

# Selected Factors Affecting the Subsectors of the Philippine Agriculture: A Panel Regression Analysis

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## Abstract

The study examined the effects of exports to Gross Domestic Product (GDP), employment, and production loans granted in the GDP agriculture of the Philippines. This paper employed descriptive and quantitative techniques to analyze the behavior of GDP, production loans granted (PLG), exports to GDP (EGDP), and employment (EMP) from 2005 to 2015 totalling 33 observations of agriculture, forestry, and fishery sectors. Specifically, panel data analysis was used to assess the effects of APLG, EMP,  $GDP_{t-1}$  and  $AEGDP_{t-1}$  in GDP. The fixed effect model corrected from autocorrelation and heteroscedasticity, a one percentage unit increase in the exports to GDP, on the average, leads to Php 774.96 increase in the GDP, other things equal; and a one-unit increase in employment, on the average, leads to Php23.55 increase in the GDP, other things equal; a one peso increase in the production loans granted lagged by one period, on the average, leads to Php 0.4760 increase in the GDP, other things equal. Using the fixed effect model, all the explanatory variables such as, exports to GDP, employment and production loans granted lagged by one period exhibited significant effect on the GDP agriculture. Hence, the model is considered satisfactory from statistical perspective. The results from the fixed effect model were consistent with the priori expectations that exports to GDP, employment and production loans granted lagged by one period positively affect the GDP agriculture.

**Keywords:** *agriculture, GDP, exports, production loans, employment*

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## 1. Introduction

Agriculture is the art and science of managing plant and animal growth for human use. It includes farming and all its branches such as soil cultivation or tillage, production, planting, and harvesting of all agriculture and horticulture products, rearing of animals and poultry, dairy and practices performed out by the farmer on a farm as an incident to or in conjunction with such farms. It also includes forestry and logging operations but excludes the manufacture or processing of farm products.

The Philippines is generally an agricultural country notwithstanding its attempt to make it an industrialized nation in 2000. According to the Philippine Department of Agriculture (DA), the Philippines is an agriculture country with a land area of 300,000 km<sup>2</sup>, 47 percent of it is comprised of agricultural land. The key agricultural lands are clustered around large urban areas with high population density. The agricultural sector of the country is divided into farming, fisheries, livestock/poultry, and forestry. The major agriculture crops are coconut, rice, bananas, corn, coffee, sugarcane, pineapple, mangoes, tobacco, and abaca. Based on the World Bank data, the contribution of agriculture in Philippine GDP from 1960 to 2016 has an average value of 21 percent with the lowest of 10 percent in 2016 and the highest of 31 percent in 1974.

The country is also the second largest archipelagic state and one of the largest fishing countries in the world. In 2012, with a production of 3 million tons of fish, mollusks, crustaceans and other marine animals, the Philippines topped the global major fish producing countries. Aquaculture contributed to total fish production by 790 900 tons, or 25.4 percent. Most of its output is locally consumed with a consumption of 33 kg per caput of fish in 2011. Furthermore, in 2012, the Philippines is the third largest farmed seaweed producer with a production of 1.8 million tons. An estimated 1.5 million people were employed by the fisheries and aquaculture industry nationwide in 2010, with fisheries accounting for over 1 million. The fishing industry is contributing an estimated 1.24% (priced at 223 billion pesos) to the current prices of the Gross Domestic Product (GDP), respectively in 2020. Based on Food and Agriculture Organization 2014 report, the fish and fishery products exports were valued at USD 1.2 billion in 2013. Tuna was the top commodity for export, followed by prawns and shrimps.

The forests of the country are exceptional. It is composed of thousands of plants and animals from tree forests of the mountains to mangrove forests of coastal areas. The variety of the forest is rich, it spans from about 1,200 types of mammals, birds, amphibians, and reptiles, while at least 8,900 species of trees, plants, orchids, and shrubs are known. According to the Department of Environment and Natural Resources, at least 46 percent of the fauna and 39 percent of the flora are native. Thirty percent of the Philippine population utilizes the forest and its resources for the livelihood and needs of the people. Forests serve as shield and can pacify the intensity of storm waves. For instance, 100-meter thick mangrove forest can reduce 66 percent of the strength storm waves, thus saving the lives of coastal barangays. Based on the 2020 Philippine Forestry Statistics, the forest cover of the Philippine is around 23.38 percent. The country has lost about 100 thousand square kilometers of forest from 1934 to 1988. The destruction of forests results in several problems such as landslide, flash floods and siltation in water bodies, low fertility of the soil and water quality, and minimal number of watersheds. Forests are also very important during climate change. The planting of trees also reduces atmospheric carbon dioxide and reduces the possibility of climate-related disasters such as storms and drainage.

The government has acknowledged the decreasing contribution of the agricultural sector in the country's GDP, from fourteen percent (14%) GDP share in 2000 to eight percent (8%) GDP share in 2018. This is primarily due to extreme natural disaster, infestation of the pests and lack of high-quality of crops at the end of the harvest. The maximization of land potential is prevented because of limited diversification of agricultural product such as rice, corn, and sugarcane. Issues such as lack of irrigation, limited access to financial institutions, outdated farm machineries and scarce post-harvest facilities, ageing farmers, among others have also been recognized.

With the government's efforts to address the problems of agriculture sector, the Philippine Development Plan 2017-2022 will secure the sustainability of its endeavor to enhance the productivity and continuously build the capacity of its stakeholders. Some of the development plan strategies are to improve productivity within ecological limit, increase agriculture-based enterprises, access to technology, financial inclusion, and ensure and protect land tenure security of agrarian reform beneficiaries.

This study is an attempt to analyze the behavior Philippine agriculture output along with selected exploratory or independent variables such as, exports to GDP, employment, and production loans granted across the different sectors of agriculture for the period of 2005 to 2015. Specifically, this study finds answers to the following research questions:

1. Is there a significant correlation among exports to GDP ratio, employment, production loans granted, and agricultural output?
2. Do production loans granted, exports to GDP ratio, employment significantly affect the agricultural output, when taken individually and collectively?
3. Is the effect of the explanatory variables mediated by the differences across agricultural subsectors?
4. Do the subsector differences significantly affect the agricultural output?
5. What is the appropriate panel regression model to be used as model for Agricultural Output?

## **2. Literature review**

### ***2.1. Theoretical framework***

***Production Theory Basics.*** The main concept of production is to transform the resources into capital goods. Production, storage, shipping, and packaging can be included. Economists broadly describe production as something other than consumption economic activity. Any commercial activity other than the final purchase is considered a form of production. The production process is carried out in time and space. It is a concept of flow that determined by means of output rate per time. The production process covers three aspects: the quantity of the produced commodity, the quality of the produced commodity, and the temporal and spatial distribution of the produced commodity. Any activity which increases the similarity between the demand pattern for products and the quantity, forms and distribution of such goods on the market can be described as a process of production.

Economists refer to the resources or inputs used for the production process as production factors. Various potential inputs are typically grouped into four or five categories such as commodities (natural capital), labor (human capital), capital goods and land. The fifth category that is the managerial and entrepreneurial skills is added considering that it is a subcategory of labor services. Capital goods are those goods that have previously go through a production

process. Other authors considered technology as factor of production process. Management can adjust all these factors in the long-term production. However, the short-term production usually consider at least one factor of production must be permanent. Fixed production factor is a factor whose amount cannot easily change such as large equipment, such as suitable production areas, and key management personnel. Variable production factors are factors whose level of use can be easily changed like consumption of agricultural products, transportation services and most raw materials. In the short-term production, the company's business scope determines how many products can be maximally produced. In the long-term production, there is no limitation in the scale.

***Cobb-Douglas Production Theory.*** The functional form of the Cobb-Douglas production function is often used in the business world to define the relation between output and input. On the advice of Knut Wickel (1851-1926), Charles Cobb and Paul Douglas tested 1928 for statistical evidence.

In 1928, Charles Cobb and Paul Douglas published a report in which they influenced American economic development during the period from 1899 to 1922. They examined a simplistic view of the economy, wherein production efficiency is calculated by the amount of labor involved and the amount of capital invested. While there are several other factors influencing economic growth, their model has shown remarkably accurate. The function Cobb and Douglas used to model production was:

$$P(L, K) = b L^{\alpha} K^{\beta}$$

where:

- P is total production (the monetary value of all goods produced in a year)
- L is labor input (the total number of person-hours worked in a year)
- K is capital input (the monetary worth of all machinery, equipment, and buildings)
- b is total factor productivity
- $\alpha$  and  $\beta$  are the output elasticities of labor and capital, respectively. These values are constants dictated by technologies available.

***Export-Led Growth Theory.*** The export-led growth hypothesis (ELGH) assumes that increasing one's country exports results in increasing the growth of the entire economy. Exports can lead as a "growth engine" based on its advocates.

The relationship between growth and export is widely related to the probable effective externalities for the local economy resulting from participation in global markets, e.g. the reallocation of existing capital, economies of scale and other impacts of labor training. These mechanisms, however, are often used without any theoretical support or scientific evidence. A significant number of ELGH research has been carried out in developing countries (DCs) over the last 30 years. In fact, a new series of scientific studies on a number of different research lines, methodologies, time periods and countries were conducted during the 1990s (Smith, 2001).

***Agriculture-based economic development*** is an agricultural-based economic development strategy that involves a shift in technological, institutional and financial incentives change that will increase small farmers' productivity. Wiggins (2006) explained that in the process of economic growth, agricultural financial incentives play a dual role. First, it will provide more food and create many great jobs that are needed as well. The theory targets the methods by which underdeveloped countries can turn their domestic economic systems from a heavy focus on traditional livelihood farming to a more current and advanced farming practice through significant financial support to achieve an industrial breakthrough (Igyo, 2016).

## ***2.2. The Importance of Exports and Labor Productivity in Agriculture***

China is the world's most populated nation and also a country with numerous farmers. According to 2005 World Bank data, forty-five percent of total employment is in agriculture. In 2005, 59.49 percent of rural labor force of China was engaged in agriculture and the rest in other sectors. But through times, labor force became smaller and smaller in agriculture. Chinese economy continues to change since 1978; the government employs laws and policies that could bring back China's economy back to life. The changes made impact on food supply for the Chinese market. China's exports of agricultural products are mainly vegetables, fruits and aquatic products. In 2001, China became a member of World Trade Organization (WTO), which signifies that the country is fully involved in economic globalization and its agriculture has become part of the globalization process.

The economic crisis will affect the U.S. agriculture directly and indirectly. Changes in U.S. economy will cause a direct effect. On the other hand, the intensity of crisis impacts foreign revenue and trade and global energy prices will result to indirect effects. The growth of the dollar for declining world GDP will significantly reduce import and agricultural work and reduce export and agricultural prices. The main element of uncertainty in the long term is the exchange rate of the dollar, especially in relation to the Chinese yuan. The dollar can still be measured or depreciated. In the latter case, the return of global growth combined with valuable dollars would create a strong foreign demand for United States agricultural products.

The importance of the link between sustainable development and agricultural exports is much depicted in growing economies. Agriculture serves as a significant driver for economic development mostly for developing countries. Countries like Thailand, Pakistan, China and Brazil experienced a high capital for production but gains low income because of the degradation of resources and low prices of small farmer. It is clear that fair trade export scheme can be an essential tool to make exports a benefit to local communities (Fan et.al, 2013).

According to Al Hamwi (2005), Syria sees the potential of export trade improve their GDP by means of raising the export earnings. Their product seeks to develop competitiveness in the world market. The government uses policies such as anti-export distortions and restrictions on imports in order to satisfy its agricultural products. The effect of these policies has been hampered before the state interference in price, trade, and foreign exchange controls, thus reducing exports of some commodities, banning other exports and export taxation. Now that their economic reform has been carried out, agricultural policies such as exemption of taxes in exported agricultural product, elimination of connection between the imports and exports, reduction of aerial transportation for exports, used machinery classifications, sorting and packing have been allowed to be imported, and an exchange rate has been unified.

According to Umar (2010), agriculture is Nigeria's largest economic activity. The estimated 70 percent of the total workforce is involved in agriculture. While the oil sector is primarily responsible for the growth and development of the Nigerian economy, agriculture is still a main source of economic sustainability. Nigeria accepts substantial amounts of natural rubber and cocoa exports. However, large export income variations raised concerns over the potential to grow and sustain the country's future.

Other policies like tariffs that maintain high domestic prices and high domestic support interrelate export subsidies. These measures can result in overproduction or export subsidies on the world markets with adverse effects on non-subsidiary producer countries. These countries could impose high tariffs in order to protect their producers from cheap subsidized imports. Therefore, a revision of internal policy and the reduction of import tariffs could go hand in hand with eliminating export subsidies. Developing countries would benefit from liberalizing their own markets to abolish export subsidies without costly changes (Peters, 2006).

According to Ellis (2008), the main dependence on the agriculture is still on weather. Climate change in numerous parts of the world has already had a detrimental effect on agriculture due to growing weather conditions. The Food and Agriculture Organization (FAO) released a caution that a sudden rise in global average temperature of two to four degrees Celsius over pre-industrial levels is enough to diminish the crop yield of Africa and Western Asia by 15-35 percent, and 25-35 percent in the Middle East. The study concludes that there is no concrete, long-term solution for this problem that is published in the existing literature on agriculture, trade and climate change. The rising demand for energy-intensive food also increases the volume of agricultural commodities in international market. How the greenhouse gas emissions from processes like transport and packaging decreases related to trade must be continually emphasized. Governments and policymakers need to focus emphasizing attention to direct and indirect discharges from export-oriented farming, such as production, packaging, transport and storage methods.

Agricultural activities are seen lower for the past decade but still contribute to the economy since bulk of its labor force which compromise 37 percent comes from agriculture. Agricultural exports posted substantial growth in 2000-2005, with geographical growth of 48 percent, while fishery exports grew in East Asia by 12 percent overwhelming even non-farm export growth of 75 percent. These strong contrasts represent the main source of growth in the respective export industries: it's East Asia for fishing and non-agricultural exports; other parts of the world are for agriculture. It is their main destination, with 26 percent of all Filipino agricultural and fish exports absorbed by East Asian markets. The US accommodates 22 percent, although locally far away, followed by the European Union (Liao & Pasadilla, 2006).

Coconut farming is the main source of livelihood in the Philippines. Coconut products as the highest yielding export play a very important role in increasing the agricultural output. It



produces jobs to many rural areas which land are cultivated for coconut industry. But some cases showed that coconut farming benefits decline due to some instances like long period of cropping of coconut trees, no sustain irrigation and others. The WESMIARC or Western Mindanao Integrated Agricultural Research Center (2005) conducted a study to identify suitable and sustainable technologies that will improve the productivity and income from coconut farming. The result has shown that space scarcity is not always equal to a limited productivity. Even small-scale farmers could produce more if their farming systems are appropriate and well adapted to the area. By optimizing the use of every area on the land of the farmer, the total farm productivity can be achieved.

With the enactment of the Agriculture and Fisheries Modernization Act (AFMA) in 1997, the agricultural sector in the Philippines was steadily modernizing and at the center of the country's economy – with a contribution of 25 percent to the Gross Domestic Product and employing 50 percent of the working population. However, the industry as a whole, continues to exist as units of small farms that operate individually, most of which grow fruit and vegetables for own consumption or as substitute source of small-time income.

The production of livestock is an important contributor to the gross domestic product in many developing countries. Agro-forestry practices mainly focusing on trees, forages and cattle are known as Silvopasture. Forages are deliberately introduced into wood production systems or trees are deliberately placed into a drilling system is the process of silvopasture systems. Through the interactions between timber, drilling and livestock, wood, high quality drilling resources and effective livestock production can be produced at the same moment. Silvopasture can generate overall economic returns and create a sustainable system that delivers many benefits for the environment. These systems range from traditional silvopastoral to fodder cuts and systems of very high intensity.

Macabasco (2004) surveyed the state of the Philippine Fruit Industry. It argued that fruits are major dollar earners and major sources of employment in the Philippine economy. Fruit production grew by 3.6 percent from 1998-2002, which was mainly driven by the 6.5 percent increase of banana production during the same time frame. Banana accounts for 60 percent of total fruit volume during the past five years (1999-2004), while pineapple and mango account for 20 percent and 10 percent of fruit production, respectively. As such, these three crops account for 90 percent of the total fruit production of the country. With regard to trade, Macabasco stated

that fresh and processed fruits reached over \$600 million (FOB) yearly from 1998-2002. The country also exports papayas, jackfruit, lanzones and calamansi and the major destination for these fruits is Japan, accounting for over 40 percent of the total value of fresh/dried fruit exports in 2003. The other markets are China, U.S.A., South Korea, U.A.E., and Taiwan.

Lastly, Macabasco (2004) also analyzed the strengths, weaknesses, opportunities, and threats to the Philippine fruit industry. It argued that the fruit industry continues to suffer due to untapped potentials. The main constraints remain to be limited application of recommended production technologies and low productivity, inefficient marketing infrastructures, lack of long-term financing and largely unorganized producers. The main advantage is agro-climatic endowment and pockets of global excellence. The argument therefore shows the need for increased government assistance to be able to help exporters overcome the said constraints. As such, Macabasco concludes that the Philippine fruit industry must ensure the production of high quality products to remain competitive in the world markets. This high-quality production and competitiveness are based on three key factors: production, technology, and management.

The study of Habito et al. (2005) reviewed the trends in the Philippine agricultural sector's performance, and relate it to the policy environment within which the sector has operated through the years. It specifically examines the trends in production and productivity of the sector and how was it influence by the policies created. The results show that Philippine agricultural sector deteriorated over time compared to its neighboring countries.

### ***2.3. The Role of Financial Markets to Agriculture Output***

Akram et al. (2008) defined the constraints and proposed remedial steps that would allow efficient use of agricultural credit schemes. Most farmers reported that due to the need for collateral, they could not use credit. The rough hits were tenants and shareholders who do not own the property and were therefore unable to take advantage of credit. Another constraint was the high mark up from both formal and informal sources. The respondents' borrowing behavior was estimated using the logit model and the determinants of credit constraints were identified. Results showed that the transitory income, educational level, and forecast interest rate coefficients have significant impacts on borrowing behaviour. The expenditure on household consumption was determined positively and significantly by operating holdings and equipment value.

Onyishi et al. (2015) found a negative relationship of agricultural credit support scheme and large scale agricultural credit scheme in agricultural sector effect to gross domestic product of Nigeria. While the credit schemes are relevant to the intervention on the agricultural sector by the Nigerian government, they may not have been funded adequately enough to have any effect on agricultural funding.

Nawaz (2011) studied and investigated the role of credit to Pakistan's agriculture sector. The study showed a highly significant long-term crop area coefficient since the land is a fundamental input to the agricultural sector. The study also showed that the proportion of soil intensity increases the sector output. Scientific results show that direct credit has a positive relationship with agricultural output. Credit always helps purchase various inputs from this sector, so it has an indirect role to play.

### 3. Methodology

#### 3.1. Statistical Treatment of Data

##### 3.1.1. Measure of Correlation

The Pearson Correlation Coefficient ( $r$ ) is employed with the following formula to calculate the correlation between variables (Walpole et al. 2007, 434):

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$$

The value of  $r$  close to one implies very strong correlation or degree of linear association between  $X$  and  $Y$ , while values close to zero indicate little or no correlation, *ceteris paribus*.

##### 3.1.2. Measure of Regression

The research utilized three (3) panel regression techniques to analyze the behavior of GDP. The following model was utilized in the study:

$$GDP_{it} = \beta_0 + \beta_1 EGDP_{it} + \beta_2 EMP_{it} + \beta_3 GDP_{it-1} + \beta_4 PLG_{it-1} + \mu_{it} \quad (Eq.1)$$

where:

GDP = GDP of  $i^{th}$  agriculture sector at  $t$  year.

EGDP = Exports to GDP of  $i^{th}$  agriculture sector at  $t$  year.

EMP = Employment of  $i^{th}$  agriculture sector at  $t$  year.

PLG = Production Loans Granted of  $i^{th}$  agriculture sector at  $t-1$  year.

GDP = GDP of  $i^{th}$  agriculture sector at  $t-1$  year.

### 3.1.3. Tests on Panel Regression Model:

#### a. Stationarity Test

The Levin-Lin-Chu (LCC) Test procedure – which assumes a common unit root process – is used to test for stationarity of the data and the existence of panel unit root with null hypothesis that each time series contains a unit root against the alternative hypothesis that each time series is stationary (Kunst, Nell & Zimmermann 2011, 1).

Where the lag order  $p$  is permitted to vary across individuals (The null hypothesis is  $p = 0$ ). The procedure work first by running augment Dickey-Fuller (ADF) for each cross-section on the equation (2):

$$\Delta y_{it} = (p_i - 1)y_{it-1} + \sum_{L=1}^{p_i} \Delta y_{it-L} + \delta_{mi}d_{mt} + v_{it}, \quad m = 1, 2, 3$$

The second step is taken for the two auxiliary regressions (2):

$\Delta y_{it}$  on  $\Delta y_{it-L}$  and  $d_{mt}$  to obtain the residuals  $\hat{e}_{ei}$

$y_{it-L}$  on  $\Delta y_{it-L}$  and  $d_{mt}$  to get residuals  $\hat{v}_{it-1}$

The residuals are then standardized with the following procedures (3):

$$\bar{e}_{ei} = \hat{e}_{ei} / \hat{\sigma}_{ei}$$

$$\bar{v}_{it-1} = \hat{v}_{it-1} / \hat{\sigma}_{ei}$$

Finally, run the OLS pooled regression:

$$\bar{e}_{ei} = p\bar{v}_{it-1} + \bar{\epsilon}_{it}$$

If  $|p_i| < 1$ ,  $\bar{e}ei$  is said to be weakly (trend-) stationary, while if  $|p_i| = 1$  then  $\bar{e}ei$  contains a unit root.

### *b. Pooled Least Squares*

The estimation of the model depends on the assumption of the researcher who makes on the intercept, the slope coefficients and the error term (Gujarati 2004, 640). The following are the assumed Fixed Effect Model (FEM) and Random Effect Model (REM) that were applied in this study.

#### *Fixed Effect (Cross-section) or Least Squares Dummy Variable Model (LSDV)*

Employing the fixed effect model, which allows the slopes to vary across the classification of the sectors of agriculture, the differential slope dummies were added to the model as follows:

$$GDP_{it} = \beta_0 + \Sigma \beta_1 EGDP_{it} + \Sigma \beta_2 EMP_{it} + \Sigma \beta_3 GDP_{it-1} + \Sigma \beta_4 PLG_{it-1} + \Sigma \lambda_{it} D_{it} \quad (Eq.2)$$

#### *Random Effect (Cross-section) Model*

The REM allows the slopes of the models as random variable with mean value of  $\beta_i$  for the first model and  $\alpha_j$ , where  $i = 1, 2, 3$  and  $j = 1, 2$ .

$$GDP_{it} = \beta_0 + \Sigma \beta_1 EGDP_{it} + \Sigma \beta_2 EMP_{it} + \Sigma \beta_3 GDP_{it-1} + \Sigma \beta_4 PLG_{it-1} + \mu_{it} \quad (Eq.3)$$

### *c. Test for individual Significance*

To test for individual statistical significance of exogenous variables, the t-test is used with the following the formula:

$$t_n = \frac{\hat{\beta}_i - \beta_i}{se \hat{\beta}_i}$$

If the computed t-statistic exceeds the tabular t value, or critical region at  $\alpha = 0.05$ , the null hypothesis that  $\beta_i = 0$  is rejected. Alternatively, if the p-value of the computed value is less than the chosen level of significance, the null hypothesis is rejected. iv. Test for Overall Significance To test for the overall significance of the regression model, the F-test is used. It tests the overall explanatory power of the parameters using the following formula:

$$F_{k-1, n-k} = \frac{R^2 / (k - 1)}{(1 - R^2) / (n - k)}$$

If the value of the F-statistics exceeds the critical value of the distribution at 5 percent level of significance with k-1 and n-k degrees of freedom, it can be inferred that not all of the regression coefficients are not equal to zero and thus the regression estimate is significant and the model is to be considered valid (Gujarati, 2004). v. Measure of Multiple Determination to test how well the sample regression line fits the data, the coefficient of regression, R<sup>2</sup>, is employed with formulas as follows:

$$R^2 = 1 - \frac{\sum e_i^2}{\sum y_i^2}$$

However, the adjusted coefficient of determination,  $\overline{R^2}$ , was used to penalize for the reduction in degrees of freedom as the number of injected independent variables in the regression increase.

$$\overline{R^2} = 1 - (1 - R^2) \frac{n - 1}{n - k}$$

#### *d. Durbin Watson Test to Autocorrelation*

To check for the presence of autocorrelation or the assumption that the error terms are not correlated, the Durbin-Watson statistic, d, is used with the following formula:

$$d = \frac{\sum_{t=2}^n (e_t - e_{t-1})^2}{\sum_{t=1}^n e_t^2}$$

The calculated value of d ranges between 0 and 4, with no autocorrelation when d is in the neighborhood of 2. If the computed d-statistics is greater than the upper limit of d (du) but less than 4-du (i.e., du < d < 4-du), there will be no evidence of positive or negative autocorrelation (Gujarati, 2004).

#### *e. Test for Homoscedasticity*

To determine the assumption of Homoscedasticity, that is, the error terms in the regression model is of equal variances, the study utilizes the Breusch-Pagan Test.

#### 4. Findings and Discussions

The results from Pearson correlation tests indicate that the Gross Domestic Product (GDP) have significant and strong positive linear relationship with the all the variables production loans granted (PLG), exports to GDP ratio (EGDP), and employment (EMP). Given each p-value of 0.0000, which is below the five percent level of significance and thus, REJECT the null hypothesis that these independent variables have no significant correlation with the GDP.

**Table 1**

*Pearson Correlation Tests*

	<b>PLG</b>	<b>EGDP</b>	<b>EMP</b>
GDP	0.9402	0.972	0.9901
Sig. (2 tailed)	0	0	0
N	33	33	33

Panel unit root tests using Levin, Len and Chu Statistic (LLC) method were conducted on stacked series. The results in Table 6 showed that GDP and Production Loans Granted are non-stochastic at their levels. The Exports to GDP is non-stochastic at its first difference while the Employment is non-stochastic at second difference.

**Table 2**

*Panel Unit Root Tests*

Variables	Level		1st Difference		2nd difference	
	Levin, Lin & Chu	Prob	Levin, Lin & Chu	Prob	Levin, Lin & Chu	Prob
GDP	-2.5144	0.006	-3.3093	0.0005	-5.5497	0
PLG	-10.327	0	-10.54	0	-4.2743	0
EGDP	-0.9513	0.1707	-2.146	0.0159	-4.2742	0
EMP	3.0787	0.999	-1.3992	0.0809	-9.6239	0

The adjusted R-squared value of 0.9995 in the initial pooled model means that 99.95 percent of the variation in the GDP is explained by Exports to GDP (EGDP), employment

(EMP), production loans granted (PLG) lagged by one period and GDP lagged by one period taking into account the number of explanatory variables used in the model.

**Table 3**

*Initial Pooled Regression Model*

GDP =	-189.9296	+2240.405	EGDP	+1.8500	EMP	+0.9595	GDP <sub>(t-1)</sub>	-0.2336	PLG <sub>(t-1)</sub>
t-value	-0.1201		3.5053		1.2387		29.8963		-3.4538
p-value	0.9053		0.0017		0.227		0.0000		0.0020
R-squared = 0.9996					F-statistic = 15275.67				
Adjusted R <sup>2</sup> = 0.9995					DW statistics = 1.500727				
Critical Values:									
5% Critical t-value = 2.045					DW du = 1.739				
5% Critical F-value = 2.93					4-du = 2.21				

As expected, all explanatory variables have positive coefficients except for production loans granted (PLG) lagged by one period. The negative coefficient is in line with related literature of the effect of payments and costs of borrowing in the GDP. The null hypothesis for Exports to GDP, GDP lagged by one period and for production loans granted (PLG) lagged by one period variables was rejected at 0.0017, 0.0000, and 0.020 probability, respectively. However, there is presence of positive autocorrelation. The DW statistic of 1.501 falls below 1.739  $du < dw < 2.21$  4-du.

**Table 4**

*Pooled Regression Model (Corrected from Autocorrelation)*

GDP =	-642.7245	+2067.805	EGDP	+2.245692	EMP	+0.9549	GDP <sub>(t-1)</sub>	-0.2172	PLG <sub>(t-1)</sub>
t-value	-0.2775		3.3489		1.0213		20.7961		-2.8145
p-value	0.7841		0.003		0.3187		0.0000		0.0104
R-squared = 0.9996					F-statistic = 10949.69				
Adjusted R <sup>2</sup> = 0.9995					DW statistics = 1.9631				
AR(1) = 0.271194					t-value = 1.2322 p-value = 0.2315				
Critical Values:									
5% Critical t-value = 2.045					DW du = 1.861				
5% Critical F-value = 2.93					4-du = 2.139				



The second pooled model in table 4 corrected the presence of autocorrelation at first order. The adjusted R-squared value of the second model at 0.9995 means that 99.95 percent in the variations of GDP is explained by exports to GDP (EGDP), employment (EMP), production loans granted (PLG) lagged by one period and GDP lagged by one period taking into account the number of explanatory variables. The computed adjusted R-squared is the same with the initial pooled model in table 3 at 99.95 percent.

Consistent with the results in initial pooled model, the coefficients exports to GDP (EGDP), employment (EMP) and GDP lagged by one period are positive while the production loans granted (PLG) lagged by one period is negative. Except for employment, all the independent variables are at five (5) percent level of significance.

The F-test also indicated that all the variables are jointly significant in the model at five 5 percent level. The f-statistic of 10949.69 value exceeds the critical value of 2.93. The results also showed normal distribution of residuals in this model as per Jarque-Bera statistic 2.1309 exceeded the 5 percent level of significance (Appendix 5.1). The DW statistic of 1.963 is now within the region of  $1.861 < DW < 2.139$  4-du indicating no presence of autocorrelation at first order (Table 4).

**Table 5**

*Initial Fixed Effect Model Result*

GDP =	1211178	+2374.328 EGDP	-2.3361 EMP	+0.7787 GDP <sub>(t-1)</sub>	-0.1044 PLG <sub>(t-1)</sub>
t-value	1.2581	3.6747	-0.3081	1.1966	-0.997
p-value	0.2209	0.0013	0.7608	0.0000	0.3291
DFORESTRY = -120684.9		t-value= -1.2659		p-value= 0.2182	
DFISHERY = -92858.85		t-value= -1.1695		p-value= 0.2542	
R-squared = 0.9996			F-statistic = 10632.88		
Adjusted R <sup>2</sup> = 0.9995			DW statistics = 1.7474		
Critical Values:					
5% Critical t-value = 2.045			DW du = 1.931		
5% Critical F-value = 2.93			4-du = 2.069		

The next model is the Fixed Effect model that incorporated dummy variables for each subsector. The exports to GDP (EGDP) and GDP lagged by one period are at 5 percent level of significance. The dummy variables for forestry and fishery are not significant, meaning there is

no variation between the subsectors of agriculture. The DW statistic of 1.747 indicates a presence of positive autocorrelation which falls  $1.931 < DW < 2.069$ .

**Table 6**

*Fixed Effect Model Result (Corrected from Autocorrelation and Heteroscedasticity)*

GDP =	-70995.64	+774.9641	EGDP	23.5508	EMP	+0.5531	GDP <sub>(t-1)</sub>	+0.4760	PLG <sub>(t-1)</sub>
t-value	-0.644			2.1317			4.6176		3.8301
p-value	0.5546			0.0500			0.0003		0.0016
DFORESTRY = 69543.95		t-value= 0.5983		p-value= 0.5586					
DFISHERY = 91357.96		t-value= 0.9379		p-value= 0.3632					
AR(1)= 0.6255		t-value= 7.2117		p-value= 0.0000					
AR(2)= -0.5292		t-value= 7.2118		p-value= 0.0001					
R-squared = 0.999912				F-statistic = 21301.16					
Adjusted R <sup>2</sup> = 0.999865				DW statistic = 2.2258					
Critical Values:									
5% Critical t-value = 2.045				DW du = 2.318					
5% Critical F-value = 2.93				4-du = 1.682					

The model in Table 6 is corrected for the presence of both autocorrelation and cross-section heteroscedasticity. The Fixed Effect model with dummy variables for the agricultural subsectors that the model explains 99.99 percent of all the variations in the dependent variable GDP.

The variables export to GDP (EGDP), employment (EMP), GDP lagged by one period and production loans granted (PLG) lagged by one period are now significant at 5 percent. The production loans granted (PLG) lagged by one period turns out to be positive incorporating the dummy variables of forestry and fishery. The positive coefficient is in line with the theory of agriculture-based economic development. Consistent with the initial fixed effect model, the dummy variables of forestry and fishery are not significant.

The F-statistic of 21301 exceeded its critical f-value 2.93, rejecting the null hypothesis that the regressors in the model are not jointly significant at five percent level. The DW statistic of 2.2258 falls within the  $2.31 > DW > 1.682$ , accepting the null hypothesis of no autocorrelation (Table 6).

The Wald test has a 577.06 F-statistic and a probability of less than 5 percent, thus concluding the Fixed Effect model is the appropriate model than the Pooled Regression.

**Table 7**

*Wald Test Coefficient Restriction*

Equation: EQ\_FIXED\_AR1AR2

Test Statistic	Value	df	Probability
F-statistic	16995.20	(8, 15)	0.0000
Chi-square	135961.6	8	0.0000

The Random Effects estimation requires number of cross sections, number of coefficients for between estimators of estimate of RE innovation variance. Random effects model cannot establish small sample properties for the RE estimator. The RE estimator is consistent and asymptotically normally distributed under linearity, independence, strict exogeneity, and error variance when the number of individuals  $N \rightarrow \infty$  even if T is fixed (Schmidheiny, 2018). The panel data did not meet the requirement for Random Effects.

In relation to the fixed effect model, pooled regression is a restrictive model in that it imposes a common intercept on all regions. Therefore, restricted F-test is used. The F-value is:

$$F = \frac{R^2_{UR} - R^2_R / m}{(1 - R^2_{UR}) / (n - k)} = \frac{(0.999912 - 0.999617) / 3}{(1 - 0.999912) / (33 - 5)} = 31.28$$

The F-value of 31.28 exceeds the critical F-value of 2.93 at five (5) percent level is highly significant. Therefore, the restricted regressor is invalid. Specifically, fixed effect model is better than the pooled regression model.

## 5. Conclusion

In the final pooled regression model, the positive sign preceding the coefficients of exports to GDP, employment and GDP lagged by one period, indicate a positive relationship with the dependent variable GDP except for production loans granted which resulted a negative

relationship. This relationship is in accordance with the theoretical framework and literature discussed in this study.

The results from the unit root test on panel data using the Levin, Lin and Chu procedure suggested that the variable GDP and production loans granted are stationary at level, the export to GDP ratio is stationary at first difference and the employment at its second difference. All of the explanatory variables have strong positive correlation with dependent variable, GDP.

Based on the fixed effect model corrected from autocorrelation and heteroscedasticity, a one percentage unit increase in the exports to GDP, on the average, leads to Php 774.96 increase in the GDP, other things equal. A one-unit increase in employment, on the average, leads to Php23.55 increase in the GDP, other things equal. Lastly, one-peso increase in the production loans granted lagged by one period, on the average, leads to Php 0.4760 increase in the GDP, other things equal.

Using the fixed effect model, all the explanatory variables such as, exports to GDP, employment, GDP lagged by one period, and production loans granted lagged by one period exerted significant effect on the GDP agriculture. Hence, the model is considered satisfactory from statistical perspective.

The results from the fixed effect model were consistent with the prior expectations that exports to GDP, employment and production loans granted lagged by one period positively affect the GDP agriculture.

The result from the effects of exports to GDP, employment and production loans granted lagged by one period are positive, hence, the following recommendations are suggested:

1. Policy options such as reducing cost of borrowing to small farmer, effective crop insurance program with immediate claim, effective guarantee program for smallholder financing, and easing access to financial intermediaries for the farmers are essentials to increase the agricultural output.
2. The private sector plays an important role in agriculture. Increase responsible and productive investments in agriculture and enhance competence in the supply chain. Expand entrepreneurship to create an employment and stable local agribusinesses.
3. Increase investment in forestry by creating market for forest services. Developing plantations that will facilitate the legal harvesting of forest products for household and industry consumption.

4. Locally mobilizing investment funds is very important in meeting at least part of the investment needs of the future. And to attract participation from the private sector, it is necessary to make available investment profiles of appropriate projects with relevant information and analysis.
5. As there is a potential for Philippine agriculture products and the global price becomes competitive, it is recommended for the government to support export activities for farmers. An increase in access to international markets, improved participation in global value chain and addressing prospects for a regional trade are relevant moves.

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