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The Influence of Marketing Margins, Production Cost, and Labor Productivity on Farmers’ Welfare: A regression analysis

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ABSTRACT

Farmers encounter difficulties gaining real profit due to the inequalities brought by the middlemen-centric agricultural system, depreciating their overall welfare. Middlemen are contributors to a lengthened supply chain; hence, profit margins absorbed by middlemen are higher compared to farmers. Production costs are also integral to production, with long-run growth associated with lowering production costs. Efficiency in labor productivity of the agricultural sector is attained through the improvement of systems, which in turn yields crop profitability for farmers. The purpose of this research was to analyze the influence of middlemen, production costs, and labor productivity on farmers' welfare in the agricultural sector of the Philippines since local studies are scarce concerning middlemen and farmers and also to provide additional information for the policymakers in terms of the decision-making process to identify the farmers' dilemma and develop a policy that would help improve farmers' welfare. The approach used in this research was quantitative. The study used a multiple regression model to determine the effects of exogenous variables on Farmers' Welfare. The researchers used farmers' wages as a proxy variable for farmers' welfare. The results showed that Marketing Margins depreciate Farmers' Welfare due to lower income received by the middlemen caused by the broader gap between the farm gate price and consumer price from the marketing channel. It is also found that production cost has a negative significance on farmers' welfare showing that there are inefficiencies in farmers' production such as technical and allocative inefficiencies. Lastly, Labor Productivity increases farmers' income by efficiently allocating resources such as human resources and using land plots instead of overspending on inputs.

Keywords: Philippines, Middlemen, Marketing Margins, Labor Productivity, Farmers’ Welfare, Farmers’ Wages, Farmers’ Income

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Introduction

Agriculture is one of the key sectors that allow further economic growth and development (Blandford, 2011). Farmers are the pillars of agriculture as they produce commodities that allow other industries to exist simultaneously. A total of 9.72 million people are employed in the Agriculture sector, accounting for 22.9% of the country's total employment. Wages of individuals employed in the agriculture sector are at an average of Php 312.51 per day; higher than the average daily pay of agriculture workers in fisheries and aquaculture which stands at about Php 262.42 per day; less than the daily minimum wage rates for the regions of Central Luzon, Western Visayas, and Northern Mindanao which accounts for 33.4% of the total share of production value to the Agriculture, Forestry, and Fishing sector. (Department of Labor and Employment, 2022; Philippine Statistics Authority, 2020).

According to a generally accepted definition, farmers' welfare "includes abilities, assets, and activities essential for a way of life". This definition explicitly focuses on the relationship between people's possessions and their choices in pursuing the income level that they need to increase their survival. In simpler terms, income is one of the definitions of welfare (Tan, 2021). Thus, farm income is highly variable due to its volatility, it affects agricultural production and household welfare because it affects key farm decisions, these decisions consist of how much labor to use on-farm, how much income to save for emergencies or cushion for bad years, how much capital to invest, what crops or livestock to produce, and how much to spend on risk reducing inputs such as pesticides or irrigation (Key et. al., 2017).

Sugiana (2018) stated in his study that the farmers' desire in their lives is to fulfill their welfare through fairness and equality in the forms of rights and duties – the condition of attaining welfare is constrained with respect to his decision-making process. One of the farmers' dilemmas is the allocation of farming resources, which is also known as the agricultural production factors. Moreover, inefficient market systems and low level of agricultural technology affect farmers' welfare; the former factor brings about farmers receiving low prices; whereas the latter results in having a small harvest. On the other hand, Kinuthia B. & Mabaya E. (2017) stated that even if enhanced seed varieties can boost farmers' welfare, it shows that many farmers are slow to adapt to new agricultural technology due to added costs. At farmers' rapidly increasing average age, they are most likely hesitant to adopt new and innovative practices. With this in mind, improving the welfare of rural farmers means improving agricultural productivity to expand significantly. (Darko et al. 2018)

Mukaila et al (2021) studied that the majority of smallholder farmers' major source of income depends on their agriculture. With this, changes in income is used as an indicator of the farmers' welfare, but there are other dimensions of welfare; considering the revenues and expenditures of the farmers, specifically through the use of Farmer's Term of Trade Indices. (Satyasi, K. J. et al 2021; Sugiana, G. 2018). Having said that, increasing crop profitability plays an important role in improving the farm household income (Vatta & Budhiraja, 2020). However, Key, et al (2017) revealed in their study that farmers' income is defined as the sum of the

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operator household's share of farm business income (net cash farm income less depreciation), wages paid to the operator and other household members, and net rental income from renting the land used.

Furthermore, one of the main sources of farmers income comes from market intermediaries such as middlemen. Hadi (1990) reiterated in his study that risk attitude, strategies, and marketing costs adopted by middlemen directly affects the variations of marketing margins.Various perceptions of middlemen exist in the agricultural sector—some label middlemen as parasites who tend to abuse market prices while others deem them essential as they play a role in the facilitation of sale, transportation of crops and fertilizers, farm input lending, cash loaning (Sudrajat et al., 2021). Middlemen also facilitates the producers (farmers) and consumers by acting as intermediaries between the two parties to process transactions (Oguoma et. al., 2011); it is recognized that middlemen lengthen the supply chain, raising the prices of goods on the consumer's end; with findings showing that the retailer reportedly has higher profit margins due to the price being greater than the initial farm gate price as it reaches the consumer. (Kala et. al., 2020). In the present, agriculture-related occupations are usually associated with having low income (Reyes et al., 2012), this may be due to the exploitation and harassment of middlemen through the farmers' weak bargaining power. (Pokhrel & Thapa, 2007); In addition to that, market information deficiencies of farmers are forced to accept low prices which hinder them from earning a decent income. If farmers would have less income, their production of agricultural goods would decrease and furthermore, smallholder farmers will not be able to sell if they have no enough money to spend for agricultural production.

According to the Food and Agriculture Organization (FAO), the production cost varies among producers of different commodities. This includes technology set, farming operations, and other production practices and input use levels. Likewise, according to the study of Irvan and Yuliarmi (2019) the cost of agricultural production consists of costs of seeds, fertilizer costs, costs of pesticides and labor costs. Since there are differences in farm's accessibility to production technology, it may affect production costs. Farmers income depends on the efficiency of production, if inefficiencies are prevalent, increase of production costs would diminish farmers' income. An example is technical inefficiency where smallholder farmers are incapable of mitigating risks and use lumpy inputs. (Diaz-Hernandez, 2020 ; Irvan & Yuliarmi, 2019 ; Maietta, 2000 ; Zhang et. al., 2019). Moreover, in the study of Zhang et. al. (2019), high production costs increase domestic prices of most gained products to the point where it surpasses the world market prices, in this case, farmers' income is affected by the increased production costs. In addition, due to the Philippines being exposed to both geophysical and climate-related disasters, the production of agricultural products are affected (Bolletino et. al., 2020). From the study of Lien et. al. (2020), harsh climate, extensive areas of rugged terrain, short growing seasons, etc. contribute to the high costs of production. Moreover, wider land area leads to an increase in the cost of production are also factors in misallocation of resources, thus, increasing inefficiency costs. (Fan, 2000 ; Hall & Leveen, 1978 ; Zhang et. al., 2019).

Inefficiencies in labor productivity also lead to a decrease in production and income. Schulz (1980) states that most people in the world derive their income from agriculture, so by virtue of knowing the economics of agriculture, we would know about the economics of poverty. On average, smallholder farmers are owners of small enterprises with low capital. (Djomo, Sikod, 2012); with significant differences in smallholder farms between countries, which often reflect differences in the stages of development across countries. Oftentimes, smallholder farmers in developing countries encounter hurdles that threaten agricultural productivity. Some of these include: food insecurity, limited access to credit and agricultural insurance policies, little to no mechanization, irrigation, and efficient machinery, inadequate post-harvest facilities for storage, slow implementation of agrarian reform programs, limited access to market information, and aging farmers and fisherfolk. Means of increasing agricultural production in the country can solely come from productivity improvement (increasing output per unit of area) since no new area can be opened up for new cultivation. Some of these factors create a reliance on the informal economy as their income is not proportionate to meet their needs and dependents in daily life. (Barret, 2007 ; Brown et. al, 2018 ; FAO, 2015 ; Markelova, 2009)

Apparently, there is a noticeable lack of literature on farmer's welfare in the local context. Related studies from neighboring ASEAN, East Asian countries, and African countries have served as the foundation for this paper. Studies from Irvan and Yuliarmi suggest that the agricultural sector must be in parallel in terms of efficiency to the industrial sector as the latter sector is highly dependent on the former for its growth and development which in turn, creates the basis for economic growth.

This study aims to examine the influence of middlemen, production costs, and labor productivity to farmers' welfare. In order to achieve this, the objectives of the researchers are to:

1. Identify the relationship between Marketing Margin and Farmers' welfare. Average prices of farmgate and retail commodities will be the basis for measuring Marketing Margin. Specific agricultural commodities are Beans and Legumes, Cereals, Condiments, Fruit and Vegetables, Fruits, Leafy Vegetables, Livestock, Poultry, and root crops. (Quintana, 2021).

2. To determine the relationship between Production Costs and Farmers' welfare. The basis for production costs will be the total agricultural expense of the Agricultural Sector collected by the Philippine Statistics Authority.

3. Describe whether or not there exists a relationship between Labor Productivity on farmer welfare. The exogenous variable, labor productivity, will focus on the Agriculture Sector in order to determine if labor productivity contributes to an increase in farmer's welfare. The Philippine Statistics Authority (PSA) computes labor productivity as the Gross Domestic Product (GDP) per employed person based on rounded figures.

The purpose of this study is to provide additional literature for future researchers in regards to the impact of middlemen towards farmers in the agricultural sector of the Philippines since there is scarcity of local studies in regards to middlemen and farmers. Also, the study would provide additional information on how influenciable are factors such as production costs and labor productivity to farmers welfare. Lastly, this paper would provide a guide for the policymakers in terms of decision-making process to identify the farmers' dilemma and develop a policy that would help alleviate farmers' issues.

Literature Review

Farmers' Welfare

Agriculture is the main source of income in developing countries and increased agricultural productivity has the potential to alleviate farmers' poverty (Koirala et. al., 2016). Several studies stated that farmers' welfare is defined as the means of achieving a life that exceeds the concept of income which includes assets that contributed to obtaining the resources needed for the farmers' survival (Ellis, 2000 ; Su, 2009 as cited by Chen & Phakdeephirot, 2021). Farmers' ability to sustain their livelihood in terms of basic needs and quality of life is determined by farm income; as reduced farm income would affect their productivity, livelihood, wellbeing, and incapacity to meet certain essential needs. Moreover, it would negatively affect the economy's growth and rural prosperity. Thus, poor well-being results from low farm income, whereas comfortable well-being results from high farm income (Mukaila, 2021). With welfare being a multifaceted variable; the researchers aim to discuss specifically farmers' income through wages in order to measure what constitutes welfare for farmers in terms of their consumption and their ability to have a decent livelihood.

Farm laborers' economy is deeply concerning. As the wages of farmers and farm laborers decline, they also face huge losses, leading to an increase in agrarian distress due to low growth rates in their sector. While the upper-class benefits from the farmers' labor, the inverse is true in the case of the farmers. Farmers subsist on cheap and instant meals to abate their hunger. The poverty condition is rooted in the income/wages received by the farmers since it is not proportionate to meet their needs and dependents in daily life. Consequently, farmers' poverty has been caused by the price manipulation of middlemen towards farmers, which leaves them no room to dictate the price that would be fair for their income (Juliatin, 2020 ; Chand, 2015).

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Marketing Margins and Farmer Welfare

Most studies state that marketing margins have a significant impact on farmers' wages. The findings of Quintana et al., 2021 supports this; as farmers' wages and marketing margin have a direct relationship. An increased growth of wages coincides with high growth of farm income (Chand, R. et al, 2015). Likewise, increased profits and wages are received by farmers through higher marketing margin (Traub & Jayne, 2008 ; Aguinaldo, 2016). Dewinta et al. (2019) stated that small farmers are heavily reliant on middlemen because of the perceived benefits; since middlemen provide the needs of the farmers, such as capital, logistics, and farm input. Farmers will be lent capital to be paid with interest by the middlemen. Reliance of farmers on middlemen is also evident in the study of Antilla (2016) since farmers perceive middlemen as easy to work with and work quickly. This is because farmers have encountered dilemmas in terms of land tenure, organizing official papers, and inability to afford the cost of logistics for transportation of the goods. For that reason, middlemen are viewed as a marketing channel that yields faster results and provides a solution for premature harvesting in the context of wood farmers.

The aforementioned studies may further explain why middlemen act as the rational entrepreneur in the agricultural market by applying strategies that would benefit them -- their marketing margin decreases if the retail price and farmers' price are high; whereas if market price and retail price decreases, they benefit from the transaction by increasing its marketing margin (Sandika, 2012). Their role as facilitators of trade and risk-bearer are allegedly seen as exploitative in nature due to the additional costs that are passed along to the final consumer which stem from marketing margins added by middlemen (Mafimisebi et. al. 2006 ; Oguoma et al., 2011). It is evident whether present-day farmer relationships with middlemen here in the Philippines coincide with its Southeast Asian counterparts; as previous literature suggests that marketing margins and trade practices are kept secret by middlemen so as not to impinge on tax and government regulations (Hayami et. al. 1999).

At the other end of the spectrum, according to some studies, it is apparent that marketing margins have an inverse relationship with farmers' wages. In accordance with the findings of Kamaruddin, et al. (2021), the wider gap between consumer and farm gate price in the domestic market contributes to the depreciation of farmers' welfare due to lower prices received by the farmers compared to the price that the end consumers paid. Furthermore, Nuthalapati et al. (2020) obtained similar results as they found that farmers receive higher prices transacting with supermarkets due to lower marketing margins. On top of that, the majority of developing nations demonstrated benefits of increasing smallholder farmers income because they sell directly to the supermarkets; this is due to 20% higher farm gate price received by the farmers from the supermarket channels as compared to dealing with the traditional channels.

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Total Production Cost and Farmer Welfare

Without production costs, a firm would not be able to function (Mulyawan et. al., 2021). According to the study of Pudaka & Rustardi (2018), the amount of production has a large impact on farmers' income since production costs are expenses to produce a product to generate revenue. Moreover, some studies argue that production costs have a significant and insignificant effect on farmers' income. Satyasai (2021) indicated in his study that production and post production factors can enhance or deteriorate farmers welfare, the factors stated are input availability, costs and quality, labor availability and wage rates, output prices, access to market, post-harvest facilities, and others.

However, reducing the cost of production would contribute to the growth of farmers' income in the long run (Vatta & Budhiraja, 2020). According to the Department of Agriculture, the cost of production must be brought down for people to gain more income. Although, income would still depend on the efficiency of inputs that would, in turn, affect their income. Moreover, inefficient costs are a large component of production cost (Maietta, 2000 ; Mosheim & Lovell, 2009). Apparently, high production costs is one of the constraints that have led to a crisis in Philippine agriculture because of inefficiencies (Koirala et al., 2016). According to Irvan, I. & Yuliarmi, N. (2019), due to inefficient production, an increase in production costs will result in a decrease in the case of rice farmers' income; otherwise, less production cost contributes to an increase of farmers' income. Consequently, there are technical inefficiencies due to inappropriate inputs along with allocative inefficiencies which are caused by excessive amounts of input costs such as fertilizer and labor (Pudaka & Rustardi, 2018). However, from the study of Zaini (2010), production costs had a significant effect on farmers' income.

Production Cost has a positive and significant effect on net income (Irvan & Yuliarmi 2019; Indrayani et al 2022). Positive effects of production costs to farmers' income are caused by efficient production since it leads to more income as it avoids excess supply or waste (Munawir 2010 ; Pudaka & Rustardi 2018). Moreover, from the study of Nicholson (2002), an efficient production is when the implementation of the activity reaches the desired output with the lowest effort (input), with this, efficiency is interpreted as the absence of waste. Furthermore, efficiency is divided into three components, technical efficiency, which reflects the capability of a farm to acquire maximum output from a given set of inputs and available technology; allocative efficiency, which reflects to the capacity of a farm to utilize the inputs in optimal proportions, given their respective prices; and lastly, economic efficiency, which is the combination of technical and allocative efficiency (Farrell 1957 ; Coelli 1995 ; Farel & Timer 2013 as cited by Sucihatiningsih, 2013). Apparently, efforts designed to improve efficiency to increase agricultural output are more cost-effective and can generate more income. (Shapiro 1983 ; Belbase & Grabowski 1985).

Labor Productivity and Farmer Welfare

Labor Productivity is defined as the value of goods and services produced in a period of time, divided by the hours of labor used to produce them. It describes how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output; driven by advancements in technologies, practices (Asian Productivity Organization, n.d).

Productivity is the measure of a country's ability to improve its standard of living in the long run which would depend entirely on its ability to raise its output per worker (Krugman, 1994). In order to raise agricultural productivity, higher educational attainment should be bestowed upon farmers in order to reduce inefficiencies in labor productivity, a focus on physical aspects and improvement of systems such as transportation, irrigation, and cultivation skill offer an increase in agricultural production; rather than focusing on subsidies and price adjustments. Linkages between rural areas and markets through the improvement of infrastructure and transportation could increase productivity in this sector; as well as lowering storage and transport costs in order to create better terms of trade for farmers. (Benu, 2003; Djomo & Sikod, 2012).

In order to increase farmer's income in the long run, addressing productivity issues seems to be the key in moving towards this goal. Budgets from the agricultural sector and fertilizer subsidies were shown to have no direct or indirect impact on productivity (Rusda, et. al, 2020). Findings from studies abroad also suggest that larger agricultural land area decreases land productivity. Productivity in the agricultural sector is positively associated with labor and farm inputs rather than land size; as it is consistent with the inverse land-size productivity relationship as many economists have theorized. Evidence from prior studies suggests that growth in agricultural productivity specifically, is associated with the increases in the demand for farm labor; and with that, real wage rates rise along with agricultural growth (Schneider & Gugerty, 2011 ; Amare et. al. 2017 ; Darko et. al 2018); and for crop profitability to increase, productivity must increase as well in order to accelerate farmer's income (Vatta & Budhiraja, 2020).

Synthesis

Based on the related literature, farmer welfare is a multidimensional variable that can be characterized by consumption, income, savings, employment, health, education, fertility, nutrition, housing and migration (FAO, 2015). The paper is focused on the aspect of wages; therefore, variables such as middlemen intervention, production costs, and labor productivity all become factors that can affect a smallholder farmer's bottom line and subsequently affects their standard of living and way of life. The researchers summarize the reviewed literature based on the relationship of marketing margins, production costs, and labor productivity to farmers' welfare.

1. Related literature suggests contrasting findings between marketing margins and farmers' wages. In terms of domination of middlemen to prices and market power, it contributed to the negative relationship between marketing margin and farmers' welfare due to systematic oppression that deteriorates farmers' wages. However, the existence of middlemen provides farmers buyers of their commodities, logistics, and funding. Thus, resulting in a positive relationship between marketing margin and farmers' welfare.

2. Lower production costs yields higher wages. According to the aforementioned studies, inefficient production leads to higher cost. Excessive and inappropriate inputs cause inefficiency costs and it leads to negative income. Thus, there is a negative relationship between production cost and farmers welfare. However, there are studies indicating that efficient production cost benefits farmers welfare due to proper inputs that yields optimum outputs resulting in more wages for farmers and avoids excess supply and waste.

3. Increasing labor productivity points toward the direction of efficient allocation of resources to reduce inefficiency and in turn create more income for laborers. Rather than input subsidies, policy making towards improvement of infrastructure, linkages, and training are more optimal choices in increasing overall productivity.

Theoretical Framework

Transaction Cost Theory

Ronald Cause (1937) reiterated the essence of transaction cost theory. It explains the transactions existing in market mechanisms that incur the cost of searching for exchange partners in agreements to contracts. He argued that the mechanism in the market is not cost-free but rather involves transaction costs which involve money and time to search for sellers and buyers in order to transact with terms and enforce deals. The utilization of information and communication technologies throughout the market hierarchy and the associated market or industry value chain can reduce transaction costs.

Transaction Cost Theory captures the relationship between farmers' wages and marketing margin. The sales price of farmers' harvest crops increases as it reaches the final consumer due to the wider gap between farm gate price and consumer price; this is caused by middlemen intervention resulting in the depreciation of farmers' wages. This explanation, therefore, fits with the researchers' study.

Theory of production (Production Function by Cobb Douglas)

Charles Cobb and Paul Douglas (1928) determined that production output is the result of the utilized amount of labor and physical capital. Cobb-Douglas production function indicates the relationship between inputs (Labor and Physical Capital) and the amount of output produced. The production function is a means for calculating the impact of changes in the inputs, the relevant efficiencies, and the yields of production activity. One of the technical properties of production function is the returns to scale wherein it refers to the changes in output due to the changes in production inputs. Any production factors exhibit increasing, decreasing, or constant returns to scale (Wicksell, 1901 ; Elsner et al., 2015). Increasing returns to scale occurs when there is an increase in inputs, output increases by a larger proportion, while decreasing returns to scale occurs when there is an increase in input, output decreases, furthermore, constant returns to scale occurs when input and output increases or decreases proportionally.

If a farmer is efficiently using the resources by division of labor and specialization of skills, the farmer will face increasing returns to scale therefore there is an efficiency in the production of the commodities. However, if the farmer consumes larger quantities of inputs and outputs are decreasing, the farmer is experiencing decreasing returns to scale due to inefficiencies in production such as larger farm size with limited scarce resources (natural resources or managerial talent), and handling it becomes more difficult.

Marginal theory of productivity

John Bates Clark and Philip Henry Wicksteed stated the central definition of the Marginal Theory of Labor at the end of the nineteenth century. A firm would pay its workers' wages based on productivity and contribution to the utility and welfare of the business. Assuming that the capital is fixed and more workers are hired, the extra output produced by the workers would be inefficient since there is no capacity to accommodate them due to the scarcity of resources.

Marginal Theory of Productivity captures the relationship between Farmers' Welfare and Labor Productivity – a growth in farmers' wages is realized through enhanced labor productivity, indicating a direct relationship between the endogenous variable to labor productivity.

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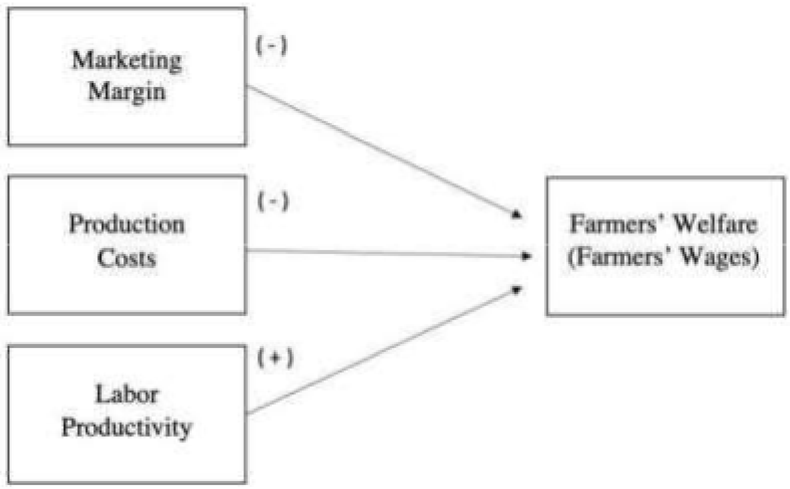
Research Simulacrum



The research simulacrum shows graphically on how Marketing Margin, Production Cost, and Labor Productivity impact Farmers Welfare in the Philippine context.

Research Method

Research Design

This paper used a quantitative approach since it is focused on identifying the relationships of the exogenous variables (Marketing Margin, Production Cost, Labor Productivity) to the endogenous variable (Farmers Welfare). Multiple regression analysis along with the diagnostic tests, test for autocorrelation, Unit root tests, Ordinary Least Squares (OLS), White's Test for Heteroskedasticity, Breusch-Godfrey test, ARCH Test, Chow Test, and Ramsey RESET test will be utilized for this study.

Study Site

This paper focused on the Philippines at a national level, specifically in the agricultural sector of the Philippines. The researchers used time-series data, and the period will be from 1995-2019.

Data collection procedures

The researchers used secondary data. The data of endogenous and exogenous variables are referenced from the Philippine Statistics Authority. For an in-depth discussion, the variables and corresponding measures are as follows: (1) The data of marketing margin was measured by the average prices of farmgate and retail commodities of beans and legumes, cereals, condiments, fruit vegetables, fruits, leafy vegetables, livestock, poultry, and root crops as adapted from the study of Quintana et al. 2021; referenced from the Philippine Statistics Authority, which in turn will be utilized in this study. (2) Production Cost was measured through data derived from the Total Agricultural Expenditures (3) Labor Productivity was measured by dividing the Agricultural GDP and Agricultural Employment data as indicated by the Philippine Statistics Authority. (4) Farmers' Welfare was measured through the Agricultural Wage Rates of farm workers, whereas farmers' wages will be the proxy variable for farmers' welfare.

Data analysis/Mode of analysis

Marketing Margin:

In measuring the impact of middlemen on farmers' welfare, marketing channels were calculated by considering the middlemen's Marketing Margin (MM). Marketing Margin (MM) is the difference between the retail price and farm value (Sandika, 2012). In this case, the margin is typically the profit made under a given market condition (FAO, 2011). The marketing Margin of middlemen was measured by adopting the following equation provided by Gardner (1975); adapted from Quintana et. al's study in 2021:

$$MM = \frac{RP - PP}{RP}$$

Where:

MM = Marketing Margin

RP = Retail Price

PP = Producer Price

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Econometric Model:

Eden and Nielsen (2020) suggests that multiple regression is used to determine the effect of several independent variables (X) on the dependent variable (Y), with the regression equation:

$$\mathbf{FW} = \beta_0 - \beta_1 MM - \beta_2 TPC + \beta_3 LP + \varepsilon$$

FW = Farmers Welfare
MM = Marketing Margin
TC = Total Production Costs
LP = Labor (AFF) Productivity
β_0 = constant term or intercept
β_1 = Beta Coefficient of Marketing Margin
β_2 = Beta Coefficient of Total Production Cost
β_3 = Beta Coefficient of Labor Productivity
ε = error term

Diagnostic Tests

Test for Autocorrelation:

Autocorrelation refers to the correlation between members of a series of observations ordered in time or space (Gujarati, 2004). It is when an observation in an equation is time dependent on past observation (Quintana et al., 2021). Research has discovered that this effect exists on commodities and prices (Clements, 2010). Thus, the researchers will use the Durbin Watson test for detecting autocorrelation. Shahbazi (2019) suggests that the Durbin Watson (DW) test is utilized to detect symptoms of autocorrelation.

Furthermore, statisticians named Trevor S. Breusch and Leslie G. Godfrey has developed a test of autocorrelation to avoid some of the pitfalls of the Durbin-Watson d test of autocorrelation. Breusch and Godfrey's test of autocorrelation allows for (1) non stochastic regressors, such as the lagged values of the regressand; (2) higher-order autoregressive schemes, such as AR(1), AR(2), etc.; and (3) simple or higher order moving averages of white noise error terms (Gujarati, 2004).

Unit Root Tests

Unit root test is used to determine the stationarity of the variables, thus Augmented Dickey–Fuller test will be used for this study. Stationarity can be observed by finding out if the time series contains a unit root. Furthermore, this test is conducted by "augmenting" the preceding three equations by adding the lagged values of the dependent variable, (Gujarati, 2004). To avoid spurious results, the ADF is a necessary test to undertake in the regression (Lean et al., 2014).

Normality of Residuals (Jarque-Bera Test of Normality; Ordinary Least Squares)

The Jarque-Bera (JB) normality test is a large-sample asymptotic test, which is also based on OLS residuals. Moreover, skewness and kurtosis is initially computed to quantify the OLS residuals (Gujarti, 2004).

Test for Specification Errors (Ramsey's RESET)

RESET is a generic test used for regression specification error tests. It is proven to have the benefit of being simple to use because it doesn't require one to describe the nature of the alternate model. This will be utilized for the linear regression model to examine various specification errors, including redundant, omitted variables, and inaccuracies of functional form (Gujarti, 2004).

Test for Multicollinearity

Multicollinearity arises when at least two highly correlated predictors are assessed simultaneously in a regression model, often encountered when performing an OLS Regression (Vatcheva et. al, 2016). Presence of multicollinearity errors are indicated through a Variance Inflation Factor. The VIF is a tool to measure and quantify how much the variance is inflated. Aside from the VIF indicating the presence of multicollinearity, the square root of VIF indicates how large a standard error may be. When correlation exists among predictors, the standard error of predictors coefficients will increase, and consequently, the variance of predictor's coefficients are inflated (Daoud, 2017).

Test for Heteroskedasticity

Heteroskedasticity is typically defined as a "non-constant error variance". After the predictors have been included in the regression model, the remaining residual variability changes as a function of something that is not present in the model (Astivia & Zumbo 2019). Breusch-Pagan tests the null hypothesis that the error variances are all equal versus the alternative that the error variances are a multiplicative function of one or more variables (Williams, 2020).

Test for Stability (Chow Breakpoint Test)

The Chow Test does not expressly state which coefficient, intercept, or slope is different or whether one and the other are different in two periods. In other words, one could acquire a significant chow test if the slope or intercept is different, or both are different. Furthermore, If the p-value is greater than alpha, no breakpoint error exists in the structure (Gujarati, 2004).

Results and Discussion

Presentation of Results

The paper aims to determine whether or not a relationship exists between the exogenous variables, namely middlemen, production cost, and labor productivity, on the endogenous variable, farmers' welfare, through a descriptive-quantitative approach. The data of endogenous and exogenous variables is based on the Philippine Statistic Authority, using the time series of 1995-2019. The multiple regression analysis will determine this along with the diagnostic tests through Gretl Analysis.

Econometric Model

Eden and Nielsen (2020) suggests that multiple regression is used to determine the effect of several independent variables (X) on the dependent variable (Y), with the regression equation:

$$\mathbf{FW} = \beta_0 - \beta_1 MM - \beta_2 TPC + \beta_3 LP + \varepsilon$$

FW = Farmers Welfare
MM = Marketing Margin
TC = Total Production Costs
LP = Labor (AFF) Productivity
$\boldsymbol{\beta_0}$ **=** constant term or intercept
$\boldsymbol{\beta_1}$ = Beta Coefficient of Marketing Margin
$\boldsymbol{\beta_2}$ = Beta Coefficient of Total Production Cost
$\boldsymbol{\beta_3}$ = Beta Coefficient of Labor Productivity
ε = error term

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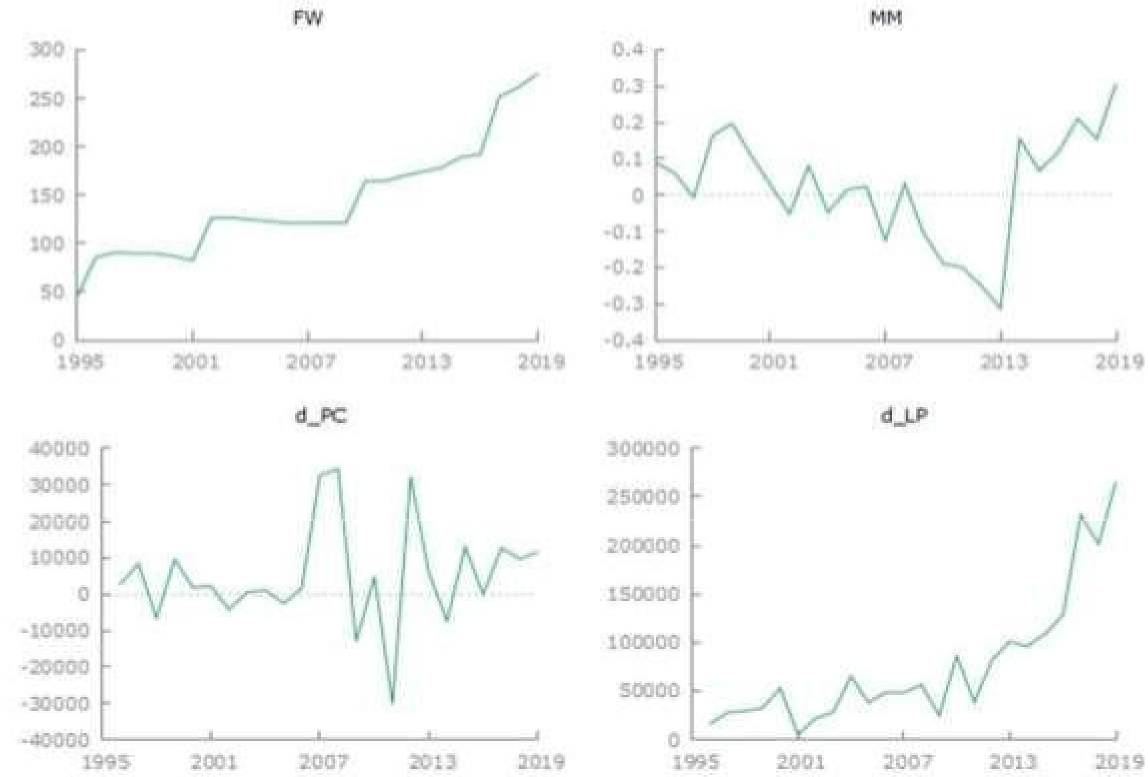
Descriptive Results

Time Series Plot



The graph illustrated above indicates the years 1995 to 2019, demonstrating the historical patterns of the endogenous and exogenous variables used in the study. The Farmers' Welfare presented an upward, staircase-pattern, representing the slow and almost consistent increase year-by-year in farmers wages (our proxy variable). In contrast, the Production Cost demonstrated fluctuations throughout the years. The Labor Productivity has shown stagnant growth from 1995 to late 2007 with a rapid increase from 2008 to 2019. The Marketing Margin has shown a steady decline from 1995 - 2013 but quickly returned to previous levels from 2014 onwards.

Summary Statistics (using the observations 1995 - 2019)				
Variable	**Mean**	**Median**	**Minimum**	**Maximum**
Farmers' Wages	142.99	124.49	45.100	275.46
Marketing Margin	0.021131	0.031421	-0.31286	0.30673
d_Labor Productivity	76545.	50925.	5157.1	2.6539e+005
d_Production Cost	5036.2	2458.5	-30227.	34316.
Variable	**Std. Dev.**	**C.V**	**Skewness**	**Ex. Kurtosis**
Farmers' Wages	58.854	0.41161	0.74175	-0.073866
Marketing Margin	0.15270	7.2262	-0.44656	-0.36330
d_Labor Productivity	68921.	0.90041	1.5115	1.3958
d_Production Cost	14236.	2.8268	0.191433	0.93529
Variable	**5%**	**95%**	**IQ Range**	**Missing Obs.**
Farmers' Wages	56.236	271.29	86.070	0
Marketing Margin	-0.29394	0.27784	0.21498	0
d_Labor Productivity	7781.3	2.5692e+005	71285.	1
d_Production Cost	-25904.	33869.	13051.	1

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The mean of farmers' wages is 149.99, while the skewness and kurtosis of farmers’ wages are 0.74175 and -0.073866 respectively, therefore the data is positively skewed since the value of skewness is greater than 0. The distribution of the data of farmers’ wages is mesokurtic since the value is -0.07 and it is closer to 0.

The mean of marketing margin is 0.021131, while the skewness and kurtosis of marketing margin is 0.44656 and -0.36330 respectively, therefore the data is negatively skewed since the value of skewness is less than 0. The distribution of the data of marketing margin is also mesokurtic since the value is closer than 0.

The mean of the first difference of labor productivity is 76545, while the skewness and kurtosis of the difference of labor productivity are 1.5115 and 1.3958 respectively, therefore the data is positively skewed since the value of skewness is greater than 0. The distribution of the data of the first difference of labor productivity is platykurtic since the value of kurtosis is less than 3.

The mean of the first difference of total production cost is 5036.2, while the skewness and kurtosis of the difference of the interest rate are 0.19433 and 0.93529 respectively, therefore the data is positively skewed since the value of skewness is positive and the distribution of the data is platykurtic since the value of kurtosis is less than 3.

Numerical Results: Ordinary Least Squares, Regression Procedure Result

Model 1: OLS, using observations 1996-2019 (T = 24)
Dependent variable: FW

	coefficient	std. error	t-ratio	p-value	
const	84.8726	5.08484	16.69	3.30e-03	***
PC	−0.000546715	0.000243162	−2.248	0.0360	**
MM	−78.4306	23.6374	−3.318	0.0034	***
LP	0.000867169	5.49828e-05	15.77	9.51e-03	***

Mean dependent var	147.0650	S.D. dependent var	56.39552
Sum squared resid	5110.326	S.E. of regression	15.98488
R-squared	0.930140	Adjusted R-squared	0.919660
F(3, 21)	88.76162	P-value(F)	9.91e-12
Log-likelihood	−98.38610	Akaike criterion	204.7722
Schwarz criterion	209.4844	Hannan-Quinn	206.024
rho	−0.038752	Durbin-Watson	2.051792

Figure 4.1.2 shows the results of the multiple regression of the variables affecting farmers welfare from 1995-2019. The p-value of f-stat (9.91e-12) is less than the 5% significance level, therefore it signifies that the regression is statistically significant. The results show that production cost, marketing margin and labor productivity are statistically significant at 5% significance level. Therefore we can accept the alternative hypothesis that production cost, marketing margin and labor productivity affects farmers' welfare.

Based on the statistical result of the OLS regression, the econometric model equation is determined as:

$$\mathbf{FW} = 84.8729 - 0.000546715\ (PC) - 78.4306\ (MM) + 0.000867169\ (LP) + \varepsilon$$

The econometric model indicates that if all independent variables are zero, Farmers Welfare will have a value of 84.8729. The Farmers welfare will decrease by 0.000546715 for every unit increased by production costs. Moreover, farmers' welfare would also decrease by 78.4306 for every unit increased by marketing margin. Furthermore, farmers' welfare will increase by 0.000867169 for every unit increased by labor productivity.

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Diagnostic Tests

<table>
<tr><th>Diagnostic Tests</th><th>Results</th></tr>
<tr><td>Autocorrelation</td><td>Durbin Watson: The p-value of f-stat (2.05179) is greater than 0.05 level of significance.

Breusch-Godfrey: The p-value of f-stat (0.831) is greater than 0.05 level of significance.</td></tr>
<tr><td>Unit Root Test</td><td>
<table>
<tr><th></th><th>Test at Level</th><th>Test at First difference</th><th>Test at Second Difference</th></tr>
<tr><td>Variables to Test</td><td>a = 0.05</td><td>a = 0.05</td><td>a = 0.05</td></tr>
<tr><td>Farmer's Welfare</td><td>1</td><td>1.949e-06</td><td>0.01496</td></tr>
<tr><td>Marketing Margin</td><td>0.2919</td><td>1.23e-08</td><td>0.002594</td></tr>
<tr><td>d_Labor Productivity</td><td>1</td><td>1</td><td>4.044e-12</td></tr>
<tr><td>d_Production Cost</td><td>0.9262</td><td>2.093e-06</td><td>0.0001</td></tr>
</table>
</td></tr>
<tr><td>Normality of Residuals (Jarque-Bera Test of Normality; Ordinary Least Squares)</td><td>The p-value of f-stat (0.805005) is greater than 0.05 level of significance.</td></tr>
<tr><td>Specification Errors (Ramsey's RESET)</td><td>The p-value of f-stat (0.546, 0.287, 0.273) are greater than 0.05 level of significance.</td></tr>
</table>

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Multicollinearity	The three endogenous variables are less than 10 VIF: ● **MM** = 1.213 ● **d_LP** = 1.293 ● **d_PC** = 1.079
Heteroskedasticity	The p-value of f-stat **(0.849753)** is greater than 0.05 level of significance.
Stability (Chow Breakpoint Test)	The p-value of f-stat **(0.0948)** is greater than 0.05 level of significance.

Test for Autocorrelation

Autocorrelation is utilized to determine if the variables are similar. Based on the result, the p-values of f-stat are greater than 0.05 level of significance. With this, it is evident that there is no autocorrelation error.

Test for Unit Root

The results show that the Farmers' Welfare, Marketing Margin, and Production Cost are stationary at first difference. However, the variable Labor Productivity is stationary at second difference. Therefore, the model was regressed at the second difference.

Test for Normality of Residuals

The Test for Normality using the Jarque-Bera Test is a function of the measures of skewness and kurtosis computed from the sample. The results show that the p-value of f-stat is greater than 0.05 level of significance; therefore, we can accept the null hypothesis that the residuals are normally distributed.

Test for Specification Error (Ramsey's RESET)

Ramsey's RESET test is used to identify specification errors such as incorrect functional form, redundant and omitted variables. The p-value of f-stat is greater than the 0.05 level of significance, therefore, accept the null hypothesis that there are no specification errors.

Test for Multicollinearity

The Multicollinearity test was used to identify if there are existing collinearity problems. The result of the Variance Inflation Factors of each independent variable are less than 10, therefore, accept the null hypothesis that the independent variables have no multicollinearity issues.

Test for Heteroskedasticity

For Heteroskedasticity testing; both White's test and Breusch-Pagan were used in order to identify the dependency of the estimated variance on the values of the dependent variables. Based on the results of the two tests, the p-value of the f-stat is greater than 0.05 level of significance; indicating the absence of heteroskedasticity.

Test for Stability

In order to identify the stability of the regression model, the researchers used the Chow Breakpoint test. The results shown above indicate that the p-value of the f-stat is greater than 0.05 level of significance, therefore, we can accept the null hypothesis that there is no evidence of a structural breakpoint in the model.

Discussion of Results Hypothesis Testing and Results of the Objective

Hypothesis 1:

H0: Marketing margins have no effect on farmer welfare.
Ha: Marketing margins affect farmer welfare negatively.
Conclusion: Accept alternative hypothesis

Marketing Margins and Farmers' Welfare

Agricultural-related occupation plays a significant role in sustaining the farmers' welfare, which includes the income from dealing with middlemen, as their role impacts the marketing margin. According to the OLS result, the Marketing Margin Farmers' Welfare, shows a highly negative relationship. As smallholder farmers rely heavily on the presence of middlemen due to perceived benefits, the latter controls the market price that would only benefit them, exploiting the farmers' welfare. This is because middlemen play the farmers' incapability of transporting crops from farmgate to the market centers. Farmers' incapability to transfer crops to the market. (Pokhrel & Thapa, 2007 ; Sandika, 2012 ; Dewinta et al, 2019).

Our model shows a significant decrease in farmers' welfare (using the proxy variable of farmers' wages) due to the higher marketing margin that middlemen possess in the marketing channel. This is aligned with the findings of Wowiling et al. (2019); as marketing channels expand, the higher the marketing margin will be, indicating a lower share to the farmers. Kamaruddin et al. (2021) also asserted that farmers' dependency on the middlemen in the domestic market creates a wider gap between the consumer and farm gate price due to lower income received by the farmers compared to the price shouldered by the consumers. The study by Nuthalapi et al. (2020) recommended that farmers transact directly with supermarkets to obtain lower marketing margins, thus, increasing their income by 20% higher farm gate price. Rahayu et al. (2021) also assert that the efficiency of the marketing chain is achieved through 100% higher farmers' profit due to the elimination of middlemen in the marketing channel.

These claims confirm the researchers' findings that marketing margins negatively affect the farmers' welfare by the proxy variable of farmers' wages.

Hypothesis 2:
H0: Total Production Cost has no effect on farmer welfare.
Hb: Total Production Cost affects farmer welfare negatively.
Conclusion: Accept alternative hypothesis

Total Production Cost and Farmers' Welfare

Based on the OLS results, total production costs have a negative effect on farmers' welfare. The study of Mehrotra and Satyasai (2020) concluded that rising production costs is one of the major issues of agriculture since it erodes income. Moreover, the researchers can conclude that farmers' production of goods is inefficient since according to Irvan, I. & Yuliarmi, N. (2019), due to inefficient production, an increase in production costs will decrease farmers' income. Furthermore, inefficiencies in production such as excessive amounts of inputs and inappropriate inputs result in technical and allocative inefficiencies in production (Pudaka & Rustardi, 2018; Afidchao et al. 2014).

Moreover, Afidchao et al. (2014) stated that seed cost and fertilizer cost have negative significance to farmers income since there are financial constraints such as high seed costs along with an expensive credit system where farmers pay 7 to 15% interest to support their inputs. From the study of Yorobe and Quicoy (2006), farmers received negative benefits from more costs and they also experienced harsh climate change and externalities which led to more expenses for farmers.

Hypothesis 3:
H0: Labor Productivity has no effect on farmer welfare.
Hc: Labor Productivity affects farmer welfare positively.
Conclusion: Accept alternative hypothesis

Labor Productivity and Farmers' Welfare

Our model uses partial factor productivity in order to emphasize labor productivity as a component to farmer's welfare instead of a total factor productivity approach. We can accept the alternative hypothesis due to the results of the regression model pointing strongly towards a positive relationship between our two variables. The results of our model show a marginal increase in farmer's welfare due to its highly dependent nature on improving the output of the already existing labor populace when they are using smallholder land plots efficiently, thus, creating more value per square meter of land. As prior studies from Rusda et. al in 2020 and Vatta & Budhiraja in 2020 suggest, Labor Productivity offers greater yields to farmers in the long-run due to its positive relationship with crop profitability which in turn accelerates farmer's income.

Smallholder farmers in developing countries such as the Philippines, would benefit more from skill building rather than land expansion in order to maximize existing labor over the already dwindling numbers in agricultural employment. With the average age of farmers being 53 years old, a shortage of farmers and farm laborers may eventually hamper the growth of the agricultural sector in the next few years (Palis, 2020)

Consistent with the findings of Benu in 2002, Djomo & Sikod in 2012, cultivation skill as well as other improvements in total factor productivity offer a better avenue for reducing inefficiencies and roadblocks in the agricultural labor market. Linkages, improvements in the supply chain, and storage costs to reduce spoilage are all key solutions our country needs to undertake in order to grow its labor productivity and ensure a better standard of living for Filipino farmers.

Result of the Objective

The objectives listed on Chapter 1 of this paper, and basing on the regression output, we can sufficiently say that:

1. Marketing margins have a highly negative relationship with farmer welfare.
2. Total production costs have a moderately negative relationship with farmer welfare.
3. Labor productivity has a highly positive relationship with farmer welfare.

Conclusion and Policy Implications

Conclusion and Recommendation

The study aims to determine the relationship between the Marketing Margin, Labor Productivity, and Production Cost to Farmers' Welfare. The researchers focused on the agricultural sector of the Philippines through the use of multiple regression analysis. The secondary data used is a time-series data and were drawn from the Philippine Statistics Authority and data collected from various agricultural commodity prices, with 25 observations from 1995 to 2019. Multiple regression analysis and diagnostic tests were utilized to determine the relationship between the exogenous variables to the Farmers' Welfare, moreover, the results signifies no error from all the tests conducted. Therefore, the study accepts the alternative hypothesis of all hypotheses.

The study's statistical findings depict that all exogenous variables are statistically significant to the endogenous variable. It indicates that farmers do not benefit from middlemen since the results show that marketing margins negatively impact farmers' welfare. Farmers also are experiencing production issues where excessive inputs and technical and allocative inefficiencies cause higher production costs and lead to lower income for farmers. However, farmers' welfare is better off by improving the output of the agricultural labor sector by efficiently utilizing the land plots from the limited pool of laborers, thus, increasing the demand for labor and increasing farmers' real wages.

5.2 Policy Implications

The results of this paper determined that middlemen gain more profit compared to farmers, inefficiencies in production which leads to higher production costs and improving real output through the improvement of agricultural labor and other factor productivity components. Therefore, the researchers can recommend that the government empower smallholder farmers' bargaining power to the market to increase its farm gate price against the middlemen. The government must create policies that provide farmers more access to information and communications technology to provide them more information about the market price and demand to improve their production and avoid the exploitation of middlemen, thus decreasing their marketing margin.

The Department of Agriculture must provide policies that would finance smallholder farmers to secure them in case of calamities that would affect the quality of their harvested products' and in turn, depreciate their income. This would help protect the farmers' investment and make sure they have the means to resume production when severe weather is rampant. Moreover, training and development for farmers is another factor to improve their skills, decision making, and productivity. It would be beneficial to the farmers as they are more knowledgeable in strategizing for their purchase of seeds and chemicals thus, achieving efficient production.

Roadblocks to improving labor productivity must be addressed: the lack of technical and educational skill improvements coupled with the rising average age of farmers in the Philippines, and the overall difficulty of getting to market. The Department of Education (DepED), Technical Education and Skills Development Authority (TESDA), and Department of Agriculture (DA) must actively collaborate in improving already existing farm schools and employing more specialized tutors under Republic Act 10618 (Rural Farm Schools Act). In strengthening the program, experienced farmers may be able to contribute their knowledge while at the same time, gain applied technical skills and financial development advice from tutors. Materials and modules provided by these farm schools should contain beginner to advanced practices on farming, financial literacy, and entrepreneurial development as part of its core curriculum in order to boost labor productivity. These farm schools should also create avenues for encouraging young adults in these areas to take up an agribusiness venture or become farmers in order to mitigate the aging population of the agricultural labor force.

Linkages and rural infrastructure must be improved in order to lessen the cost and difficulty of transport of goods from farm to market. With improved avenues of transportation, farmers can spend more time on productive activities than struggle with transportation of goods to trading posts. Predatory practices from middlemen must also be mitigated from the supply chain in order for farmers to secure marginal profit from their harvests.

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Appendices

Appendix A

YEAR	FW	PC	MM	LP
1995	45.1	12839	0.090234203	170937.3094
1996	85.8	15479	0.060842088	186591.2371
1997	90.57	23854	-0.005888606	214566.1362
1998	89.5	17354	0.164691639	243829.8262
1999	89.71	26847	0.196929175	276407.1495
2000	86.89	28722	0.108556389	329540.9627
2001	82.22	30999	0.02983679	334698.0645
2002	126.36	26798	-0.051311675	356463.3993
2003	126.63	27370	0.080474681	384706.0606
2004	124.49	28462	-0.048048298	449950.3515
2005	122.85	25939	0.014782553	488198.6242
2006	120.82	27515	0.023363347	536914.1267
2007	121.15	60042	-0.124500683	585120.6282
2008	120.87	94358	0.031420906	641804.0732
2009	120.91	81422	-0.105703437	666623.1728
2010	164.62	86,239	-0.188953855	752799.3311
2011	164.4	56012	-0.198884945	791225.1019
2012	169.88	88186	-0.249794971	873539.206
2013	173.98	94,166	-0.312861203	974527.8716
2014	174.44	86,807	0.15515143	1070693.814
2015	189.32	99,788	0.067822557	1179985.917
2016	191.69	99,688	0.118714241	1309217.45
2017	251.45	112,420	0.210445862	1540701.365
2018	261.55	122083	0.154233029	1742620.2
2019	275.46	133707	0.306726556	2008012.654

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Appendix B

```
Model 1: OLS, using observations 1996-2019 (T = 24)
Dependent variable: FW

              coefficient     std. error    t-ratio    p-value
  ------------------------------------------------------------
  const       84.8726         5.08484       16.69      3.30e-013 ***
  MM         -78.4306        23.6374        -3.318     0.0034    ***
  d_PC        -0.000546715    0.000243162   -2.248     0.0360    **
  d_LP         0.000867169    5.49828e-05   15.77      9.51e-013 ***

Mean dependent var   147.0650   S.D. dependent var   56.39552
Sum squared resid    5110.326   S.E. of regression   15.98488
R-squared            0.930140   Adjusted R-squared   0.919660
F(3, 20)             88.76162   P-value(F)           9.91e-12
Log-likelihood      -98.38610   Akaike criterion     204.7722
Schwarz criterion    209.4844   Hannan-Quinn         206.0224
rho                 -0.038752   Durbin-Watson        2.051792
```

Appendix C

```
Durbin-Watson statistic = 2.05179

H1: positive autocorrelation
   p-value = 0.42168
H1: negative autocorrelation
   p-value = 0.57832

Breusch-Godfrey test for first-order autocorrelation
OLS, using observations 1996-2019 (T = 24)
Dependent variable: uhat

                     coefficient    std. error   t-ratio   p-value
  ------------------------------------------------------------------
  const              -0.348049      5.52608      -0.06298   0.9504
  d_LaborProductiv-   4.75935e-06   6.16997e-05   0.07714   0.9393
  d_ProductionCost    5.58291e-06   0.000250978   0.02224   0.9825
  MarketingMargin    -1.39810      25.3267       -0.05520   0.9566
  uhat_1             -0.0495003     0.261185     -0.1895    0.8517

  Unadjusted R-squared = 0.001887

Test statistic: LMF = 0.035919,
with p-value = P(F(1,19) > 0.0359187) = 0.852

Alternative statistic: TR^2 = 0.045285,
with p-value = P(Chi-square(1) > 0.0452853) = 0.831

Ljung-Box Q' = 0.0394216,
with p-value = P(Chi-square(1) > 0.0394216) = 0.843
```

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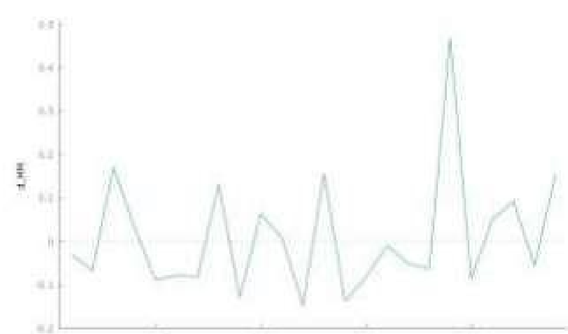
Appendix D

```
Augmented Dickey-Fuller test for FW
testing down from 8 lags, criterion AIC
sample size 16
unit-root null hypothesis: a = 1

  test with constant
  including 8 lags of (1-L)FW
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.724388
  test statistic: tau_c(1) = 3.24843
  asymptotic p-value 1
  1st-order autocorrelation coeff. for e: -0.196
  lagged differences: F(8, 6) = 2.279 [0.1657]
```

```
Augmented Dickey-Fuller test for d_FW
testing down from 8 lags, criterion AIC
sample size 23
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)d_FW
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.10536
  test statistic: tau_c(1) = -5.47729
  asymptotic p-value 1.949e-06
  1st-order autocorrelation coeff. for e: -0.003
```

```
Augmented Dickey-Fuller test for MM
testing down from 8 lags, criterion AIC
sample size 24
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)MM
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.373623
  test statistic: tau_c(1) = -1.98913
  asymptotic p-value 0.2919
  1st-order autocorrelation coeff. for e: -0.119
```

```
Augmented Dickey-Fuller test for d_MM
testing down from 8 lags, criterion AIC
sample size 23
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)d_MM
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.34589
  test statistic: tau_c(1) = -6.40033
  asymptotic p-value 1.23e-08
  1st-order autocorrelation coeff. for e: -0.051
```



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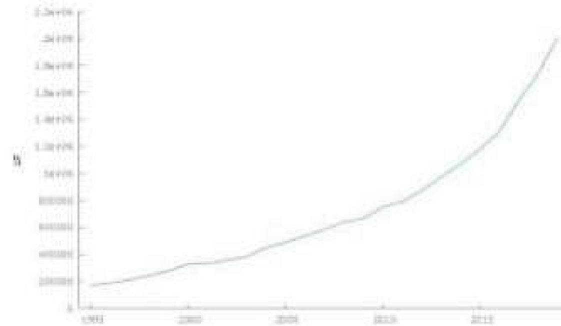
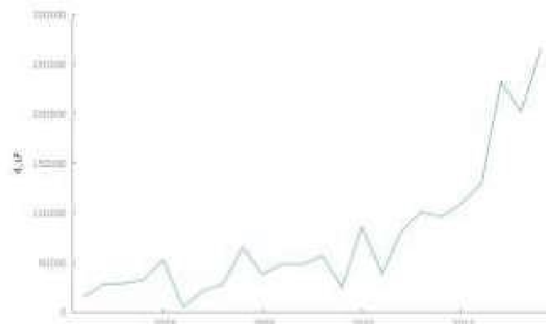
```
Augmented Dickey-Fuller test for LP
testing down from 8 lags, criterion AIC
sample size 24
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)LP
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): 0.145195
  test statistic: tau_c(1) = 11.43
  asymptotic p-value 1
  1st-order autocorrelation coeff. for e: 0.048
```



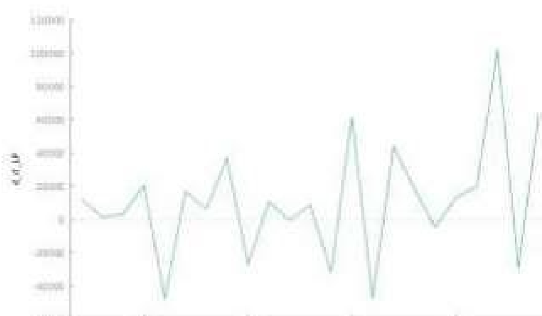
```
Augmented Dickey-Fuller test for d_LP
testing down from 8 lags, criterion AIC
sample size 22
unit-root null hypothesis: a = 1

  with constant and trend
  including one lag of (1-L)d_LP
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.0374247
  test statistic: tau_ct(1) = 0.166556
  asymptotic p-value 0.9978
  1st-order autocorrelation coeff. for e: -0.108
```



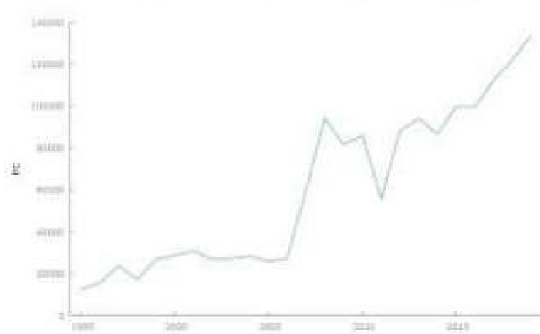
```
Augmented Dickey-Fuller test for d_d_LP
testing down from 8 lags, criterion AIC
sample size 22
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)d_d_LP
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.54962
  test statistic: tau_c(1) = -7.68675
  asymptotic p-value 4.044e-12
  1st-order autocorrelation coeff. for e: 0.087
```



```
Augmented Dickey-Fuller test for PC
testing down from 8 lags, criterion AIC
sample size 24
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)PC
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.0230045
  test statistic: tau_c(1) = -0.275236
  asymptotic p-value 0.9262
  1st-order autocorrelation coeff. for e: -0.160
```



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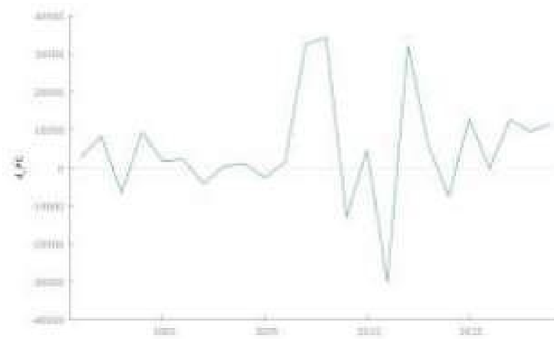
```
Augmented Dickey-Fuller test for d_PC
testing down from 8 lags, criterion AIC
sample size 23
unit-root null hypothesis: a = 1

  test with constant
  including 0 lags of (1-L)d_PC
  model: (1-L)y = b0 + (a-1)*y(-1) + e
  estimated value of (a - 1): -1.17825
  test statistic: tau_c(1) = -5.46333
  asymptotic p-value 2.093e-06
  1st-order autocorrelation coeff. for e: -0.013
```



```
Augmented Dickey-Fuller test for d_d_PC
testing down from 8 lags, criterion AIC
sample size 19
unit-root null hypothesis: a = 1

  test with constant
  including 3 lags of (1-L)d_d_PC
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -3.68124
  test statistic: tau_c(1) = -4.6006
  asymptotic p-value 0.0001
  1st-order autocorrelation coeff. for e: -0.036
  lagged differences: F(3, 14) = 2.553 [0.0973]
```

Appendix E

```
Test for normality of uhat28:

 Doornik-Hansen test = 0.326738, with p-value 0.849278

 Shapiro-Wilk W = 0.974216, with p-value 0.77048

 Lilliefors test = 0.0775922, with p-value ~= 1

 Jarque-Bera test = 0.433814, with p-value 0.805005
```

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Appendix F

```
RESET test for specification (squares and cubes)
Test statistic: F = 0.626261,
with p-value = P(F(2,18) > 0.626261) = 0.546

RESET test for specification (squares only)
Test statistic: F = 1.202455,
with p-value = P(F(1,19) > 1.20246) = 0.287

RESET test for specification (cubes only)
Test statistic: F = 1.274051,
with p-value = P(F(1,19) > 1.27405) = 0.273
```

Appendix G

```
Variance Inflation Factors
Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

d_LaborProductivity    1.293
   d_ProductionCost    1.079
    MarketingMargin    1.213
```

Appendix H

```
White's test for heteroskedasticity
OLS, using observations 1996-2019 (T = 24)
Dependent variable: uhat^2

                       coefficient      std. error    t-ratio   p-value
  ----------------------------------------------------------------------
  const                 16.4523        185.105         0.08888  0.9304
  d_LaborProductiv~      0.00792597      0.00574029    1.381    0.1890
  d_ProductionCost      -0.0116701       0.0153379    -0.7609   0.4594
  MarketingMargin     -200.533         1618.05        -0.1239   0.9031
  sq_d_LaborProduc~     -5.42596e-08     4.65893e-08  -1.165    0.2636
  X2_X3                  2.81931e-07     2.87838e-07   0.9795   0.3440
  X2_X4                  0.0108580       0.0229217     0.4737   0.6430
  sq_d_ProductionC~     -3.13400e-07     3.26400e-07  -0.9602   0.3533
  X3_X4                  0.0154289       0.0419181     0.3681   0.7183
  sq_MarketingMarg~   2104.06          4194.14         0.5017   0.6237

  Unadjusted R-squared = 0.200811

Test statistic: TR^2 = 4.819472,
with p-value = P(Chi-square(9) > 4.819472) = 0.849753
```

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Appendix I

```
Augmented regression for Chow test
OLS, using observations 1996-2019 (T = 24)
Dependent variable: FarmersWages

                     coefficient    std. error   t-ratio  p-value
  -----------------------------------------------------------------
  const               98.1978       10.3702       9.469   5.83e-08 ***
  d_LaborProductiv-    0.000403780   0.000260427  1.550   0.1406
  d_ProductionCost    -0.00130082    0.000952593 -1.366   0.1910
  MarketingMargin   -109.746        56.7578      -1.934   0.0711   *
  splitdum             6.60802      14.4746       0.4565  0.6541
  sd_d_LaborProduc-    0.000326362   0.000272738  1.197   0.2489
  sd_d_ProductionC-    0.000765802   0.000978198  0.7829  0.4451
  sd_MarketingMarg-   80.7519       64.5333       1.251   0.2288

Mean dependent var   147.0650   S.D. dependent var   56.39552
Sum squared resid    3202.200   S.E. of regression   14.14700
R-squared            0.956224   Adjusted R-squared   0.937073
F(7, 16)             49.92872   P-value(F)           1.08e-09
Log-likelihood      -92.77700   Akaike criterion     201.5540
Schwarz criterion    210.9784   Hannan-Quinn         204.0543
rho                 -0.062617   Durbin-Watson        2.079567

Chow test for structural break at observation 2007
  F(4, 16) = 2.38352 with p-value 0.0948
```

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