The Relationship between Agribusiness Development and Agricultural Growth: Time Series Data from PR China

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ABSTRACT

The major contribution of the agricultural sector to the growth of the Chinese economy can be linked to the sector's effective linkage with the agro-industries. The sector still plays a critical role in promoting the world's agricultural trade in the area of cereal production, meat production, and vegetable production. However, the current ranking of China as the major exporter of agricultural products is attributed to the long-term historical development of agriculture and agribusiness sector. The study investigates empirically the effect, the existence and direction of causal relationship between agribusiness development and agricultural growth in China by adopting granger causality test and quantile regression approach. The results of the study reveal the existence of bi-directional Granger causality running from agricultural growth to agribusiness development. The quantile regression results reveal a positive and statistically significant effect of agribusiness development on the growth of the Chinese agricultural sector. The quantile plot further gives the graphical interpretation of the relationship between agribusiness growth and agricultural development.

Keywords: Agricultural Growth; Agribusiness Development; Granger causality; Quantile regression; China.

INTRODUCTION

The role of agriculture in sustainable development and poverty reduction for the vast majority of developing and most developed countries has been the interest of many researchers (Pretty, Morison, & Hine, 2003). According to the World Bank report, forty-five percent of the developing world’s population lives in households involved in agriculture and 27 percent in smallholder households. However, out of about one billion people worldwide living in the stream poverty, most of these people depend on agriculture for their livelihoods.
Agricultural sector plays a critical role in poverty reduction in most of the less developed countries in Sub-Saharan Africa and Asia (Ellis & Biggs, 2001; Randolph et al., 2007). The sector, moreover, generates about 29 percent of gross domestic product (GDP) and employs 65 percent of the labor force in agrarian-based economies. Meanwhile, the demand for major agricultural products across the globe is increasing tremendously due to higher population growth, an increase in consumer incomes and dietary changes. According to UN statistics, between 1980 and 2000, the global population rose from 4.4 billion to 6.1 billion, which expected food production to increase by 50 percent in 2050. This is due to the fact that the world's population is expected to hit over nine billion. Experts say agricultural production needs to increase in the next '40 years to meet the rising demand for food. This has called for a steady increased in agricultural production through high productivity. The incidence of food shortages, which occurred in 2007 and 2008, drew the attention of many stakeholders, more especially in the agrarian economies to take the matter of food security more serious. The global demand for agricultural products, however, compelled the World Bank and International Finance Corporation (IFC) to increase the investment in agrarian economies to develop the agricultural sector and promote agribusiness growth.

World Bank, moreover, reports that the investment in agriculture from 2008 to 2009 increased about three hundred percent of the previous years, which was accompanied by a reduction in analytical work. These financial interventions provided by the World Bank and International Finance Corporation (IFC) in the agricultural sector helped in poverty reduction by increasing the income level of the smallholder farmers. However, to increase agricultural productivity growth through agribusiness development, there is the need to embark on effective national policies and programs to strengthen the local agribusinesses through the provision of technical support and capacity building (Olowa & Olowa, 2015). For example, most of the countries in Sub-Saharan African and India are introducing numerous policies to promote agricultural growth and sustainable agribusiness development. To increase food production and meet food demand in China and the world at large there is the need to boost agricultural productivity growth along value chains and to equip small holder farmers with the needed skills and tools to integrate themselves into supply chains, to achieve food security and emergency preparedness, growth in incomes, the availability of the market, effective land system, application of science and technology and enhanced institutional coordination.

Since the 1978 economic reforms in China, the agricultural sector has played a pivotal role in developing the socioeconomic aspects of the economy. Currently, China is seen as the major importer and exporter of agricultural products. With the population of about 1.4 billion and about 10 percent of arable land, China feeds about 20 percent of the worldwide population. Aside from food production, Chinese agricultural sector employs about 300 million farmers. However, due to the increasing role of agriculture, the agribusiness sector has become a crucial stake for both local and foreign development (Liu & Yeh, 2015; Pigato & Tang, 2015).

According to U.S Department of Agriculture, agricultural productivity growth in China outweighed that of the United States due to proper institutional and technological policies put in place to increase food production as at 2015. However, between the period of 1961 and 2013, China increased the total agricultural productivity by three times, while the United States little more than doubled its productivity during the same period. After joining the World Trade Organization in 2001, the contribution of Chinese agriculture to world agricultural trade has experienced a rapid increase. The sector plays a critical role in promoting world’s largest agricultural trade in terms of cereal production, meat production, and vegetable production.

Studies have reported that after the China’s WTO accession, the agricultural products exported to China from United State increased from $2 billion to $5 billion in 2005(Gale et al., 2015; Willer & Lernoud, 2016). Before the commencement of the "trade war" by the US government in July, 2018 the two nations had strengthened their economic ties and had become strong key trading partners in the areas of agriculture and manufacturing. From 2012-2013, United State exported an average of $25.9 billion agricultural products to China, which recorded ten times increased in the late 1990s. Moreover, the share of United State agricultural exports from China increased from 2 to 3 percent during the 1990s to 18 percent during 2012-13, which has made China to become the largest overseas market for U.S. farm products (Gale et al., 2015).

The agricultural sector is one of the vital industries in China, contributing to socio-economic development in terms of job creation, food provision and GDP growth (Liu & Yeh, 2015). Although its share in Gross Domestic Product (GDP) is declining due to rapid development in the industrial sector, agriculture
still serves as the basis for stabilizing national economic development and an industry for solving the problem of rural unemployment and disparities in farmer’s income in China (Gale et al., 2015). However, empirical evidence remains largely scanty, isolated and devoid of an in-depth analysis of agribusiness development and agricultural growth in mainland China. This creates a great lacuna in agribusiness literature and this study seeks to fill it. The large body of literature that examined the causes of agricultural productivity growth in China attributed the growth to the widely used of agricultural inputs (Razavi, 2016; Tan, Heerink, & Qu, 2006). A study conducted maintained that the output elasticity with respect to land is generally higher despite the relative scarcity of land resource in China (Yu & Zhao, 2009). Regarding the use of physical inputs, (Lin, 1992) disclosed that between the period of 1965 and 1993, agricultural productivity growth was due to increased in fertilizer application and irrigation. Furthermore, the study conducted by X. Zhang and Fan (2001) from 1980 to 1990, Fan and Pardey (1997) 1865 to 1993 and Nin-Pratt, Yu, and Fan (2010) concluded that the productivity growth in China during and after the reform periods was due to the institutional reforms that took place.

The main goal of this study is to investigate empirically the existence and direction of causal relationship between agribusiness development and agricultural growth in China and to measure the impact of agribusiness on agricultural growth at the various quantile distributions. Such knowledge can play a significant role from the policy formulation point of view. If, for example, there exists unidirectional Granger causality running from agricultural growth to agribusiness development, it may be implied that effective and efficient agribusiness policies may be implemented to boost agricultural growth in future. On the other hand, if unidirectional causality runs from agribusiness development to agricultural growth, ensuring the growth and survival agro-industries at the international market could increase agricultural growth.

The rest of the paper is organized as follows. Section 2 looks at materials and methods. Section 3 presents results and discussion. Section 4 discusses the conclusion of the study.

MATERIALS AND METHODS

The study adopted the widely used Engle-Granger methodology developed by (1987). In addition, Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) test of stationarity proposed by (1981) and (1988) were also adopted. According to (1987), if both X and Y are non-stationary, it is presumed that a linear equation of X and Y is random stop. However, if X and Y (i.e. integrated of one order) and cointegrated there would be causal relationship at least one direction(Abbes, Mostéfa, Seghir, & Zakarya, 2015; Ghosh, 2002). According to (2002), the presence of cointegration reject any classical spurious correlation effect among X and Y variables. However, the study employed the Vector Error Correction Mechanism to detect the direction of causality that runs through the variables, that standard Granger fails to consider. Moreover, the Vector Autoregression (VAR) models of long-term cointegrating vectors can be easily detect the direction of causality. Further, Granger Representation theorem tries to disclose how to model cointegrated I (1) series in a VAR format. Normally, either the construction of VAR is in terms of the levels of the data or in terms their first differences, with additional error correction term (ECM) to capture the short-term dynamics. If the variables are I (1) but not cointegrated, causality test may give overestimated or underestimated results unless the data are transformed to induce stationarity. As reported by Ghosh (2002), the causality test is determined by following the three stages, which have defined as follows; The first stage involves testing for the order of integration with the data in natural logarithm form using Augmented Dickey-Fuller (ADF) statistics and Philips-Perron (PP) test. Conditional on the results of the test, the stage two involves investigating bivariate cointegration using VAR mechanism of Johansen maximum likelihood approach, see (Oxley & Greasley, 1998). The third stage (or the second if bivariate cointegration is rejected) involves constructing standard Granger-type causality tests, augmented where appropriate with a lagged error-correction term. For testing causality, the three-stage procedure leads to three alternative approaches.

In the case of cointegrated variables Granger causality tests may use I (1) series because of the super-consistency properties of estimation, with two variables, agricultural growth (GAP) and agribusiness development (AGB). Following Ghosh (2002), the study propose the this model:

\[ AGB_t = \gamma + \sum_{i=1}^{I} \delta_i AGB_{t-i} + \sum_{j=1}^{J} \beta_j GAP_{t-j} + \varepsilon_t. \]

(1)
$GAP_t = \alpha + \sum_{i=1}^{w} \Omega_i GAP_{t-i} + \sum_{j=1}^{p} \sigma_j AGB_{t-j} + \mu_t.$

(2)

Where $\epsilon_t$ and $\mu_t$ are zero-mean, serially uncorrelated, random disturbances, and the lag lengths $s, v, w$ and $p$ are assigned on the basis of minimizing Akaike’s Final Prediction Error (FFP), following (Oxley & Greasley, 1998).

Secondly, Granger causality test cointegrated variables may utilize the I (0) data, including error-correction term i.e.

$\Delta AGB_t = \gamma + \sum_{i=1}^{w} \delta_i AGB_{t-i} + \sum_{j=1}^{p} \beta_j \Delta GAP_{t-j} + \Phi_{ECM} + \epsilon_t.$

(3)

$\Delta GAP_t = \alpha + \sum_{i=1}^{w} \Omega_i GAP_{t-i} + \sum_{j=1}^{p} \sigma_j AGB_{t-j} + d_{ECM} + \mu_t.$

(4)

Where the error-correction term is denoted ECM. Thirdly, if the data are I (1) but not cointegrated, Granger-type tests require transformations to induce I (1). However, the equation is represented as

$\Delta AGB_t = \gamma + \sum_{i=1}^{w} \delta_i AGB_{t-i} + \sum_{j=1}^{p} \beta_j \Delta GAP_{t-j} + \epsilon_t.$

(5)

$\Delta GAP_t = \alpha + \sum_{i=1}^{w} \Omega_i GAP_{t-i} + \sum_{j=1}^{p} \sigma_j AGB_{t-j} + \mu_t.$

(6)

With optimal lag lengths determined by minimizing Akaike’s (AIC) and or Schwarz Bayesian (SBC) and log-likelihood ratio test (LR) criterion.

The Granger causality tests based on Eq. (1) and Eq. (2) involve the following:

$\Delta AGB$ Granger causes (GC), AGB if,

$H_0 : \beta_1 = \beta_2 = \beta_3 = \ldots = \beta_n = 0$ is rejected against

$H_1 := \text{at least one } \beta_j \neq 0, j = 1, \ldots, v$ and

AGB Granger Cause (GC) $\Delta GAP$ if,

$H_0 : \sigma_1 = \sigma_2 = \sigma_3 = \ldots = \sigma_n = 0$ is rejected against the alternative

$H_1 := \text{at least one } \sigma_j \neq 0, j = 1, \ldots, p$

For Eq. (3) and (4), $\Delta GAP$ GC $\Delta GAP$ if,

$H_0 : \beta_1 = \beta_2 = \beta_3 = \ldots = \beta_n = 0$ is rejected against

$H_1 := \text{at least one } \beta_j \neq 0, j = 1, \ldots, v,$ or $\Phi \neq 0$ and

$\Delta AGB$ Granger Cause (GC) $\Delta GAP$ if,

$H_0 : \sigma_1 = \sigma_2 = \sigma_3 = \ldots = \sigma_v = 0$ is rejected against

$H_1 := \text{at least one } \sigma_j \neq 0, j = 1, \ldots, p,$ or $d \neq 0$

For Eq. (5) and (6), $\Delta GAP$ GC $\Delta AGB$ if,

$H_0 : \beta_1 = \beta_2 = \beta_3 = \ldots = \beta_n = 0$ is rejected against

$H_1 := \text{at least one } \beta_j \neq 0, j = 1, \ldots, v,$ and

$\Delta AGB$ Granger Cause (GC) $\Delta GAP$ if,

$H_0 : \sigma_1 = \sigma_2 = \sigma_3 = \ldots = \sigma_v = 0$ is rejected against

$H_1 := \text{at least one } \sigma_j \neq 0, j = 1, \ldots, p,$ and

The study also employed quantile graph to show the elasticity of the agricultural with respect to the fertilizer input over the selected quantiles. According to (2013), quantile regression is an appropriate tool to model conditional quantiles of the joint distribution of $x$ and $y$. The quantile regression model firstly introduced by (1978) is presented as follows;

Let $\hat{y}(x)$ be the prediction function and $\varepsilon(x) = y - \hat{y}(x)$ be the prediction error.

Therefore, $L(\varepsilon(x)) = L(y - \hat{y}(x))$, denoting the losses in the prediction error. However, if $L(\varepsilon) = \varepsilon^2$ signifies the availability of squared error loss the least square becomes the optimal predictor. Med $(y/x)$ ad the optimal prediction changes to $\hat{\Phi}$, which causes reduction of $\sum_{i} |y_i - \chi_i \Phi |$. Since the squared-error and absolute –error loss function becomes asymmetric; the prediction error sign becomes irrelevant (Koenker, 2004). However, if $q$ is not 0.5, it means asymmetry increased as $q$ get closer to either 0 or 1.

This study adopts the specifications of the previous literature on quantile regression. The conditional quantiles function for quantile $\tau$ firstly introduced by Koenker and Bassett Jr (1978) can be written as;

$Q(\Phi_q) = \sum_{i:y_i > x_i \Phi} q |y_i - x_i \Phi | + \sum_{i:y_i < x_i \Phi} (1-q) |y_i - x_i \Phi |

(7)$

Where $q$ is the chosen quantile and $\Phi$ is the vector of parameters to be estimated.

The data set of agribusiness development consists of a country-data from the period of 1985 to 2015 obtained from China Statistical Yearbook, various issues, 2016. Agribusiness performance (AGB) is measured by total profit of agro-industries in rural China within the study period. Moreover, agricultural growth (GAP) is measured by agriculture contributions to the national GDP, which is obtained from World Bank Data on China, 2017.

Results and Discussion

We investigated into the first order of integration of the time series data. Table 1 presents the results of ADF and PP test on the natural logarithms of the levels and first differences of the two time series, that is, agribusiness development and agricultural growth. According to the results of ADF & PP statistics, the null hypothesis of the unit roots cannot be rejected. Stationarity is only obtaining by running the same test on the first difference of the variables. This means that both series \( I(1) \).

Table 1: Results of unit root tests

The second stage of the analysis presents Johansen maximum likelihood procedure to detect cointegration, table 3. This helps to get a unified model to estimate and test cointegration relations in the context of a VAR error correction model. We test the cointegration rank, \( n \), of the time series using two test statistics.

Representing the number of cointegrating vectors by \( n_0 \), the maximum eigenvalue (\( \lambda_{\text{max}} \)) test is calculated under the null hypothesis that \( n_0 = n \), against the alternative of \( n_0 > n \). We calculate the trace statistics under the null hypothesis that \( n_0 \leq n \), against \( n_0 > n \).

Table 3, presents the results of the Johansen maximum likelihood cointegration tests. The study revealed that with the null hypothesis of no cointegration, between agribusiness development and agricultural growth, that is, \( n = 0 \), the maximal eigenvalue statistics is 12.264, which is less than the 95 percent critical value of 15.357. The results from the trace test as presented in table 3, shows that the null hypothesis of the absence of cointegration is not rejected at 5 percent significance level. This shows that both the eigenvalue (\( \lambda_{\text{max}} \)) and trace statistics show no cointegration relationship between \( \Delta \text{LGAP} \) and \( \Delta \text{LAGB} \). The correct order of VAR selection, also support the absence of residual serial correlation in the series.

Table 2: Optimal Lag Selection Criterion

Table 3: Results from Johansen’s maximum likelihood co-integration test

Notes: Trace test indicates 1 cointegrating eqn. (s) at 0.05 level.*Denotes rejecting of the hypothesis at 0.05 level

Finally, we study Granger causality Test to the bivariate VAR. While testing the non-causality between \( \Delta \text{LGAP} \) and \( \Delta \text{LAGB} \), the observed statistics revealed a statistically significant Ch-square of 5.053 and 2.342 (follow chi-square distribution with one degree of freedom)

Table 4: Results of Granger-causality test

This establishes the presence of bi-directional (feedback hypothesis) for the case in China. This implies that increase in the growth of agribusiness
leads to the increase in agricultural productivity growth and the vice versa. Since there is bi-directional causality between the variables, the study measured the possible effects of agribusiness on the growth of Chinese agriculture within the study period.

Table 5: OLS and Quantile Regression Results

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>LAG</th>
<th>Intercept</th>
<th>CH-SQ(λ)</th>
<th>P*-VALUE</th>
<th>CH-SQ(λ)</th>
<th>P*-VALUE</th>
<th>DoF</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAP</td>
<td>2.342</td>
<td>0.0034</td>
<td>5.053</td>
<td>0.0554</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Statistical significance at 10%, **Statistical significance at 5%, ***Statistical significance at 1%.

The study compared the OLS and quantile regression coefficients by adopting quantile plots and measured the deviations in the asymmetric quantile coefficients. The results of the study revealed sharp variations of the quantile coefficients at the various quantile points, from the OLS mean effect estimates. According to OLS regression estimate from table 5, the effect of agribusiness on agricultural growth is found positively insignificant during the study period. However, the study disclosed some interesting results from the quantile regression estimates. The quantile regression results, further revealed that the estimated coefficients of agribusiness on agricultural growth is positively significant at the 20th and 40th quantiles of the growth distribution. For example, the effect of agribusiness development on agricultural growth recorded 35% at the OLS estimate, which is quite lower as compare to the various quantile points results. That is a percentage increased in the growth of the agribusiness sector within the study period increased the growth in the agricultural sector by 35%, all things being equal. At 20th quantile of the growth distribution, a percentage increase in agribusiness growth contributed about 61% to agricultural growth, moreover, the increase in agribusiness growth had about 63% and 26% on the growth of agricultural production at the 40th and 60th quantile of the growth distribution. Surprisingly, the 60th quantile of the growth distribution had highest effect by increasing agricultural growth by 95% within the study period.

![Figure 1: The Effects of Agribusiness Performance (AGB) on Agricultural Growth (GAP): OLS versus Quantile Regression.](image-url)

Notes: The dashed lines represent OLS parameter estimate, and the dark shaded areas are the confidence intervals for the estimation of quantile regression parameters. OLS estimates represented by the horizontal lines with confident intervals.

Source: Authors construct

From figure 1, the impact of agribusiness performance partly deviates from the OLS estimates across the conditional distribution; however, the graphical results of the quantile regression reveal some inconsistencies between OLS and quantile coefficients.

CONCLUSION

The Chinese economy with the population growing at the rate of 0.59% as at 2015 and the increasing demand for food has been a major challenge. However, the government overreaching approach to safeguard agricultural development since 1990 paved way to the introduction mechanized small-scale farming, which increased the output growth of agro-industries in China. Through this amendment, the central government of China adopted the replacement of local markets with contract farming and focused on dispersing production with consolidation. The government’s goal to develop the agribusiness sector to boost food production led to the appointment of agribusiness firms called dragonhead enterprises (‘DHEs’) as heads to ensure modernization and industrialization of the agricultural sector and to support enterprises to support farm entrepreneurs. The increasing demand for food considering the rapid increase in population growth, which resulted in the numerous policies introduced by the central government have played a significant role in promoting food security in China. For example, the introduction of Household Responsibility System (HRS), the institution of a new land system, the
provision of agricultural insurance to the farmers and the increase in procurement prices of some agricultural products have increased both farmer's income and agricultural growth significantly. Moreover, according to the ministry of agriculture, the agricultural reclamation economy in 2013 generated a total output value of 593.755 billion Yuan, with an increase of 12.8 percent over the previous years.

This paper investigated the existence and direction of Granger causality between agribusiness development and agricultural economic growth in China using time series data from 1985 to 2015. We further adopted the quantile regression approach to analyze the impact of agribusiness development on agricultural growth in the entire distribution of the sample, rather than just the conditional mean. The results of the study revealed the presence of bi-directional causality (feedback effect) for the case in China. This implies that the development of agribusiness sector leads to increase agricultural growth and the vice versa. Moreover, the quantile regression results revealed that the influence of agribusiness development of agriculture growth varies along the growth distribution, with its having a larger impact on agricultural growth at the middle of the distribution as compare to the lower and upper ends of the distribution.

In these circumstances, the existence of bi-directional causality running from agricultural growth in agribusiness performance in mainland China has policy implications for decision-makers as the development of agribusiness sector positively affect agricultural growth and the vice-versa.

REFERENCES


