigate the factors leading to the growth in palm oil prices. The selected factors are soybean oil prices and crude oil prices. They discover that, there is a relationship between both factors and palm oil prices. However, the interaction of palm oil and crude oil prices are negative. In addition, their study also shows that a soybean oil market is a vital driver of the palm oil boom but not for crude oil.

Grey System

Liu, Forrest and Yang (2012) discover that probability and statistics, fuzzy mathematics and also grey systems theory are among the methods and theories used in studies of non-deterministic systems. Even though they study the objects with difference uncertainties, the commonality of all these theories is to make meaningful sense out of incompleteness and uncertainties. The fundamental meaning of grey system is by having partially complete information. The comparisons between grey system theory, probability statistics, rough sets and fuzzy mathematics are tabulated below.

	Grey systems theory	Probability statistics	Fuzzy mathematics	Rough sets
Objects of study	Poor information	Stochastic	Cognitive	Indiscernibility
Basic sets	Grey haze sets	Cantor sets	Fuzzy sets	Set approximation
Methods	Information coverage	Probability distribution	Function and affiliation	Partition
Procedure	Grey series generation	Frequency distribution	Marginal sampling	Lower and upper approximation
Requirement	Any distribution	Typical distribution	Experiences	Equivalent relations
Emphasis	Intention	Intention	Extension	Intention
Objectives	Laws of reality	Laws of statistics	Cognitive expression	Concept Approximation
Characteristic	Small samples	Large samples	Experiences	Information systems (tables)

Table 1. Comparison between Grey System Theory, Probability Statistics and Fuzzy Mathematics.

Grey Incidence Analysis

Grey incidence analysis is put forward by Professor Deng Julong in grey system theory. The grey incidence analysis is an important part in grey systems theory. According to Li-zhi and Si-feng (2009), grey incidence analysis is used to know the mutual reaction among the factors, since it can determine the development situation and tendency of the systems. It is a kind of system analysis method which applies the degree of grey incidence to weight the relationship between system characteristics factor and system behavior factor quantitatively (Wang & Dang, 2009). The fundamental idea of grey incidence analysis is that the closeness of a relation is judged based on the similarity patterns of sequences curves. It indicates, their relationship is closer. The more similar the curves are, the higher the grey incidence degree between the sequences and vice versa. There are many types of grey system such that Grey Incidence Analysis, Grey Cluster and Grey Statistical Evaluations, Grey Systems Modeling, Grey Combined Models, Grey Prediction and many more (Liu & Yin, 2006). The calculation procedure of the absolute degree for grey incidences is as follows:

- 1) Constitute the behavioral sequence and characteristic sequence

Assume that X_0 is a sequence of a system's characteristic and

$$X_0 = (x_0(1), x_0(2), \dots, x_0(n)) \tag{1}$$

X_i are behavioural sequences such that

$$X_i = (x_i(1), x_i(2), \dots, x_i(n)) \quad i = 1, 2, \dots, m. \tag{2}$$

2) Computing zero starting point image

Assumed is behavioral sequences and D is a sequence operator

$$X_i D = (X_i(1)d, X_i(2)d, \dots, X_i(n)d) \quad k = 1, 2, \dots, n \tag{3}$$

Where $x_i(k)d = x_i(k) - x_i(1)$. (4)

Then D is called a zero starting point operator with $X_i D$ as the image of zero starting point of x_i , denoted

$$X_i^0 = (x_i^0(1), x_i^0(2), \dots, x_i^0(n)).$$

3) Find $|s_0|, |s_i|, |s_i - s_0|$.

Assume that $|X_i|$ and $|X_0|$ are 1- time interval sequences of the same length,

$$\begin{aligned} X_0^0 &= (X_0^0(1), X_0^0(2), \dots, X_0^0(n)) \\ X_i^0 &= (X_i^0(1), X_i^0(2), \dots, X_i^0(n)) \end{aligned}$$

and are the zero image of $|X_i|$ and $|X_0|$. Then

$$|s_0| = \left| \sum_{k=2}^{n-1} x_0^0(k) + \frac{x_0^0(n)}{2} \right| \tag{5}$$

$$|s_i| = \left| \sum_{k=2}^{n-1} x_i^0(k) + \frac{x_i^0(n)}{2} \right| \tag{6}$$

$$|s_i - s_0| = \left| \sum_{k=2}^{n-1} x_i^0(k) - x_0^0(k) + \frac{x_i^0(n) - x_0^0(n)}{2} \right|. \tag{7}$$

4) Compute the absolute degree of grey incidences

$$\varepsilon_{0i} = \frac{1 + |s_0| + |s_i|}{1 + |s_0| + |s_i| + |s_i - s_0|}. \tag{8}$$

The Application of Grey Incidence Degree

Suppose palm oil prices as a system's characteristic sequences and all other variables as systems of behavioral sequence. First is to constitute the system characteristic sequences and behavioral sequence by applying equations (1) and (2). The value in equation (2) represents the factors that affect palm oil prices such as soybean oil, rapeseed oil, palm kernel oil, coconut oil and Brent crude oil. Whereas, the number of considered factors and in this study is 5. X_i is represented as follows:

X_0 : The palm oil prices.

X_1 : The soybean oil prices.

X_2 : The rapeseed oil prices.

X_3 : The palm kernel oil prices.

X_4 : The coconut oil prices.

X_5 : The Brent crude oil prices.

while the variable n in equation (3) refers to the sequence data in each considered factor as follows:

$X_0(1)$ is the first input in the series of palm oil price data.

$X_1(1)$ is the first input in the series of soybean oil price data.

$X_2(1)$ is the first input in the series of rapeseed oil price data.

$X_3(1)$ is the first input in the series of palm kernel oil data.

$X_4(1)$ is the first input in the series of coconut oil data.

$X_5(1)$ is the first input in the series of Brent crude oil data.

whereas the value of $X_0(3)$ means the 3rd input in palm oil data series. Then, computing zero starting point image by using equations (3) and (4). Here D is called a zero starting point operator with $X_i D$ as the image of zero starting point of X_i . The variable X_i^0 means the notation for zero starting point image for each factor. i refers to the considered factor. Here each data in the series of data minuses the 1st input data in that series. X_0^0 means the notation for zero starting image for palm oil prices. The 2nd input in palm oil price data subtracts the 1st input data. The 3rd, 4th, 5th and all data in palm oil data series minuses the 1st input data. Whereas X_1^0 refers to the notation for zero starting image for soybean oil prices and the same goes to rapeseed oil prices, palm kernel oil prices, Brent crude oil prices and coconut oil prices. In this study, X_i and X_0 are 1- time interval sequences of the same length. In order to find grey incidence degree we shall find $|S_0|$, $|S_i|$ and $|S_i - S_0|$ for all factors by using (5), (6) and (7) respectively. Then, the absolute degrees of grey incidence were computed by using equation (8). The degrees of grey incidence are as follows

- i. ε_{01} = The grey incidence degree for soybean oil prices
- ii. ε_{02} = The grey incidence degree for rapeseed oil prices
- iii. ε_{03} = The grey incidence degree for palm kernel oil price.
- iv. ε_{04} = The grey incidence degree for coconut oil prices
- v. ε_{05} = The grey incidence degree for crude oil prices

According to Yuan, Liu and Chen (2010), the grey incidence degrees ε_{0j} were measured from $0.5 \leq \varepsilon_{0j} \leq 1$. In the first stage, grey incidence degree was evaluated when $L = 0$. In order to compute grey incidence degree, by using data from 25/10/2012 to 13/11/2013 for both sets of data (Rahman,2012), we took the palm oil prices as a system characteristic sequences or called it as benchmark sequences and marked it as X_0 . Then took the sequences of considered factors, e.g., soybean oil prices as a system behavior sequences and marked it as X_1 .

According to the formula of absolute degree of grey incidence, we could work out the absolute degree of incidence between X_0 and X_1 that expressed it as ε_{01} . The zero starting point was evaluated by using (3) and (4) in order to determine the grey incidence degree. Then, the values of

$|s_0|, |s_j|$ and $|s_j - s_0|$ were calculated by using (5), (6) and (7). The degree of grey incidence is calculated by using (8). Complying with this method, the degree of grey incidence of rapeseed oil prices, palm kernel oil prices, coconut oil prices and Brent crude oil prices with palm oil prices under the same time ($L=0$) were calculated separately.

In this study, grey incidence degree was compared with correlation. Taking the same length in both sequences of data, the correlation was computed by using Excel window spreadsheet.

The Proof Grey Incidence Degree Is Measure From $0.5 < \varepsilon_{0j} < 1$

	$\varepsilon_{0j} = \frac{1 + s_1 + s_0 }{1 + s_1 + s_0 + s_1 - s_0 }$
Let,	$ s_1 = a s_0 .$
where a is a constant. Then	$ s_1 - s_0 = a s_0 - s_0 $
Let,	$ s_1 - s_0 = a - 1 s_0 $
	$\varepsilon_{0j} = \frac{1 + s_1 + s_0 }{1 + s_1 + s_0 + s_1 - s_0 }$
	$= \frac{1 + [a s_0] + s_0 }{1 + [a s_0] + s_0 + [a - 1 s_0]}$
	$= \frac{1 + a s_0 + s_0 }{1 + a s_0 + s_0 + [a - 1 s_0]}$
	$= \frac{1 + [1 + a] s_0 }{1 + [1 + a + a - 1] s_0 } > \frac{[1 + a] s_0 }{[1 + a + a - 1] s_0 }$
Suppose	$ a - 1 < a + -1 $
Then,	$\frac{1}{ a - 1 } > \frac{1}{ a + -1 }$
	$\frac{1 + a }{1 + a + a - 1 } > \frac{ a }{1 + a + a - 1 }$
	$> \frac{ a }{ a + a }$
	$> \frac{1}{2}.$
Therefore it is confirmed that the grey incidence degree is measured from $0.5 \leq \varepsilon_{0j} \leq 1$. This means the grey incidence degree is never being below than 0.5.	

Conclusion

Variables	Factors affecting palm oil prices	Grey Incidence degree	Correlation
X_1	Soybean oil prices	0.6001	-0.2929
X_2	Rapeseed oil prices	0.5874	-0.1785
X_3	Palm kernel oil prices	0.8451	0.6555
X_4	Coconut oil prices	0.8213	0.5352
X_5	Brent crude oil prices	0.5856	-0.1795

Table 2. The Grey Incidence Degree when $L=0$ and Correlation of Palm Oil Prices in Malaysia.

From Table 2, under the same time, all the absolute grey incidence degree is from 0.58 and above which is from $0.5 \leq \varepsilon_{0j} \leq 1$. From this study, it is found that, whenever ε_{0j} increases or close to 1 then the prices in palm oil and the variables is directly proportional, which means they move in the same direction. This demonstrates the relationship between palm oil and the considered factor prices are highly co-integrated.

The palm kernel oil and palm oil prices were really close, grey incidence degree reaches to 0.8451, followed by coconut oil prices and soybean oil prices with 0.8213 and 0.6001 respectively. Besides that, the correlation of palm kernel oil is also quite high which is 0.6555. This indicates there is a quite strong positive correlation. Correlation for soybean oil and coconut oil is -0.2929 and 0.5352 respectively. Rapeseed oil prices with 0.5874 degree and the correlation is -0.1785 also with negative correlation. This means when the prices of palm oil go up the prices of rapeseed oil goes down. Brent crude oil also shows a negative relationship with palm oil prices with correlation about -0.1795. The work attests that there are many factors involved in the movement of palm oil prices. In this research work, we have empirically verified the factors that affecting palm oil in Malaysia that are soybean oil prices, rapeseed oil prices, palm kernel oil prices, coconut oil prices and crude oil prices towards the palm oil prices. The aim of the study is to ascertain the impact of price volatility of soybean oil prices, rapeseed oil prices, palm kernel oil prices, coconut oil prices towards the palm oil prices.

In the study, it was found that coconut oil prices and palm kernel oil prices have a significant positive relationship with the crude palm oil, whereas soybean oil, rapeseed oil and Brent crude oil have a significant negative relationship with crude palm oil prices. The most vital factor that gives huge impacts on palm oil price volatility is palm kernel oil prices followed by coconut oil prices, soybean oil prices, rapeseed oil prices and the last is Brent crude oil prices. The grey incidence value and correlation of each variable are tabulated in Table 1. The grey incidence rank in this study is $X_3 \succ X_4 \succ X_1 \succ X_2 \succ X_5$.

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