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RICE SUPPLY RESPONSE IN THE PHILIPPINES: AN ALMON LAG APPROACH

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ABSTRACT

This study used the Almon lag model in estimating the supply response of irrigated rice in the Philippines. The quantity response lag length resulted from the sequential testing procedure revealed that irrigated rice ecosystems in the Philippines has a lag length of four periods. The model showed that there is delay in the effect of price to quantity by four years.

The short-run elasticities in quantity ranged from 0.004 to .094 while the long-run elasticities ranged from 0.52 to 0.70. Irrigated rice is inelastic both in the short-run and long-run. The inelastic attribute of irrigated rice indicated that farmers are less responsive to the increase in prices.

The study also included the trends of rice production, area harvested, yield per hectare and farmgate price of rice. The Philippine rice industry is characterized by low productivity, high farm gate price and non-expanding area for rice farming. These concerns are very important for food security and self-sufficiency in rice.

Keywords: Almon lag model, supply response, rice, polynomial distributed lag models

INTRODUCTION

The Philippines is basically an agricultural economy and its principal source of income comes from agriculture. An improvement in agriculture greatly affects the welfare of the people and the national economy (Fajardo *et al*., 1992). Therefore, the use of economic principles in agriculture is very vital. Proper agricultural development leads to industrialization, and this is the dream of every poor nation.

Rice (Oryza Sativa Linn.) is in the heart of Philippine agriculture. It is considered the single most important commodity because rice is the major staple food of approximately two-thirds of Filipinos. As the country's staple food, rice accounts for 35 percent of the population (now about 77 million) to as high as 60 – 65 percent for households in the lowest income percentile (GMA, 2002).

Rice is a very important commodity in our country and the government should maintain its stable production with respect to the increasing population. Twenty-three percent (23%) of the total Philippine population directly and indirectly derives their income from the industry (Philippine Peasant Institute, 1992).

Not only is rice an important staple, it also significantly contributes to the economy of the country. Rice is cultivated in 2.7 million hectares or 30 percent of the country's total arable land. It contributes an average of 15.5% percent of the country's gross value added (GVA), 13 percent to the consumer price index (CPI), 3.5 percent to the gross domestic product (GDP) and 3.3 % percent to the gross national product (GNP) (Ginintuang Masaganang Ani, 2002). In the light of this contribution, the country still has difficulty to attain self-sufficiency and price stability in rice production. The government has initiated different rice programs (e.g. Ginintuang Masaganang ani), and researches in order to formulate relevant policies in the rice industry.

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For the past several years, different models and approaches in studying supply response were used. Some supply response models use only few of past values in forming expectations. Some other models use the entire past history, with the past values receiving declining weights as we go further into the distant past. These models were called distributed lag models of expectations (Maddala, *et al.*, 1992).

Distributed lag models are potential models to be used in estimating supply response. There were few attempts to use these models in estimation. The specific distributed lag model that is well-known is the Polynomial Distributed Almon Lag Model, which was developed by Shirley Almon in 1965.

Distributed lag analysis is a specialized technique for examining relationship between variables that involve some delays or lags. In particular, the Almon Polynomial Distributed Lag Model, are used in order to reduce the effects of collinearity in distributed lag setting (Greene, 1993).

Rationale of the Problem

Supply response is a method used to analyze the role of price in shaping the farmers' production decision. Several studies of the supply response, aggregate or individual crop are based on time series data and either used Nerlove (1958) model devised for single commodities or method developed by Griliches (1960) for aggregate supply response (Guibao, 2005). Many economists and agriculturists internationally or locally have made quite a number of researches on agricultural supply response.

Managahas studied the response of Philippine farmers to price in 1965. The study revealed that Philippine farmers could be as price responsive as commercial crop farmers in other countries. In his statistical analysis, he used the traditional and adjustment lag models. A short-run elasticity 0.07 and 0.42 for the long-run elasticity were observed.

Five decades later, Guibao (2005) revisited the supply response of rice in the Philippines using the adaptive expectation model. Quantity-rice price elasticity elasticities were found to range from 0.57 to 0.72 while corn price were inelastic which ranged from 0.12 to 0.32. She observed that most of the estimates computed for the area response were not consistent with the economic theories of agricultural response. Therefore, new approaches in studying supply response should be conducted in order to identify appropriate models for the study.

This paper used a new approach using the Almon Lag Approach (Polynomial Distributed Lag Model) in order to validate the results of the two previous studies and to further examine the appropriate estimates which are consistent with the economic theories of agricultural response.

Furthermore, this study is the first one that attempted to use the Almon lag model in studying the supply response of rice in the Philippines. In the past, this model was used to produce reliable estimates of the parameters for past supply response studies who encountered problems with the estimation of their models because of the high correlations occurring between the independent variables (Griffiths, *et al.*, 1986).

Objectives of the study

The general objective of the study is to estimate the supply response of rice in the Philippines using the Almon Lag Model. The following specific objectives are:

a. To analyze the rice trends in production, area harvested, productivity (yield per hectare) and rice pricing; and
b. To estimate the quantity elasticities of irrigated rice

Significance of the study

This study estimated the supply response of rice in the Philippine using the new method (Almon Lag Approach). The approach may yield significant coefficients which is very important in the interpretation of results in this study.

Economic Theory states that prices of commodities are important factors that influence the decision making of producers so that a better knowledge about supply and price relationship make a precise and reliable forecast to guide policy makers as well as entrepreneurs in making appropriate long-run and short-run decisions (Garzon, 1981).

Furthermore, this study may contribute to the formulation of policies and will contribute to the greater understanding of the responses of rice farmers to price and other explanatory variables.

Scope and Limitations

One limitation of this study is that it made use of existing published data (Philippine Rice Statistics Yearbook, 1970-2002). The reliability of the results depended on the accuracy of the data published by the agency from which the data was taken (Guibao, 2005). The period of thirty-three years were considered for this is the only range of years that were available in the Philippine Rice Statistics Yearbook, only in 1970-2002.

Furthermore, the specific supply response estimates of irrigated rice by major islands in the Philippines were taken into consideration. Regional supply response was not possible because the data would not allow their estimation. No crop was chosen as a competing crop for irrigated rice. Supply response was computed only for irrigated rice for it contributed the bulk of the total rice production in the Philippines.

METHODOLOGY

Theoretical Framework

In a free market system, the distribution of output is determined in a decentralized way. The basic coordinating mechanism in a free market system is price. Price is the amount that a product sells for per unit, and it reflects what the society is willing to pay. Prices of inputs, labor, land and capital, determine how much it costs to produce a product. Output products are supplied by firms (Case and Fair, 2003).

The number of firms supplying the market and size structure of the agricultural industry is required to extend the theory of supply. Size structure refers to the quantity and distribution of land and other fixed factors throughout the agricultural sector and each individual firm's marginal cost curve will differ in relation to its own particular allocation of fixed factors (Ritson, 1997).

The relationship between quantity supplied to a market and product price is, however, rather more complicated that is indicated by the aggregation of the marginal cost curves of the firms supplying the market. In the market, products are produced thorough the inputs of production gathered by firms. Producers respond to price in their decision about how much to produce. Prices of commodities are important factors that influence the decision making of producers. Economists measure the responsiveness of producer to changes in prices through price elasticity of supply.

The concept of price elasticity of supply was used in an analogous way to demand elasticity to measure the responsiveness of quantity supplied to changes in the price of the product. It is defined as (Ritson, 1997):

$$\text{Elasticity of supply } (\eta_s) = \frac{\text{Proportionate change in quantity supplied of a product}}{\text{Proportionate change in price of a product}}$$

The value of elasticity of supply is positive for increase in price is likely to increase the quantity supplied to the market and vice-versa (www.tutor2u.net).

The shape of the different elasticities is presented in Figure 1. Zero elasticity, or perfectly inelastic supply curve, is where the quantity supplied does not change in response to price changes, and it is shown by a vertical line. A horizontal line represents infinite elasticity, or a perfectly elastic supply curve, below certain price, nothing is supplied, but a small increase in price above that level is sufficient to cause the quantity supplied to increase from zero to an infinite quantity. Any straight line supply curve which passes through the origin must have constant elasticity of unit ($\eta_s = 1$) since all such lines trace a locus of points such that a given proportionate change in price is always associated with the same proportionate change in quantity supplied.

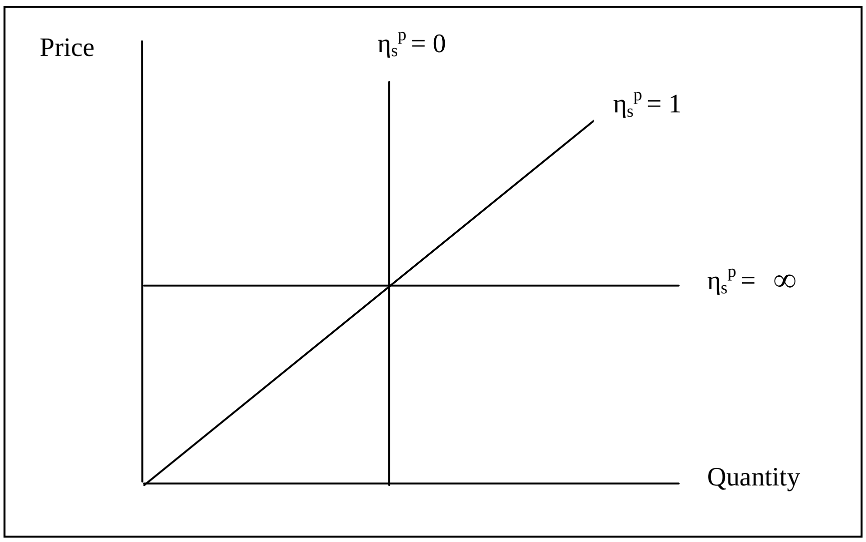
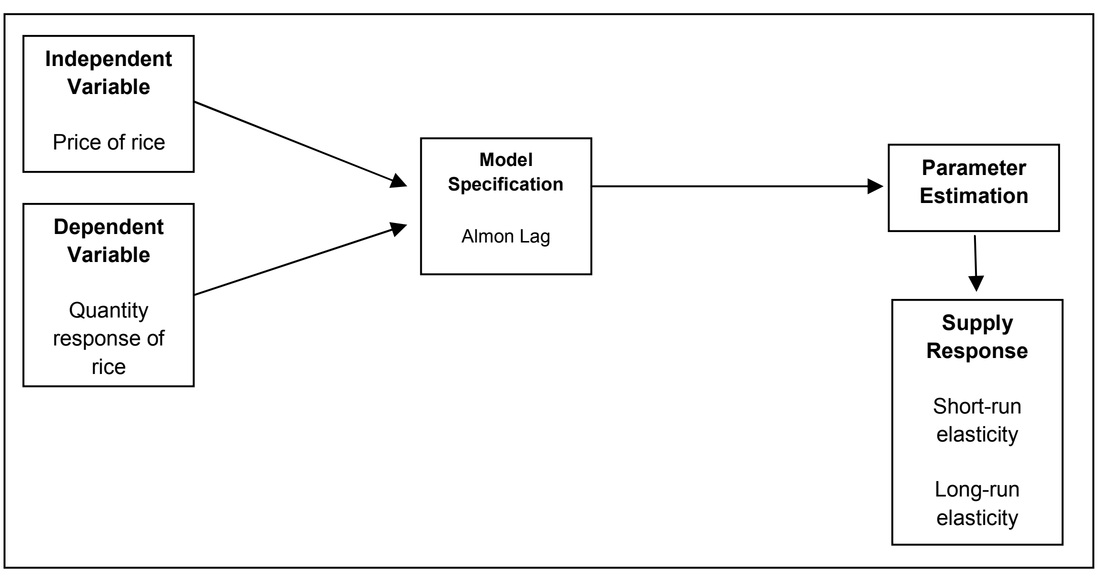


Figure 1. Price supply elasticities (Source: Case and Fair, 2003)

Conceptual Framework

Figure 2 presents the concept of the study, which provided the direction of the study. The first step is the identification of the independent variable (price of rice) and the dependent variable (quantity response) these variables were used to specify the Almon Lag Model. Estimation of the parameter was used. Finally, the supply response through the short-run and long-run elasticities was derived, using the coefficients obtained.



Data Figure 2. The conceptual framework of the study.

Time-series data on Philippine rice production (in metric tons), area (in hectares), rice farm gate prices from 1970-2002 were used in this study. These data were obtained from the Bureau of Agricultural Statistics published in the Philippine Rice Statistical Yearbook (2002).

Economic Model

Algebraically, we can represent lag effect by saying that a change in the explanatory variable x_{t-1}, x_{t-2}, …. x_{t-n}, has an effect on predictor variable y_t, y_{t+1}, y_{t+2}, …. y_{t+n}. This is well represented in an economic model:

$$\textit{Rice production}_t = f\,(\textit{price of rice}_{\ t-1,\ t-2,\ \ldots\ t-n})$$

This is an economic framework for a distributed lag model. It is finite as the duration of the lag effects is a finite period of time, namely in n periods.

The quantity of farmers' rice production is assumed to be dependent on the price of rice.

$$Q_t = f\,(P_t, P_{t-1}, P_{t-2}, P_{t-3}, \ldots\ldots P_{t-n}) \quad (1)$$

where:

Q_t = quantity of rice production (in metric tons) in period t, t-1, t-2 up to n, which denotes lag length

P_t, P_{t-1}, P_{t-2}, P_{t-3},. P_{t-n} = farm gate price of rice, the independent variables in t, t-1, t-2 up to n lag length

The Almon Lag Model

Distributed lag analysis is a specialized technique for examining relationship between variables that involve some delays. In this case, we have independent or explanatory variables that affect the dependent variable with some lags. The distributed lag allows one to investigate those lags.

The Almon Polynomial Distributed Lag Model is a finite lag model in which change in an independent variable has an effect on the outcome variable that is distributed over several future periods (Griffiths, *et al.*, 1984). Imposing a shape on the lag distribution will reduce the effects of collinearity. Thus, the lag distribution $\beta_0, \beta_1, \beta_2, \ldots, \beta_n$, maybe thought of as describing the way the dependent variable y_t reacts through time to a unit impulse in the exogenous variables.

The distributed response is due to frictions caused by the rigidities caused by the rigidities in rice production, like price of rice. It is reasonable to assume that the lag distribution would be smooth. That is, if β_i were plotted against i for i = 0,1,2,…., n the graph would not fluctuate wildly as in Figure 3.

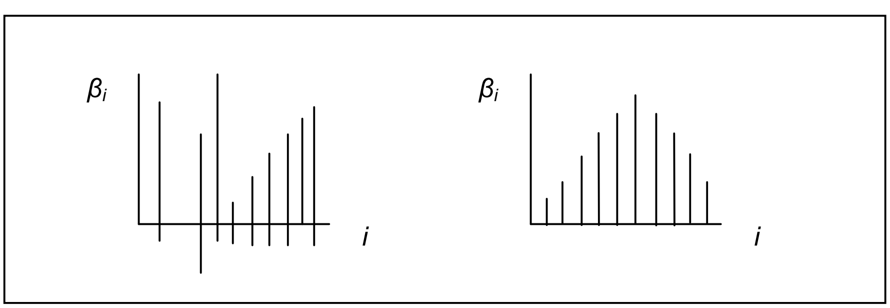


Figure 3.Contrast between non-smooth and smooth lag distribution
(Source: Maddala,1992)

The assu ›y Shirley Almon in 1965. Hei approximate it by a low-order polynomial.

This estimated the effect of lags of a variable x on y_t and to select the degree of order of polynomial to represent the lag weight.

$$\frac{\partial(Ey_t)}{\partial x_{t-1}} = \quad {}_i = ¥_0 + ¥_1 i + ¥_2 i^2 + \ldots + ¥_n i^k \qquad i = 0,1,2,\ldots.n \qquad (2)$$

The β_i are distributed lag weights, in which the effect of a change in x_{t-1} on (Ey_t) is well represented by *k* order of polynomial in *i-th* to *n-th* length of lag.

The changes in x will be distributed over n periods. The statistical model for this is:

$$Y_t = \sim + \quad {}_0 x_t + \quad {}_1 x_{t-1} + \quad {}_2 x_{t-2} + \ldots + \quad {}_n x_{t-n} + £_t \qquad (3)$$

where:

Y_t = dependent variable at year t
α = the intercept
$\beta_{i=}$ parameters at *i-th* to *n-th* lagged periods
$x_t, x_{t-1}, x_{t-2} \ldots. x_{t-n}$ = independent variable at *i-th* to *n-th* lagged periods
ε_t = the error term

In this case, the relationship between the polynomial lag terms and the distributed lag coefficients can be found by substituting i=0,1,2,3…n into the equation, where i=number of lag terms in k order of polynomial in *i* lag terms. It is assumed that *k* (degree of polynomial) is less than *n* (the maximum length of lag). It is expressed as (Maddala, 1992):

$$\begin{array}{ll} {}_i = ¥_0 & \text{i=0} \quad (4) \\ {}_i = ¥_0 + ¥_1 + ¥_2 + \ldots. + ¥_k & \text{i=1} \\ {}_i = ¥_0 + 2¥_1 + 2^2¥_2 + \ldots. + 2^k¥_k & \text{i=2} \\ {}_i = ¥_0 + 3¥_1 + 3^2¥_2 + \ldots. + 3^k¥_k & \text{i=3} \\ | \qquad | \qquad | & \\ {}_i = ¥_0 + n¥_1 + n^2¥_2 + \ldots. + n^k¥_k & \text{i=3} \end{array}$$

Now substitute the $¥_i$ into equation (3) to get an estimable equation:

$$Y_t = \sim + \sum_{i=0}^{n} (¥_0 + i¥_1 + i^2¥_2 + \ldots. + i^k¥_k) \qquad (5)$$

$$Y_t = \sim + ¥_0 \sum_{i=0}^{n} x_{t-i} + ¥_1 \sum_{i=0}^{n} i x_{t-i} + ¥_2 \sum_{i=0}^{n} i^2 x_{t-i} + \ldots. + ¥_k \sum_{i=0}^{n} i^k x_{t-i} \qquad (6)$$

$$Y_t = \sim + x_{t-1}(¥_0 + ¥_1 + ¥_2 + \ldots. + ¥_k) + x_{t-2}(¥_0 + 3¥_1 + 3^2¥_2 + \ldots. + 3^k¥_k) + \ldots. \qquad (7)$$
$$+ (¥_0 + n¥_1 + n^2¥_2 + \ldots. + n^k¥_k)$$

We may write equation (6) as

$$Y_t = \sim + ¥_0 z_{0t} + ¥_1 z_{1t} + ¥_2 z_{2t} + ... + ¥_k z_{kt} + £_t \qquad (8)$$

where:

$$z_{0t} = \sum_{i=0}^{n} x_{t-i} \qquad z_{1t} = \sum_{i=0}^{n} i x_{t-i} \qquad z_{2t} = \sum_{i=0}^{n} i^2 x_{t-i} \qquad z_{kt} = \sum_{i=0}^{n} i^k x_{t-i}$$

The Almon Lag Scheme Y is regressed on the constructed variables z, not the original variable x. The estimates of $\sim$ and $¥_i$ obtained, have all the desirable statistical properties provided the stochastic disturbance term £ satisfies the assumption of the classical linear regression model, where:

1. E (£) = 0
2. E ($£^2$) =σ^2
3. cov ($£_i$, $£_j$) = cov(y_i , y_j)

To apply the Almon technique, the following are observed (Gujarati, *et al.*, 1995):

1. The maximum lag length must be specified in advance. The best approach is to settle the lag first by starting with very large values of *i* (lag length) and then seeing whether the fit model deteriorates significantly when it is reduced without imposing any restriction on the shape of the distributed lag.

2. Having specified the lag length, the degree of polynomial *k* must also be specified. Generally, the degree of the polynomial should be at least one more than the number of turning points in the curve relating β_i to *i.* This is determined by starting with a very large value and reducing it, gradually.

3. Once the *k* and *i* are specified, the z's can be readily constructed. For instance, in the relationship between the quantity of rice production and farm gate price of rice, n=3 and k=2, the z's are:

$$z_{0t} = \sum_{i=0}^{n} x_{t-i} = (x_t + x_{t-1} + x_{t-2} + x_{t-3}) \qquad (10)$$

$$z_{1t} = \sum_{i=0}^{n} x_{t-i} = (x_t + x_{t-1} + 2x_{t-2} + 3x_{t-3})$$

$$z_{2t} = \sum_{i=0}^{n} x_{t-i} = (x_t + x_{t-1} + 4x_{t-2} + 9x_{t-3})$$

Choosing the appropriate lag length

The Ordinary Least Squares method was used to estimate the quantity response for lag length i=2,3,4 and 5. The sequential testing procedure with maximum lag length of 5, and of 0.05 level of significance level at each step, and a hypothesis testing in each level of lag length was done (Gujarati, 1995):

$H_0 : \beta_i = 0$

$H_1 : \beta_i \neq 0$ *where i= 0,1,2,3,….,n* where:

i = the lagged periods from i-th to n-th lag
β_i = parameters at i-th to n-th lag periods

The procedure is stopped when the null hypothesis that the parameter β_i is equal to zero, otherwise accept the alternative hypothesis. It made use of t-ratios and p-values in arriving at the first significant t-statistic.

Choosing the Degree of Polynomial

The proper way is to start with high degree and go backwards, until one hypothesis is rejected.

$H_0 : \beta_i = \beta_n = 0$
H_1 : at least one of the β_i is non-zero *where i= 0,1,2,3,….,n*

where:

i = the lagged periods from i-th to n-th lag
β_i = parameters at i-th to n-th lag periods

The F-ratios and the corresponding p-values were used in testing the hypothesis with .05 level of significance in each level of degree. The procedure stops when the hypothesis that the β_i and β_n is equal to zero is rejected*;* otherwise accept the null hypothesis that is not equal to zero. Finally, after the process the degree of polynomial was chosen.

The specified lag length and degree can be approximated with the following polynomial lag models (note that lag length should be greater than the polynomial degree):

Lag length	Polynomial degree
i=5	k=4,3,2,1
i=4	k=3,2,1
i=3	k=2,1
i=2	k=1

Computing the Elasticities

The supply responses through short-run and long-run elasticities were derived, using the coefficients obtained from the estimation of the quantity response using the Almon lag model. The obtained supply elasticities were estimated using this formula:

$$\text{¦}^{s}_{p} = \frac{\Delta Q_s}{\Delta P} \times \frac{P_o}{Q_o}$$

The formula can also be expressed in the form (Griffiths, 1984):

$$\text{¦}^{s}_{p} = \frac{\frac{\Delta E(y)}{E(y)}}{\frac{\Delta x}{x}} = \frac{\Delta E(y)}{\Delta x} \times \frac{x}{E(y)} = {}_{i} \times \frac{x}{E(y)}$$

In the distributed lag settings, the short-run elasticity is expressed in this form:

$$\hat{\eta}_p^s = \beta_0 \times \frac{E(x_t)}{E(y)}$$

where:

$E(x_t)$ = the expected (mean) value of the independent variable
$E(y)$ = the expected (mean) value of the dependent variable
β_0 = the regression coefficient at year t

The long-run elasticity is estimated using this equation:

$$\hat{\eta}_p^s = \sum_{i=0}^{n} \beta_i \times \frac{E(x_{t-i})}{E(y)}$$

where:

$E(x_{t-i})$ = the expected (mean) value of the independent variable at *i-th* to *n-th* lagged periods
$E(y)$ = the expected (mean) value of the dependent variable
β_i = the regression coefficient at year t-i, where $i = 0,1,2,3,\ldots,n$

It is expected that the short-run elasticity is lower than the long-run elasticity. Short-run is the time period of insufficient length to permit decision makers to adjust fully to change in market conditions (Bernardo, *et al.,* 1992).

Long-run is the period where producers can adjust fully in changing market conditions. The principal determinant of supply elasticity is the time involved in the ability of producers to respond to price changes. In the case of agricultural or farm products, it takes a long time to produce the products, the supply inelasticity, that's why it is expected that in rice production, the responses of farmers are highly inelastic (Fajardo, *et.al*, 2001).

The following procedures in estimation were applied in the quantity response of irrigated rice, by major island. SHAZAM Version 9.0 was used to estimate the parameters.

RESULTS AND DISCUSSIONS

Described below is the performance of the rice industry in terms of production, area harvested, productivity (yield per hectare), rice pricing for the past 33 years. Supply response was estimated using the Almon Lag Model in terms of the quantity response of rice in the irrigated ecosystem.
Analysis of trends

Rice Production

The rice industry has been doing quite well for the past thirty-three challenging years. From 5.0 million metric tons (MT) in 1970, it grew by 60.7% in 2002 after it registered 12.7 million metric tons. In 2005, it reached about 14.4 MT volume of production and a crop area of 4.07 million hectares. The value of rice production at current prices was estimated at Php 155.7 million. Thailand produced 26 million tons (PhilRice, 2005). The annual growth rate of rice production is 3.5% (Figure 4). Luzon contributed 57%, Visayas 19% and Mindanao contributed 24% to the total rice production (BAS, 2005).

Figure 5 presents the volume of rice production, by ecosystem. Irrigated rice accounted for about 67% of the total production, at an annual growth rate of 4.25%. Irrigated rice is grown in bundle, puddle fields with an assurance of probable or potential irrigation for cropping in a year.

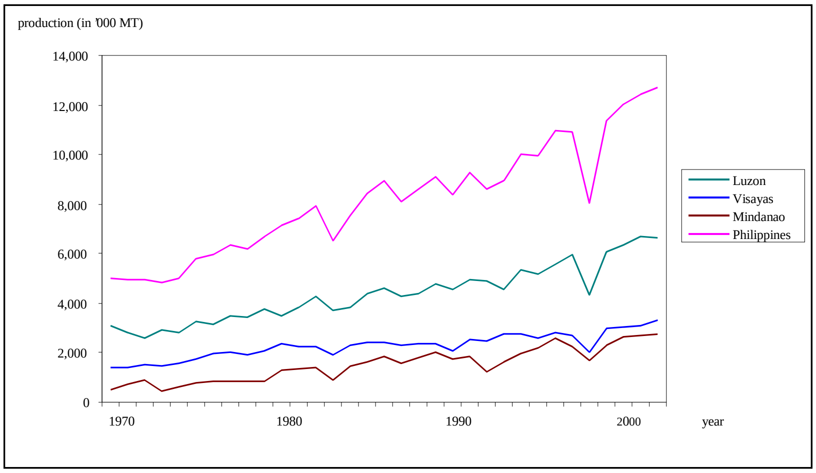


Figure 4. Production of Rice in the Philippines, by island (1970-2002)
Source: Bureau of Agricultural Statistics

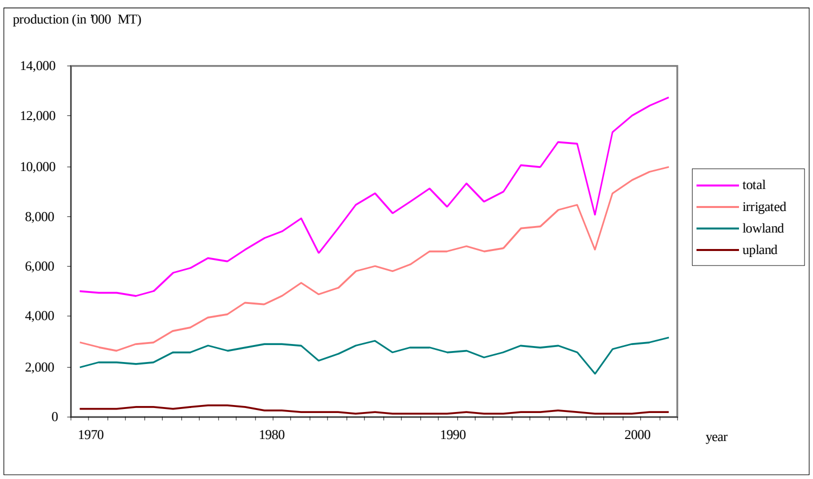


Figure 5. Production of Rice in the Philippines, by ecosystem (1970-2002)
Source: Bureau of Agricultural Statistics

In 2002, lowland rainfed contributed nearly 32% of the country's total rice production with more than 3 million MT produced. They are characterized by lack of water control, with floods and drought being potential issues and concerns of the industry. The rice production in lowland areas has an average annual growth rate of 2.36%.

The upland rice constituted almost 3% of the total Philippine production and growing at an average annual rate of .48%. These ecosystems are grown in highlands, hills and mountainous area.

Area Harvested

In terms of area harvested, irrigated contributed about 55% of the total land devoted to rice. Lowland rainfed accounted for about 39% of the total land devoted to rice while upland rice ecosystem, accounted for about 6% of the total area harvested from (Figure 6). It has an annual rate increase of 1.06%.

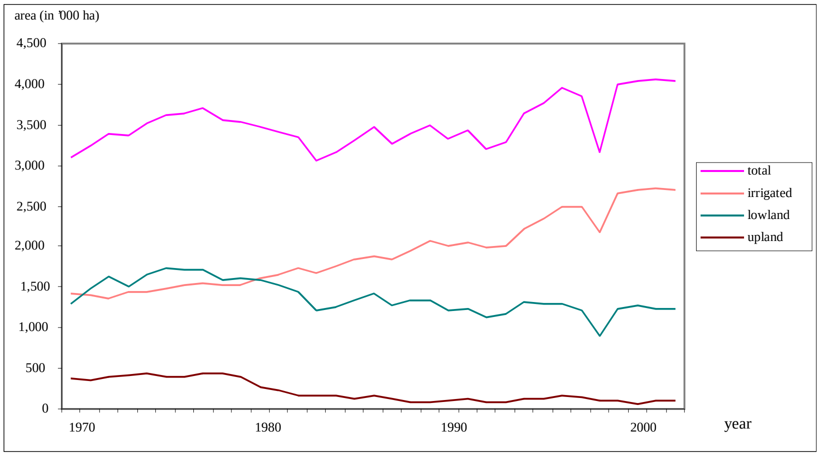


Figure 6. Area Harvested to Rice in the Philippines, by ecosystem (1970-2002)
Source: Bureau of Agricultural Statistics

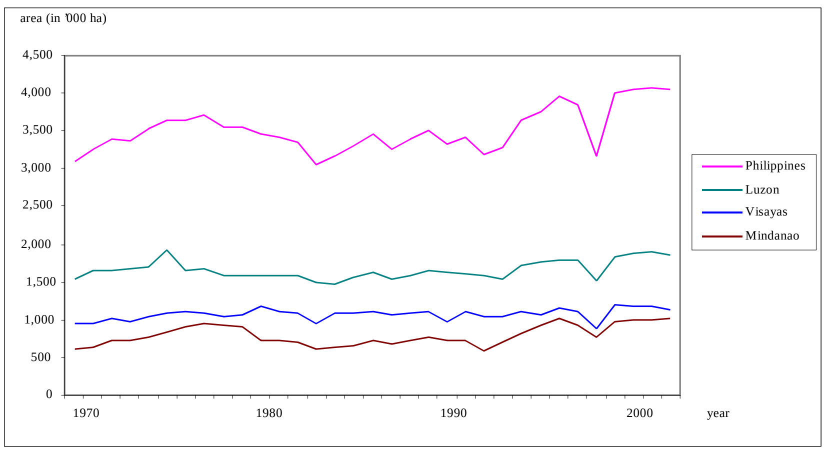


Figure 7. Area Harvested to Rice in the Philippines, by island (1970-2002)
Source: Bureau of Agricultural Statistics

Luzon, contributed more than 47% of the total rice lands in the country. Visayas contributed almost 30% of the total Philippine rice land area while Mindanao contributed 23%. There have been no dramatic changes in the area harvested in all the islands given the almost flat curves (Figure 7).

Productivity

Productivity in rice production is presented in Figure 8. It is clearly seen from figure that the productivity fluctuated wildly over the years. Luzon has greater productivity than Visayas and Mindanao. The Philippines attained its highest productivity at 3.18 in 2022 and an average annual growth rate of 2.31%. The average annual growth rate in terms of productivity in Luzon is 2.63%, Visayas is 2.11% and Mindanao is 1.93%.

By rice ecosystem, the irrigated rice farms have higher productivity compared to upland and lowland rainfed farms (Figure 9). There is an average annual growth rate of 2.43% in all ecosystems. An average annual growth rate of 2.94% is seen on the irrigated rice farms, lowland is 1.92% and upland is 1.19%.

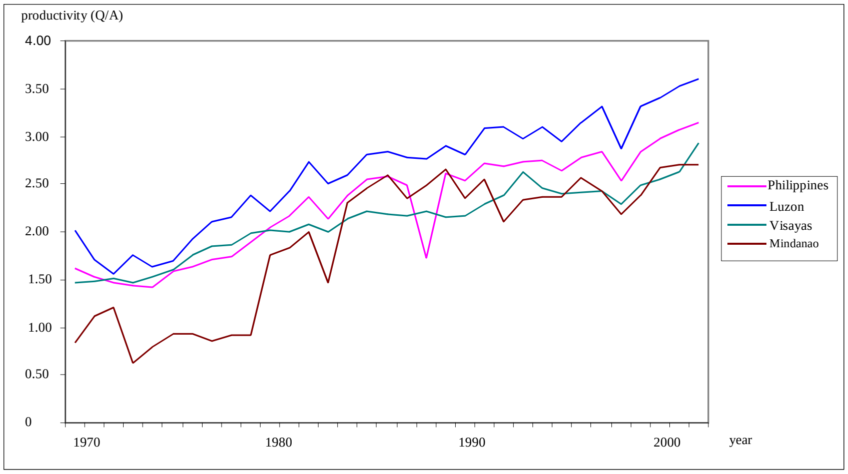


Figure 8. Productivity of Rice in the Philippines, by island (1970-2002)
Source: Bureau of Agricultural Statistics

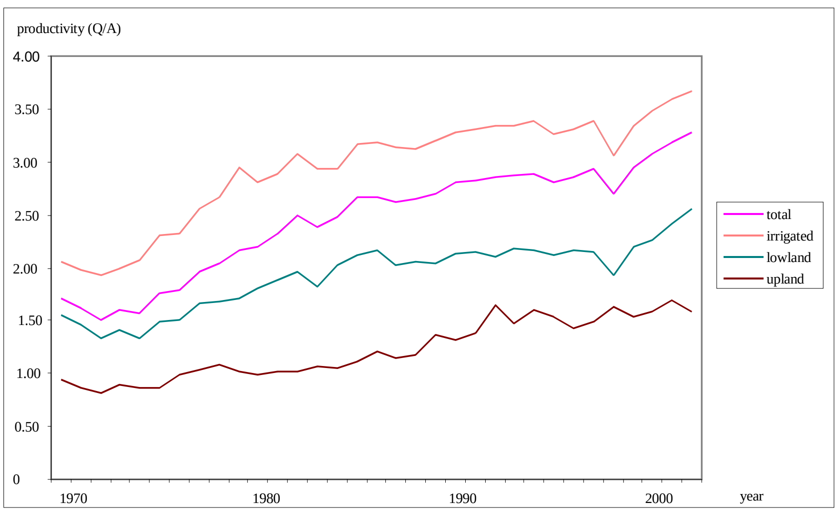


Figure 9. Productivity of Rice in the Philippines, by ecosystem (1970-2002)
Source: Bureau of Agricultural Statistics

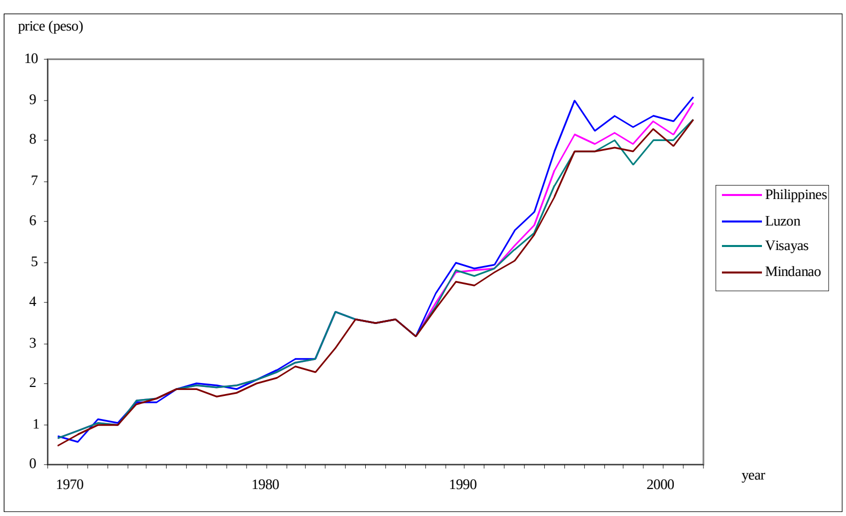


Figure 10. Farmgate Price of Rice in the Philippines, by island (1970-2002)
Source: Bureau of Agricultural Statistics

Price

Pricing did not vary much among the islands (Figure 10). On the average, prices grew by about 9.40% annually.

For the past thirty-three years, the Philippine rice industry faced a dilemma of low supply of rice, high farm gate price and non-expansion of rice farming. These concerns are very important for food security and self-sufficiency in rice. The study of Food and Agriculture Organization (FAO) on the farmgate price of play in the Philippines from 1992 to 2001 showed that the Philippines has one of the highest prices in Asia. In 2001, the price of palay in the country is around Php 8.00 per kilogram, which is higher than China's Php 7.00; Vietnam, Indonesia, Thailand and India's Php 6.00 (roughly) per kilogram (PhilRice, 2005). At farmgate, the January to April 2006 average price was quoted at Php 10.87 per kilogram, higher than the corresponding average prices in 2005 and 2004, which is Php 7.52 and Php 8.87, respectively (BAS,2005). High prices are due to its low supply and high cost of production. One of the reasons for its low supply is the country's small agricultural area. Only about thirty-two percent (32%) of the total Philippine agricultural area is planted to rice (BAS, 2005).

A study conducted by the International Rice Research Institute and PhilRice showed that the cost of producing one kilogram of palay in Central Luzon is Php 4.80, compared with only Php 2.95 in the Central Plain of Thailand and Php 3.70 in the Mekong Delta of Vietnam. It is expensive to produce palay in the Philippines primarily because of high labor costs. Most Filipino farmers use manual labor for harvesting and a small portable thresher , consuming around 30 man-days per hectare. Among Asian countries, annual net income per hectare in the Philippines is far the highest at nearly Php 60,000 primarily owing to the farmers' high selling rate of palay (PhilRice, 2005). Farmers remain to be poor given the high price of palay for they only own an average of 2 hectares of land only, making it difficult for them to earn higher incomes from rice farming alone.

Almon Lag Estimation

Results of the lag length determination for quantity response in irrigated rice by major island is presented in Table 2.

Table 2. Lag Selection for the quantity response of irrigated rice in the Philippines, by major island, 1970-2002

Lag	Philippines		Luzon		Visayas		Mindanao	
Length	t-ratio	p-value	t-ratio	p-value	t-ratio	p-value	t-ratio	p-value
2	0.3909^{ns}	0.699	-0.3790^{ns}	0.1084	0.5360^{ns}	0.1270	0.3099^{ns}	0.7593
3	1.795^{ns}	0.086	1.5592^{ns}	0.1325	0.3100^{ns}	0.2120	1.93^{ns}	0.0660
4	3.408*	0.0008	3.2663*	0.0034	2.4305*	0.0233	4.5370*	0.0001
5	1.667^{ns}	0.110	1.9298^{ns}	0.7080	0.8560^{ns}	0.0987	-1.377^{ns}	0.1859

* - First significant t-statistic at 5% level of significance
^{ns} – Not Significant

The quantity response lag length resulted from the sequential testing procedure done in major islands in the Philippines is in Table 2, where the irrigated rice ecosystems in all islands, namely; Luzon, Visayas and Mindanao, and all over the Philippines got the lag length of four lagged periods.

Results of the sequential testing showed that the degree of polynomial for β_s is 1; meaning the relationship is a linear one. This degree of polynomial was used for the derivation of elasticities, both in the short-run and long-run.

Supply Response Estimation

The Almon lag model estimated the quantity response of rice with the price expectation behavior of rice production, through the model's polynomial weighing function of price.

The model was applied using price of rice as the independent variable in irrigated ecosystem in the Philippines. In accordance with the sequential testing procedure, the Almon Lag model used the lag length of four and first degree polynomial (Table 2).

Quantity response:

$$Q_t = \alpha + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \beta_3 x_{t-3} + \beta_4 x_{t-4}$$

where:

Q_t = quantity response at year t
α = intercept
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ = parameters at 0 to 4th lagged periods
x_t , x_{t-1} , x_{t-2} , x_{t-3} , x_{t-4} = price of rice at 0 to 4th lagged periods

Quantity responses of irrigated rice are presented in Table 3. The estimated R^2 ranged from 91% to 92%, which means that 91% to 92%, of the variability in the quantity of rice produced can be ascribed from the unpredictability in prices.

Table 3. Almon Lag Quantity Response of Irrigated rice in the Philippines, by major island, 1970-2002

Parameter Estimates	Philippines	Luzon	Visayas	Mindanao
Intercept	2955600* (21470)	1998300* (132790)	317200* (39986)	640110* (60590)
P_t	67528^{ns} (10730)	47307^{ns} (66376)	18655^{ns} (19987)	1365.9^{ns} (30287)
P_{t-1}	66750* (52960)	70530^{ns} (32752)	23240* (9662.4)	22984^{ns} (30287)
P_{t-2}	165980* (9039)	93554* (5589.7)	27825* (1683.2)	44603* (2330.5)
P_{t-3}	515210* (57890)	116580* (35798)	32409* (10780)	66222* (16334)
P_{t-4}	264430* (11230)	139600^{ns} (69451)	36994^{ns} (20913)	87840^{ns} (31689)
R^2	.92	.91	.92	.92
Short-run own-price elasticity η	.0471	.0532	.0935	.0040
Long-run own-price elasticity	.5785	.5240	.6972	.6503

The estimated coefficients yielded the expected positive signs that the price of rice is directly related to the quantity produced. The results are consistent with the Law of Supply that states, "the producers are willing and able to offer more goods at a higher price, and fewer goods at a lower price". Responses of producers, however, vary in accordance with the kind of goods they produce. In the case of rice, it usually takes a shorter period for them to respond to price changes (Fajardo, 1992).

The short-run own-price elasticities ranged from 0.004 to 0.094. Rice is inelastic which is in line with the concept that the consumers are less responsive to price changes if the commodity is a staple food. Consumers are willing to buy rice despite the increase of its price, because it is a necessity in the households.

Rice is inelastic which means that a change in price results to less change in quantity supplied. This shows that producers have very weak response to price changes because producers are willing to increase output given a higher price but it takes longer time to adapt these changes especially in agricultural settings.

The long-run elasticities ranged from 0.52 to 0.70. Irrigated rice is also inelastic in the long-run, which is expected when the inputs vary through time; the farmers have longer time to adjust to prices of rice. In the consumer's side, the long0run price increase does not affect the demand for rice because they are still willing to pay a higher price in return for its consumption, for rice is a necessity in every household.

The estimated elasticities were lower compared to the results of guibao (2005) which only ranged from 0.58 to 0.72 in the short-run and 0.72 to 0.90 in the long-run. The resulted elasticities were consistent with economic theory both in the short-run and lng-run.

SUMMARY AND CONCLUSIONS

The Philippine rice industry faces a dilemma of low supply of rice, high farm gate price and non-expansion of area for rice farming. These concerns are very important for food security and self-sufficiency in rice. There are a lot challenges that the rice industry had faced for years, but the most important thing is the attainment of the availability and affordability of rice. The essence of survival of Filipinos lies on food security and self-sufficiency of rice in our country, and therefore it should be the main concern of the government.

The Almon Lag estimation yielded short-run elasticities ranging from 0.004 to 0.094. The long-run elasticities ranged from 0.52 to 0.70. The quantity responses of irrigated rice ecosystem in the Philippines were inelastic both in the short-run and long-run. The estimated coefficients obtained were consistent with economic theories.

RECOMMENDATIONS

The inelastic attribute of irrigated rice indicated that farmers are less responsive to the increase in rice prices. Farmers are not able to respond to changes in price immediately because of the following issues that need to be addressed:

1. The government should provide credit support to rice farmers. This could eliminate middlemen who prey on these farmers.
2. Productivity programs to address the food security and self-sufficiency of rice should be the key factor in attaining sustainability in the rice industry.
3. Acceleration in the implementation of the Comprehensive Agrarian Reform Program (CARP) to address the issue of land ownership, including the provision of infrastructure support.

4. To improve irrigation performance, to include irrigation management, payment collection, water delivery, and irrigation structure and design.

AREAS FOR FURTHER STUDY

The success of the Almon lag model does not really appear to be the optimum method in estimating the supply response of rice in the Philippines. There should be thorough exploration in different distributed lag models that will capture the movement or trends of rice prices, production and area harvested.

The Geometric lag model developed by Koyck is worth exploring. Panel data estimation can also be tested using the fixed or random effects model. The "Semi-Cooperative" game theory model and the Heckman Switching Regression could also be attempted to confirm the validity of this study.

Furthermore, estimating the Almon Lag Model with multiple independent variables should be explored in order to validate the results obtained in this study, which only used one predictor variable. Attempts should be made to estimate the supply response at the regional level.

REFERENCES

Bernardo, M. 1999. *Economics for the Consumers.* Sinigtala Publishers, Inc., Manila

Case and Fair. 2002. *Principles of Economics*. 12th Edition. New Jersey Prentice-Hall.

Garzon, P.1981. *The Supply of Response of Natural Rubber in Mindanao, Philippines.* M.A. Thesis. University of the Philippines-Los Baños. Philippines.

Ginintuang Masaganang Ani. 2002. Department of Agriculture. Philippines

Guibao, M.2005. *Supply Response of Rice(Oryza Sativa) in the Philippines.* An Undergraduate Thesis. University of Southeastern Philippines, Obrero, Davao City.

Gujarati, D.N.1995. *Basic Econometrics*. Third Edition. Mc-Graw Hill, Singapore

Greene, W.H.2002. *Econometric Analysis,* Fourth Edition. Prentice Hall, New Jersey

Griffiths, W.H.C. Hill and G, Judge.1984. *Undergraduate Econometrics.* John and Wiley Sons. New Jersey.

Grilliches.1960. *Estimates of the Aggregate US Farm Supply Functions.* Journal of Farm Economics, 42(2), 282-293

Maddala, G.S.1992. *Introduction to Econometrics.* Second Edition. Prentice Hall, New Jersey.

Nerlove, M.1958. *Distributed Lags and Estimation of Long-run Supply and Demand elasticities: Theoretical Considerations.* Journal of Farm Economics.

Philippine Peasant Institute.1992. *Profile of the Rice Industry.* Rural Development Studies. Diliman, Quezon City, Philippines.

Philippine Rice Institute (PHILRICE).2005. *Questions and Answers: The Economics of Rice.* Maligaya, Science City of Muñoz, 3119 Nueva Ecija.

Prantilla, E.1965. *The Supply Response of Sugar in the Philippines.* Unpublished M.A. Thesis. University of the Philippines-Los Baños College. Philippines.

Ritson, N.1997. *Agricultural Economics.*6th Edition. John Wiley and Sons. New Jersey