The Effect of Soyabean Oil Price Changes on Palm Oil Demand in China

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ABSTRACT

China is the biggest market for oils and fats, with consumption indicating a steadily increasing trend from 25.7 million tonnes in 2005 to 36.6 million tonnes in 2015. Palm oil is one of the largest volume of oils and fats consumed by China, representing 18.0% of the total consumption for 2015. Palm oil is thus the largest component of the oils and fats imports, particularly for the instant noodles industry. The price of palm oil substitutes, especially soyabean oil, highly influences the demand for palm oil. China's huge crushing capacity to satisfy the demand for soyabean meal also means that there is a necessity to import large quantities of soyabean, which subsequently increases the local supply of soyabean oil, thus affecting the demand for palm oil. This study attempted to examine the short-run and the long-run relationships between China's palm oil imports and palm oil prices, soyabean oil prices, soyabean meal prices and domestic income, using the Autoregressive Distributed Lag (ARDL) method with data from 1980 to 2015. The result of the bound test indicates that there is a long-run relationship between the studied variables. The empirical results reveal that domestic income, measured by the gross domestic product (GDP), and the difference between soyabean oil and palm oil prices have positive significant relationships with palm oil demand in China in the long-run. At the same time, soyabean meal price show a significant negative relationship with palm oil demand in China. The result indicates that GDP, the difference between soyabean oil and palm oil prices, and soyabean meal price play important roles in determining palm oil demand in China.

Keywords: palm oil, soyabean, China, ARDL, GDP.

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INTRODUCTION

China's economic transformation gives a very positive impression of the country's economic prospects. China has become the world's fastest growing economy after the implementation of free market reform in 1979. China has now emerged as a major global economic

power with a real annual gross domestic product (GDP) growth averaging nearly 10% from 1979 to 2014 (Morrison, 2015). According to the National Bureau of Statistics of China, China's economy grew at 7.3% in 2014, close to the government's target of 7.5% (IMF, 2014). In 2015, China's GDP grew at 6.9%, and it has been forecast to grow more than 6.5% in 2016 (IMF, 2016). This will continue to create more disposable income for China's consumers.

Rapid urbanisation and population growth in China have increased the demand for oils and fats, both for direct domestic and industrial use. In 2014, soyabean oil continued to be the primary edible oil consumed, accounting for 45.3% of total consumption, followed by rapeseed oil (22.9%), palm oil (14.4%), groundnut oil (8.5%) and sunflower oil (3.4%) oils (USDA, 2016a). While palm oil continues to dominate the vegetable oils import, the growth is increasingly impacted by the availability of competing vegetable oils at more competitive prices, as well as the stagnant use of palm oil for the instant noodles industry (USDA, 2015). China is currently the main importer of soyabean and palm oil in the world market. This implies the importance of soyabean and palm oil for China, particularly for her animal feed and food processing industries.

The availability of soyabean oil is an important determinant of China's need to import palm oil. China is the world's largest crusher of soyabean. In 2013/2014, this country accounted for 28% of soyabean crushed globally, which produced an additional 790 000 t of soyabean oil, up by 7.4% as compared with the previous period (Ng, 2014b). This was in tandem with the decline in palm oil imports by 13.4%. As the local soyabean crop in China is channelled mainly into food products, the bulk of the soyabean for crushing is imported for animal feed, in the form of soyabean meal which is known for its high protein content. Domestic soyabean meal production has doubled over the past decade and is able to satisfy the demand in the animal husbandry sector. Part of the output is then exported if not required locally. Crushing has been fuelled by lucrative margins for economic growth, averaging at 10% over the past 10 years (Ng, 2014a). The huge crushing capacity and demand for soyabean meal also meant that there is a necessity to import large quantities of soyabean.

LITERATURE REVIEW

There are many issues that have been identified in various studies related to palm oil, such as demand issues. Hameed *et al*. (2007) discussed the palm oil import demand in selected Middle Eastern and North African (MENA) countries, using the Autoregressive Distributed Lag (ARDL) technique. The results show that palm oil prices, national income and the prices of the oil substitutes are significant determinants of palm oil demand in selected MENA countries. The studies also found other factors affecting the demand for palm oil in some MENA countries, such as the palm oil price discount, world petroleum prices, anti-palm oil campaigns, trade embargo on Libya and Iraq, and the exchange rate. Tety *et al*. (2009) found that factors which influenced the consumption of Indonesian palm cooking oil were domestic palm cooking oil price and the population size. On the other hand, Hameed and Arshad (2012) investigated the behaviour of top importing countries (*i.e.* India, China, Bangladesh, Pakistan and USA) with respect to palm oil demand. The research found that prices of palm oil and its substitutes, national income, trade liberalisation policy and the exchange rate were the important factors affecting import demand for palm oil. Egwuma *et al*. (2016) identified principal factors that shaped the Nigerian palm oil industry over the period 1970 to 2011, using the ARDL approach. The results reveal that significant factors which influenced the Nigerian palm oil industry included palm oil prices and income. This study recommends that macroeconomic stabilisation strategies and appropriate pricing policies be designed to ensure the expansion of palm oil's market share.

According to USDA (2016b), in 2016/2017, vegetable oils consumption as food is forecast to expand by 3% in tandem with population and GDP growth. All vegetable oils are expected to grow, led primarily by oil and soyabean oil. Palm oil and soyabean oil are considered substitutable goods because food processors often switch between the two oils as their prices fluctuate. This issue also been discussed by Fatimah Zahrah (2015). The article highlighted the possibility that palm oil trade with Pakistan will be affected by the China-Pakistan Economic Corridor (CPEC). CPEC is expected to intensify the flow of products from China to Pakistan, including oils and fats. Palm oil has to be ready to compete with similar substitutes from China, particularly soyabean oil. Hassan and Rina (2015) also discussed the demand for palm oil and soyabean oil. Edible oils are some of the most crucial cooking ingredients in the world. Palm oil and soyabean oil dominate the edible oils market, and production of these two oils makes up more than 50% of the

total world production. This study shows that there are some factors that determine the demand for soyabean oil and palm oil, such as population growth and exchange rate.

METHODOLOGY

The analysis for this study was based on yearly time series data, spanning from 1980 to 2015. Data on China's palm oil imports were obtained from MPOB's database. Data on palm oil prices, soyabean oil prices and soyabean meal prices were collected from the United Nations Conference on Trade and Development (UNCTAD) database. Data on the real GDP per capita were obtained from the World Development Indicator (WDI).

ARDL Bound Test

For empirical analysis, this study first investigated the stationarity property of the variables by employing the commonly used unit root tests in empirical literature, including the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The reason for using the unit root tests is that, the generally, economic and financial time series, such as for prices and real GDP, exhibit trending behaviour or non-stationarity of the mean. Moreover, economic and finance theory often suggests the existence of long-run equilibrium relationships among non-stationary time series variables. If these variables are integrated in the order of one [I(1)], cointegration techniques can be used to model these long-run relationships. Hence, pre-testing for unit roots is often a first step in cointegration modelling.

This study then employed the ARDL bound testing approach to cointegration, as developed by Pesaran *et al*. (2001), to verify the long-run relationships between the variables. This method was chosen for its advantages when dealing with few observations as well as the fact that it can be applied irrespective of the order of integration, *i.e*., I(0) or I(1). In addition, the ARDL method avoids the larger number of specifications that need to be made in the standard cointegration test. These cover decisions regarding the number of endogenous and exogenous variables (if any) to be included in the treatment of deterministic elements, as well as the optimal number of lags to be specified. By employing the ARDL method, it is possible to have different variables that have different optimal lags, which is unacceptable with the standard cointegration test. Moreover, the model can be used with limited sample data.

The estimated ARDL model is as follows:

$$\Delta \ln DDC_t = \alpha_0 + \sum_{i=1}^{N} \beta_1 \Delta \ln GDP_{t-i} + + \sum_{i=1}^{N} \beta_2 \Delta \ln PSPO_{t-i} + \sum_{i=1}^{N} \beta_3 \Delta \ln SBMP_{t-i} + + \delta_1 GDP_{t-1} + \delta_2 \ln PSPO_{t-1} + \delta_3 \ln SBMP_{t-1} + \mu_t \quad (1)$$

where Δ is the symbol of differentiation, ε_t is the error/residual (white noise), and α, β and δ are parameters that need to be estimated. lnDDC, lnGDP, lnPSPO and lnSBMP refer to the log of China's palm oil demand (import), real per capita GDP, the difference between soyabean oil and palm oil prices, and soyabean meal price, respectively.

The study then estimated the long-run relationships between the variables. The first step was to justify the interval for variables by using the F-statistic (variable addition test). The null hypothesis to determine the existence of no cointegration (H0: $\delta 1 \neq \delta 2 = \delta 2 = 0$) was tested against the alternative hypothesis of the existence of cointegration (H1: $\delta 1 \neq \delta 2 \neq \delta 2 \neq 0$). Two sets of critical bound for the F-statistic were generated by Pesaran *et al*. (2001) and Narayan (2005): the lower critical bound (LCB) and the upper critical bound (UCB). If the F-statistic is less than LCB, it indicates that there exists no cointegration or any long-run relationship between the studied variables. However, if the F-statistic is greater than UCB, it means that there is cointegration or long-run relationships between the variables. On the other hand, if the F-statistic is between LCB and UCB, the cointegration test is considered to be inconclusive.

The second step of the ARDL estimation procedure involved the estimation of the coefficients of the variables in the equation. The lag selection criterion of the model was based on either Akaike Information Criterion (AIC) or Schwartz-Bayesian Criterion (SBC). Once cointegration is established, the conditional ARDL long-run model can be estimated in Equation (2):

$$\ln DDC_t = \alpha_1 + \sum_{i=1}^{N} \delta_1 \ln GDP_{t-i} + + \sum_{i=1}^{N} \delta_2 \ln PSPO_{t-i} + \sum_{i=1}^{N} \delta_3 \ln SBMP_{t-i} + \varepsilon_{t-1} \quad (2)$$

The subsequent estimation and model selection were made based on three criteria, namely, the adjusted R-squared, AIC and SBC, to select the maximum length of the interval.

Finally, the study sought to determine the short-run dynamic parameters by estimating an error correction model associated with the previously determined long-run estimates. The ARDL error correction model is expressed by the following equation:

$$\Delta \ln DDC_t = \alpha_1 + \sum_{i=1}^{N} \beta_1 \Delta \ln DDC_{t-i} + + \sum_{i=0}^{N} \beta_1 \Delta \ln GDP_{t-i} + \sum_{i=1}^{N} \beta_2 \Delta \ln PSPO_{t-i} + + \sum_{i=0}^{N} \beta_3 \Delta \ln SBPM_{t-i} + \psi ECM_{t-1} + \varepsilon_{t-1} \quad (3)$$

where β_1, β_2 and β_3 are the

short-run dynamic coefficients of the model's convergence to equilibrium, ψ is the speed of the adjustment parameter, and ECM is the error correction term that is derived from the estimated equilibrium relationship of Equation (1). Equation (3) indicates that when there is a shock in the economy, the higher the value of the error correction coefficient (in negative terms), the quicker the economy will adjust itself to achieve long-run equilibrium, and *vice versa*. To ascertain the goodness of fit of the ARDL model, diagnostic and stability tests were conducted. The diagnostic test examined the serial correlation, functional form, normality and heteroscedasticity associated with the model by employing the Lagrange Multiplier (LM) test. The structural stability test was conducted to determine the stability of the model by employing the cumulative sum of recursive residuals (CUSUM) test and the cumulative sum of squares of recursive residuals (CUSUMSQ) test.

EMPIRICAL RESULTS

Unit Root Tests

Prior to testing for cointegration, this study conducted a test on the order of integration for each variable using ADF and PP procedures to examine data stationarity, and consequently the existence of unit root. *Table 1* indicates that, based on the ADF and PP tests, the calculated t-statistics for China's palm oil demand (DDC) and the difference between soyabean oil and palm oil prices (PSPO) are greater than the critical values in their level forms, suggesting that these variables were stationary at level form or integrated in the order of I(0). For the soyabean meal price (SBMP) variable, the calculated t-statistics is less than the critical values in its level form and greater than the critical value in its differenced forms. Hence, SBMP is stationary after differencing, which suggested that the variables were integrated in the order of I(0). For GDP, the ADF and PP tests suggested that the variable was stationary after the second differencing, or integrated in the order of I(2).

The bound test procedure indicated that the optimal lag length for this model was three. The absence of a residual serial correlation also confirmed the correct order of the lag selection. The result of the bound test for cointegration is reported in *Table 2*. This test was based on the Wald test or F-statistic and was conducted against the null hypothesis of the existence of a long-run relationship between the variables. Indeed, the result of the bound test indicates the existence of a long-run relationship between the variables.

The empirical results of the long-run model are presented in *Table 3*. The selected model was derived, based on the Schwarz Bayesian Criterion (SBC). The results indicate that the domestic income level as measured by GDP is an important determinant of China's DDC. Every 1% increase in real per capita GDP will result in an average of 0.45% increase in DDC. Similarly, the

TABLE 1. UNIT ROOT TESTS (with intercept)

Variable	Level		First difference	
	ADF	PP	ADF	PP
China				
DDC	-2.9235*	-3.0702**	-3.8607***	-3.8151***
GDP	-0.0418	1.4191	-2.2526	-2.3004
PSPO	-4.0350***	-3.9443***	-7.8736***	-9.1050***
SBMP	-2.1965	-2.0693	-2.9716**	-4.3174**

Note: *Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.
ADF - Augmented Dickey-Fuller.
PP – Philips-Perron.
DDC – China's palm oil demand.
PSPO – price difference between soyabean oil and palm oil prices.
SBMP – soyabean meal price.

TABLE 2. ARDL BOUND TEST OF COINTEGRATION

Significant level	Critical value# (unrestricted intercept and no trend)	
%	Lower bound	Upper bound
1	5.333	7.063
5	3.710	5.018
10	3.008	4.150
Diagnostic tests		
Max lag length: 3		
Wald Test F-Stat: 6.9937**		
LM Test χ^2: 0.6275		

Note: # Based on Narayan (2005). ** Significant at 5% level.
ADRL - Autoregressive Distributed Lag.
LM - Lagrange Multiplier.

positive sign of the price difference between soyabean oil and palm oil prices (PSPO) indicates that every 1% increase in PSPO will increase DDC by 0.005%. This shows that soyabean oil and palm oil are close substitutes. However, the SBMP had a negative relationship with DDC. It implies that every 1% increase in SBMP, leads to a decrease by 1.33% in DDC. This is because when SBMP increases, China will have an increased soyabean oil demand. When the supply of local soyabean oil increases, the demand for imported palm oil will decrease.

The result of the error correction model for DDC is presented in *Table 4*. Most of the variables were found to be significant in the short-run, except for the difference for SBMP. It is found that in the short-run, GDP, PSPO and lagged SBMP had positive relationships with DDC. However, lagged PSPO was found to have a negative impact on DDC in the short-run.

The significance of the error correction term (ECT) showed that there was causality in at least one direction. The lagged error correction term [ECT(-1)] in our results was negative and highly significant. The coefficient of -0.3155 indicates a high rate of convergence to equilibrium, which implies that deviation from the long-run to equilibrium is corrected by 31.55% over each year.

TABLE 3. LONG-RUN COEFFICIENTS ARDL (1,0,2,2) BASED ON SCHWARZ BAYESIAN CRITERION (SBC)

Variable	Dependent variable: DDC	
	Coefficient	t-value
GDP	0.4522	2.4078**
PSPO	0.0047	2.6310**
SBMP	-1.3297	-3.3789***

Note: ** Significant at 5% level. *** Significant at 1% level.
ADRL - Autoregressive Distributed Lag.
SBMP - soyabean meal price.
GDP - gross domestic product.
PSPO - price difference between soyabean oil and palm oil prices.

TABLE 4. SHORT-RUN COEFFICIENTS ARDL (1,0,2,2) BASED ON SCHWARZ BAYESIAN CRITERION (SBC)

Variable	Dependent variable: DDC	
	Coefficient	t-value
Constant	5.9649	3.3950***
ΔGDP	0.1427	1.9452*
ΔPSPO	0.0013	2.8730***
ΔPSPO(-1)	-0.0014	-3.5308***
ΔSBMP	-0.3382	-1.3363
ΔSBMP(-1)	0.7001	2.8156***
ECT(-1)	-0.3155	-4.7092***
Diagnostic tests		
R-squared:	0.9820	
R-bar-squared:	0.9760	
Durbin Watson:	2.4781	
Schwarz Bayesian Criterion:	-6.7053	
F-Statistics (8, 24):	163.95***	

Note: * Significant at 10% level.** Significant at 5% level.*** Significant at 1% level.
ADF - Augmented Dickey-Fuller.
PP – Philips-Perron.
DDC – China's palm oil demand.
SBMP - soyabean meal price.
GDP – gross domestic product.
PSPO – price difference between soyabean oil and palm oil prices.
ECT – error correction term.

CONCLUSION

The demand for palm oil in China is very sensitive to the price discount of palm oil against the price of soyabean oil. This study showed that when the palm oil price discount against the price of soyabean oil is wide, the demand for palm oil is increased. This happens because soyabean oil and palm oil are considered to be substitutes. In addition, GDP is found to have a positive relationship with palm oil demand for the short-run and long-run. It indicates the importance of palm oil in supporting the growing Chinese economy, especially in the food industries, even though palm oil is perceived as being inferior in comparison with other major oils. Nonetheless, soyabean meal price is found to adversely affect palm oil demand since the higher the soyabean meal price, the more soyabean will be crushed, therefore, the higher availability of local soyabean oil supply. Consequently, the demand for palm oil imports will be reduced.

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