The Empirical Investigation of the Nexus between Agricultural and Industrial Sectors in Malaysia

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Abstract

This paper investigates the agricultural-industrial sectors relationship in Malaysia for period from 1970 to 2009. We adopted the Johansen and Juselius (1990) cointegration procedure to examine the existence of long-run relationship and employed Granger (1969) and Toda-Yamamoto (1996) causality tests to test the causality direction between the sectors in the short and long run. From the empirical evidence reveals agricultural and industrial sector are cointegrated in the long run. In addition, the causal relationship shows that there is a one-way causality direction from industrial to agricultural sectors both in the short run and long run. Therefore, it support the notion that industrial sector might improve the agricultural sectors output.

Keywords: Malaysia, agricultural, Industrial, modified WALD, cointegration

1. Introduction

On the early independent, Malaysian economic growth was hugely generated by the contribution of agricultural sector production. However, as Malaysia moving towards a high income country in year 2020, the industrial sector becomes more favorable catalyst in boosting the economy than the so-called traditional sector. Historically, the dependency of agricultural sector in promoting economic growth to the government can be seen by the three policies which were drafted under the long term national plans; the First National Agriculture Policies (1984-1991), the Second Agriculture Policy (1992-2000), and the Third Agriculture Policy (2010). And yet, the percentage contribution to the economy is decreasing. It is believed that, the decreasing contribution of this sector may due to the inefficiencies in terms of the method of output production. Other than that, it might be constraints faced by this sector in terms of labor participation, limited capital inputs and concentration to the increasingly importance of industrial sector. Moreover, in the year 1980s, the government had emphases on the promotion of heavy industries as part of the 'look east policy', which was one of Dr. Mahathir's policies after took power as the forth Premier of Malaysia (Athukorala and Loke 2009). This new views on the importance aspect of industrial sector has been contributing to the declining of the percentage contribution of agricultural sector to the Malaysian GDP.

Figure 1 shows the percentage contribution of agricultural and industrial sectors from 1970 to 2008. We observed that the two series seems to have a negative relationship. Started from early 1970s, the percentage of agricultural sector (contributed almost 30 percent) was higher than industrial sector (25 percent). Nonetheless, the structure of economy had been changed, particularly in the mid 1970s to 1980s where the industrial contribution increased drastically. The significant increase was due to the introduction of Investment Incentive Act in 1968, then followed by two investment plans; namely First Industrial Master Plan (First-IMP) covered from 1986 to 1995 and Second-IMP from 1996 to 2005. In year 1995, agriculture sector only contributed for about 14 percent while the industrial sectors contributed as much as 45 percent.

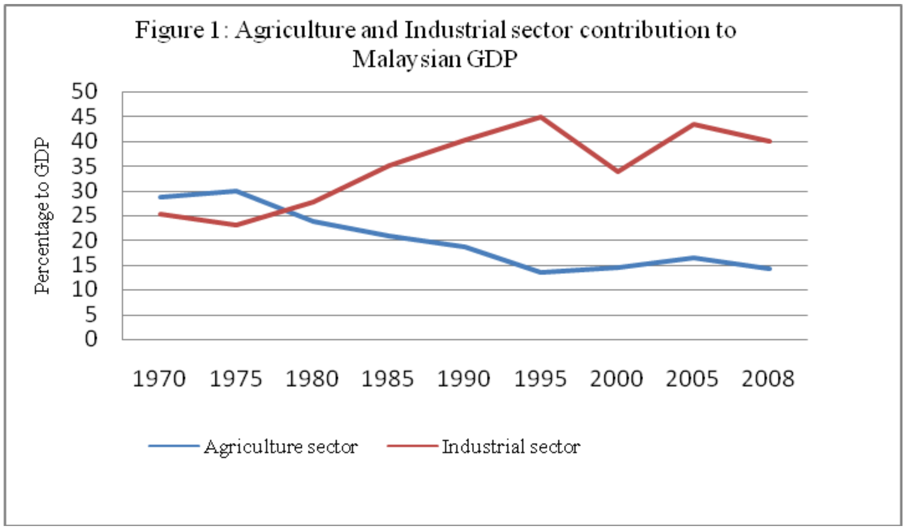

Figure (1) above clearly shown the significant contribution of agricultural sector to the economic growth in Malaysia has been decreasing. Still, the spending pattern on the sector has been increasing in order to promote productivity, particularly for food products. Moreover, the government tries to avoid highly dependent on import for food which can cause instability in general price of food. In very recent policy, agricultural sector becomes the third engine of growth behind services and industrial sector. This sector should be modernized with some technological advancement which including high-skilled labors to its production. The modernization in this sector could be a significant element to the economic growth. Awokuse (2008) argues that agriculture still can be the engine of growth based on the causality direction from agriculture to economic growth. The study of the relationship between agriculture and economic growth among others are, Triffin and Irz (2006), and Valdes and Foster (2010). Katircioglu (2006) point out that there is appear a unidirectional causality from output and agriculture sector in the Northern Cyprus economy. Chebbi and Lachaal (2008) point out that the agriculture sector plays a limited role to the Tunisian economic growth in the short run. However, they found a stable relationship among non-agriculture sectors in the long run. Similar result by Houssem (2010) point out that all sectors i.e. agriculture, industrial and services sector, tend to move together in the long run.

With respect to the relationship between agricultural and industrial sectors, Hye (2009) finds that the agricultural sector plays a significant role in promoting modern sector to achieve economic development. The study estimates these two sectors in Pakistan by employing ARDL cointegration approach proposed by Pesaran et. al (2001) for the period of 1971 to 2007. He revealed that the sectors have a bidirectional relationship both in the short and long run. On the other hand, the industrial output only can influence the agricultural sector in the long run. Likewise, Subramaniam and Reed (2009) study the interlinkages among sectors by using Romania and Poland data.

The study employs cointegration analysis and point out that non-agriculture sector has a positive impact to the agriculture sector in both countries particularly in the long run. Conversely, short run relationship shows industrial sector causes negative effect to the output. They conclude that the Romanian and Polish industrial sectors can be a harmful to agriculture sector and this study suggests that agriculture sector, particularly in the Romanian economy, have contributed to the output of industrial sector. Another study by Seka (2009) point out that appear unidirectional granger causality from agriculture to industrial growth in the West African States. In India perspective, Chaudhuri and Rao (2004) find bidirectional causality between these sectors. Other study by Paul (2010) estimate the causality among services, industrial and agriculture sector for Indian data and find the existence a unidirectional relationship from industrial or services sector to agriculture output. The result supported the previous study by Koo and Lau (1997) which found that the Chinese agriculture growth output is depends on Industrial sector.

Meanwhile, there are numbers of studies on the causality linkages between agriculture and industrial sector. For example, Abdullah (1993) investigate VAR and Hsiao Granger causality for export-led growth in agriculture sector. Tang (2002) studies the cointegration relationship among manufacturing, services and agriculture sector in Malaysia from 1960 to 1998. Based on the result, he finds that the manufacturing sector has a little impact to the agriculture production in the short run.

On the other hand, the agriculture sector can influence the manufacturing production and negatively affect services sector. Other study by Muhamad and Tang (2003) examine the causality between agricultural output and its sources of growth. Furthermore, the papers did not explain the causality direction between agriculture and industrial sector production. As a sum, there still remains an inconclusive role by these two sectors either agriculture drives industrial sector or vice versa. The inconclusiveness may due to the different situation of a country. For example a country which focuses largely on industrial sector could give up their agriculture production and therefore give a negative impact to the agriculture production. Similarly, a country which focuses of industrial sector will also have to sacrifice the agriculture production.

However, there are still lacks of studies in Malaysia case for causality analysis between these sectors. Thus, the objective of this study is to investigate the consistency of causality direction between agriculture sector and industrial sector production in Malaysia. If there is a valid interlinkages between the sectors, policies to improve one sector could also improve the other sector. Moreover, this study is significant with the new Malaysian government policy whereby to achieve a high income country beyond 2020 through Economic Transformation Program (ETP)[1]. Under this new program, the government have outlined 12 key economic activities that could boost up growth, including industrial and to modernizing the agriculture sector. Therefore this paper may provide some useful information about the interlinkages between these sectors for the use of policy makers. The reminder of this study is organized with the following. Next section will be our discussion on the data and methodology in doing this study. The estimation results is discussed on the next section while conclusion at the final section.

2. Data and methodology

2.1 Data

Annual series data for Agricultural and industrial output gathered from World Bank data from 1970 to 2009. All data are in terms of value added; determined by International Standard Industrial Classification (ISIC) and we transformed into log function with year 2000 is referred as the based year price. Industrial sector is including the value added of mining, construction, water and gas, while agricultural sector is classified which including forestry, hunting and fishing, cultivation of crops, and livestock production.

2.2 Methodology

2.2.1 Unit root test

Prior to proceed the Granger-causality test, we employ unit root test to determine the order of cointegration, I(*d*). This procedure is generally applied to ensure that variables are stationary, otherwise we will having a spurious regression. It also indicates that if the variables have the same level of stationarity, there is exist a long run relationship between the variables. Nonetheless, most of time series data face a non-stationary problem. To deal with a non-stationary data, we will conduct three different methods for the determination of unit root, namely augmented Dickey-Fuller (1979) - ADF, Phillips-Perron (1988) - PP, and Kwiatkowski, Phillips, Schmidt and Shin (1992) - KPSS unit root test. A standard ADF test equation is shown by equation (1) below.

$$\Delta y_t = \alpha_1 + \delta y_{t-1} + \sum_{t=1}^{m} \gamma_i \Delta y_{t-1} + \sigma_t \qquad (1)$$

The dependent variable, y_t, is regressed with its own lags *m*. Δ is defined as the first different operator and σ is Gaussian white noise error term. The number of *m* is determined by Akaike Information Criteria (AIC). We will fail to reject the null hypothesis (H_0: $\gamma_i = 0$) if *y* is non-stationary. Alternatively, this paper also employ Phillips and Perron (PP) unit root test for a purpose of an alternative method in controlling for serial correlation when employing a unit root test. However, due to the lack of power when using the unit root methods mentioned above (see Campbell and Perron, 1991; DeJong et al., 1992), we apply KPSS unit root test which propose by Kwiatkowski et al. (1992) as shown in equation (2):

$$LM = \eta_\mu(\eta_\tau) = \frac{1}{s^2(k)T^2} \sum_{t=1}^{T} S_t^2 \qquad (2)$$

[1] The Government Transformation Program has been introduced by the Malaysian government to transform Malaysia into a high income country by the year 2020.

Where $S_t = \sum_{i=1}^{t} u_i$, u_t are residual from OLS regression of of y_t on the exogenous variables x_t . *k* represents a lag truncation parameter. The reported critical values for LM test are reported for KPSS (1992, table 1). The lag length is chosen based on an automatic selection which proposed by Newey and West (1994). If the calculated statistic is less than critical value from KPSS (1992, table 1), the variable is said to be stationary.

2.2.2 Co-integration analysis

The stationary process signals an existence of long run relationship among data. This paper will employ Johansen (1991, 1995) cointegration procedure because this approach is performing better than other cointegration tests (Gonzalo 1994). In conducting the Johansen cointegration test, we estimate the following model:

$$\Delta y_t = \Pi y_{t-1} + \sum_{t=1}^{p-1} \Gamma_t \Delta y_{t-1} + \upsilon_t \qquad (3)$$

Where $\Pi = \sum_{t=1}^{p} A_t - I$ and $\Gamma = -\sum_{j=i+1}^{p} A_t$. Δ is the first different operators, y_t is a vector of endogenous variables (our studies are consists $\ln Ag_t$ and $\ln Ind_t$) and υ_t is the error term. The matrix Π consists of long run information between y_t variables in the vector. We will examine the matrix rank, *r*, by testing the null hypothesis that the eigenvalues Π are statistically different from zero. Two set of statistics purposed by Johansen and Juselius (1990) which indicate the number of cointegrating rank, trace statistic; $LR(\lambda_{trace}) = -T\sum_{i=r+1}^{k} \ln(1-\lambda_i)$, and maximum likelihood statistics, $LR(\lambda_{\max}) = -T\ln(1-\lambda_{r+1})$. *T* is the number of observations, while λ_i are the estimated *p-r* smallest eigenvalues. The null hypothesis for $\lambda_{\max}$ is *r* of no cointegrating vectors against alternative hypothesis that *r*+1 cointegrating vector.

2.2.3 Granger-causality test

In order to determine the causality test, this paper employs Granger (1969) causality test for a short run causality direction, as shown in equation (4). Δ is the first difference operators which indicate that the variables are in the short run process, while μ_1 and μ_2 are white noise residuals. *F*-test is used for a restriction on the VAR parameters. It is said that if there is exist a causality direction between agriculture and industrial sector, the coefficient $\phi_{12,k}$ should be different from zero, that is, by rejecting the null hypothesis we accept that the agriculture sector has Granger-caused industrial sector. Similarly, if we reject H_0: $\phi_{21,k} = 0$; with no causality, we can conclude that the industrial sector is Granger-caused agriculture sector.

$$\begin{bmatrix} \Delta \ln AG_t \\ \Delta \ln IND_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11,1} & \phi_{12,1} \\ \phi_{21,1} & \phi_{22,1} \end{bmatrix} \times \begin{bmatrix} \Delta \ln AG_{t-1} \\ \Delta \ln IND_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \phi_{11,k} & \phi_{12,k} \\ \phi_{21,k} & \phi_{22,k} \end{bmatrix} \times \begin{bmatrix} \Delta \ln AG_{t-k} \\ \Delta \ln IND_{t-k} \end{bmatrix} + \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} \qquad (4)$$

For the long run causality investigation, we employ causality test which purposed by Toda and Yamamoto (1995). This method has been widely applied by several empirical studies, among others by Tang (2008), Magnus and Fosu (2008), and Taban (2010). There are several reasons in using this method. Following Zapata and Rambaldi (1997), to test a causality direction does not need to transform a VAR system into error correction model (ECM). Therefore, without testing the level of cointegration we still can accept the result for the long run causality direction. Furthermore, according to Tang (2008), apart from its simplicity in using this approach, the use of modified WALD test may reduce the likelihood of making wrong decision on the orders of integration and cointegration. The augmented VAR system can be shown on the equation (5).

$$\begin{bmatrix} \ln AG_t \\ \ln IND_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} \\ \beta_{21,1} & \beta_{22,1} \end{bmatrix} \times \begin{bmatrix} \ln AG_{t-1} \\ \ln IND_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} \beta_{11,k} & \beta_{12,k} \\ \beta_{21,k} & \beta_{22,k} \end{bmatrix} \times \begin{bmatrix} \ln AG_t \\ \ln IND_t \end{bmatrix} + \begin{bmatrix} \beta_{11,p} & \beta_{12,p} \\ \beta_{21,p} & \beta_{22,p} \end{bmatrix} \times \begin{bmatrix} \ln AG_{t-p} \\ \ln IND_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \qquad (5)$$

k is the optimal lag order. The optimal lag *k* is determined by using Schwartz Bayesian (SBC), *d* is the maximal order of integration of the variables which determined by ($k+d_{max}$). e_t and ε_t are the error terms which we assumed follow the *i.i.d* criterion. The *F*-statistic is used to indicate the presence of causality relation. From equation (5), the hypothesis testing for non-granger causality is H_0: β_{12j} =0; industrial does not granger cause agricultural sectors, against H_1: $\beta_{12j} \neq 0$; industrial does granger cause agricultural sectors. Similarly, the hypothesis testing for H_0: $\beta_{22j} = 0$; agricultural does not granger cause industrial sectors, against H_1: $\beta_{12j} \neq 0$; agricultural does granger cause industrial sectors. Two steps involve in this methods. First step is to determine the optimal *k* lag(s) order from the original VAR model. We mentioned earlier that the optimal lag *k* is determined by using Schwartz Bayesian (SBC) and the next step is to employ a conventional Wald statistic by using seemingly unrelated regression (SUR) model as proposed by Rambaldi and Doran (1996) because it can increase the efficiency when doing Granger non causality.

3. Result and analysis

3.1 unit root tests

In order to determine the maximal order of *d*, this paper conduct a standard augmented Dickey-Fuller (ADF) test and Phillips-Perron test to indicate the stationarity of the variables. Based on table (1), we fail to reject the null hypothesis of nonstationary and suggest that both variables are not cointegrated at level. At first difference, all the variables are stationary at 5 percent significant level as we reject the null hypothesis of nonstationary. Thus, both variables are cointegrated at order one, *I*(1). The ADF and PP results show consistency with KPSS approach. By rejecting both variables at level, we conclude that agricultural and industrial sector are non-stationary at 5 per cent level. After taking the first difference, we fail to reject the null hypothesis and so both variables are stationary. Therefore, the maximum lag order, *d*, of the study is 1.

Table 1: Augmented Dickey-Fuller and Philip-Perron unit root test

Variables	ADF	Philip-perron	KSPP
Level			
ln Ag	-2.025910	-6.125592	0.757741*
Ln Ind	-1.000279	-1.103812	0.774934*
First difference			
ΔlnAg	-6.075595*	-6.125592*	0.331059
ΔlnInd	-5.319133*	-5.766092*	0.157977

Source: * indicate a rejection region at 5 per cents significant level.

3.2 Johansen cointegration test

The next step is to determine the number of lag of the VAR (*k*) from this model by using SBC. Table (2) suggests the appropriate lag length is 1 while AIC indicate the lag length is 3. However, similar to Tang (2008) that this causality analysis are sensitive due to small sample size, lower lags could preserve some degree of freedom for the estimators.

Table 2: Lag selection

Lag order	LL	AIC	SBC
3	139.3428	127.3428*	117.6773
2	133.4051	125.4051	118.9614
1	130.2045	126.2045	122.9827*
0	-199.0945	-199.0945	-199.0945

Note: LL = log likelihood, AIC = Akaike Information Criterion, SBC = Schwartz Bayesian , * denotes a chosen lag based on AIC and SBC.

We then perform cointegration test using Johansen Maximum likelihood test. Results are shown on table (3). Based on the result, both trace and max eigenvalue is rejected at 5 per cent level that is at least one vector is cointegrated. This indicates that the agriculture sector and industrial sector have a long run relationship at least 1 rank. Therefore, in order to determine the direction of causality, modified Wald test and granger causality test were being employed.

Table 3: Unrestricted Cointegration rank test

Null	Alternative	Statistic	Max eigenvalue 95% critical value	Trace stat 95% critical value
r = 0	r = 1	30.0667	19.2200	25.7700*
r ≤ 1	r = 2	7.3193	12.3900	12.3900

Source: * indicate a rejection region at 5 percent significant level.

3.3 Granger causality test

Having determined the number of lags, we then estimate the following model for Granger-causality and MWALD test respectively. The optimal lag is VAR($d_{max} + k = 2$), we estimate equation (5) and (6) by using SUR technique as shown below:

Table 4: Granger causality test and MWALD test results

Null hypothesis	Granger causality		MWALD test	
	F-stat	*p-value*	χ^2	*p-value*
lnAg does not granger causes lnInd	2.14407	0.1337	2.291945	0.3179
lnInd does not granger causes lnAg	2.51124**	0.0970	7.985455*	0.0184

Note: * and ** denote are significant at 1 and 5 per cents significant level, respectively. The optimal lag order is determined by using BIC. The opimal lag is VAR($d_{max} + k = 2$)

We conclude the Granger causality test as reported in table (4). For the short run Granger causality test, the null hypothesis of agricultural does not granger causes industrial sectors is fail to reject at 5 percent significant level. However, we reject null hypothesis for causality of industrial causes agricultural sectors at 10 per cent significant level. This result indicates that in the short run, there is a unidirectional causality running from industrial to agricultural sector. We then employed the modified Wald test for the long run direction causality between the sectors. Firstly, the direction from agricultural does not granger causes industrial sectors because we do not reject the null hypothesis, which suggest there is no reason that agricultural can influence industrial sectors. On the other hand, the granger modified Wald causality test indicates the rejection of null hypothesis that industrial sector does not granger causes agriculture sector at 5 percent significant level. It can be concluded that industrial sector can influence agricultural sector in the long run. Based on the result, we suggest that there is a unidirectional causality running from industrial to agriculture sectors for both in the short and long run.

4. Conclusion

This paper aims to investigate a causal direction between agricultural and industrial sectors in Malaysia. In order to achieve a high income status, Malaysian economy has been focusing more on the industrial sector to boost up faster growth. However, recent policy under the ETP whereby reinforcing the agriculture sector as the third engine of growth show the commitment of the Malaysian's government to revitalize this sector contribution. The existing literatures still lack of studies on the bivariate causality between these two main sectors, particularly in Malaysia. We employ two series of annual value-added output data range 1970 to 2009 from the World Bank Data to examine the agriculture-industrial nexus and find the following results; [1] Unit root tests clearly show the variables are stationary at first differencing, and [2] Granger (1969) and Toda-Yamamoto (1995) type causality tests show a unidirectional causality from industrial to agricultural sectors both in the short and long run. This result shows a consistency with Johansen (1992) cointegration that at least one cointegration relationship exists. Our result contrast with the previous studies by Hye (2009), Subramaniam and Reed (2009), Seka (2009), Chaudhuri and Rao (2004) which early explain the existence of a bidirectional causality between these sectors. In the case of Malaysia, the agricultural sector could be one of the engines of economic growth.

However, to improve the contribution of this so-called traditional sector, it needs the industrial sector to improve the quality of production. As far as the policy implication as concerned, industrializing the agricultural sector with more modern technologies and highly trained labors should be looking into consideration by the government policies. New sub-industries, such as bio-technology could be the answer on how the agricultural sector could contribute to the Malaysian GDP growth. Hence, these two sectors could be the catalyst to achieve the government's new ETP programme in achieving a high income country.

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