Supply Responsiveness of Rice Under Risk in Jambi Province

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Abstract
Farmers' supply responsiveness planting of rice in Jambi Province was estimated using Land Acreage analysis function. The objective of study is to analyze rice farmers' supply response under risk. The first, the lagged production function was postulated for empirical estimation of expectation variables. The estimated parameters showed that risk variables played an important role for farmers in making decisions. The result also showed that farmers are risk averse. Therefore, government policies have to consider risk management, and dynamic considerations. Finally, in order to evaluate the effectiveness of this policy especially in government farm program, the risk variables will again give an effect and impact on final result..
Keywords : supply response of rice, Land Acreage function, and risk

I. INTRODUCTION

At the time of Regional Autonomy (decentralization) today, local government seeks to find and exploit the potential of the region in order to increase revenue. As with other areas in Indonesia, the main source of public revenue Jambi is from agriculture, especially rice farming which has become one of the most strategic business nowadays because it can increase farmers' income. Jambi province, which is one of the rice-producing areas in Indonesia, showed improvements in rice production from year to year, this is because of the availability of infrastructure and production facilities for farmers (Anonymous, 2013).

The development of this production that while effective in recent years, may be relatively difficult to be repeated in the future (Anonymous, 2013). This is because of economic crisis and financial difficulties which resulted in reduced subsidies for this activity. With these conditions, some areas of agricultural policy experts interested in observing the response of supply and demand for inputs in rice farming. Estimation of supply response, such as changes in input use has been reported in several studies (Bapna et al. 1991; David and Barker, 1988; and Guyomard, et al. 1996). But very few have examined the response of supply and input demand in relation to price changes.

In Jambi Province, the same thing with other places, a lot of farm production and investment decisions are made under uncertainty of commodity prices, crop yields, and government policies in agriculture (Anonymous, 2013). The government has been keeping input subsidies (such as fertilizer) and price support policies to improve farm production. This policy is very controversial. In order to evaluate this policy, it is very important to understand the response of farmers to economic stimuli such as factor prices and not prices.

The farmers' responses to price changes for specific products aimed at many conditions, which include applying resources especially land and family labor, plant selection and techniques, opportunities outside labor, the price of the product and the presence of income uncertainty as well as farmers' attitudes towards risk (Olwande, 2009). Further according to Darmawi (2005) also asserted that in any business activity in sector of agriculture or agribusiness, the business is always faced with situations of risk and uncertainty.

The farmers' response to price changes is useful for policy formulation. If farmers respond positively to price movements, supply of rice will be affected by the increase in price. Effectiveness and cost of alternative pricing policies depends on the magnitude and significance of the estimated response (Smith et al. 2009).

Knowledge of the impact of other variables on the response of production is important for policy makers. Important variables include input prices, changes in technology, farm management, risk and financial constraints must be considered in studying the response of production for this study is more realistic and useful (Keeney and Hertel, 2008).

The role of the response of agricultural production has gained much attention in empirical studies today. Neoclassical theory of the model of production behavior of farmers in terms of maximum profit has been tested and accepted in the literature (Brennan, 1982). Choi and Helmberger (1993) have demonstrated theoretically that the increased uncertainties resulting price decline in optimal production from farming to compete.

Although many problems in its estimation, production response has a value of better consideration of policy makers in examining the basic program of farming in the province of Jambi to efficiency, the impact of distribution and production improvements. Key considerations in testing the response of production are (a) the production decisions made under ex-ante expectations and (b) many manufacturers are repellent risk (risk aversion) of at least limited income (Polome et al. 2006).

If there is risk involved in the production process or input prices and output, the agent assumed to behave as if they maximize expected utility of profits. Depending on the agents risk preferences, the marginal expectation of the input may not balance with the price factor. If an agent is repellent risk and production risk, the imbalance will depend on how risk into the production function and although the input will increase the risk or reduce risk marginally (Villano et al., 2005).

The process of agricultural production is generally characterized by sustainable decision because of time lags between the allocation of input and output realization. In the case of rice production in Jambi Province, farmers experience tend to decide crops to be planted with the availability of information about prices and the development of weather and infestations insecticides in the local area. Finally, farmers will decide the level of input variables such as labor and fertilizer. If constraints are not rational, farmers tend to modify its decision at each stage, depending on any changes to this information.

When all inputs are implemented, not many farmers can work to control the production process. Output level and then determined by a number of exogenous factors such as rainfall, drought, infestation insecticides and pesticides, plant diseases, and other factors that could affect agricultural production. Lack of this control makes it difficult to assess ex-ante supply function, because one can only observe the fact output as the supply function assessment ex-post.

From the above information then can be withdrawn subject matter as follows: "Can supply response of farmers to input prices, output prices, government programs in farming, the price of fertilizer, pesticide price, area harvested and other exogenous variables be explained?" From the issue and the problems above, the research objectives can be drawn: "Assessing the supply response of farmers to input prices, output prices, government programs in farming, the price of fertilizer, pesticide price, area harvested, and other exogenous variables."

II. LITERATURE REVIEW

There is a long tradition in production lagged model in evaluating supply response under risk at both the aggregate and farm level (McSweeny et al. 1987). However, the measurement of expected returns and supply response under risk in programming formulation is a modeller's dilemma. The optimal solution from building appropriate models will have significant implications for policy formulation and analysis.

In conjunction with choosing the appropriate models, this section presents theoretical frameworks of acreage supply response decisions and its implication on government farm programs. The basic models used in the analysis of risk production are acreage response model for lagged production analysis and its implication on price support and input subsidy programs' effectiveness (McCulloch, and Timmer, 2008).

Although farm production has been viewed as a single or multi product production decision (Just, 1973), these models have not included risk. In this section, theoretical formulations of production decision under uncertainty using single product (since we focus only on rice) approach are presented.

Let the general statement of acreage decision model be : $A = f(\Phi, \pi, \lambda, \theta)$, ...(1)

where : Φ = gross revenue per hectare
π = profits
λ = risk component
θ = policy component

and the farmers objective under risk that is to maximize the expected utility function defined as follows :

$$\text{Max } E\{U(\pi)\} = E\{U[X, \theta, T). A - C. X. A - F]\} \quad (2)$$

where : π = profits
X = input per hectare used
θ = policy of farm program
T = *proxy* for technological change
A = acreage harvested
C = input prices
F = fixed cost of production

The gross revenue per hectare can be denoted as $\Phi = (X, \theta, T)$ A. If the assumption that $f'(.) = 0$ is imposed as the first order condition for a maximum, the solution will yield the following equations :

$$A^* = A(\Phi, C, \theta, T) \quad (3)$$

$$X^* = X(\Phi, C, \theta, T) \quad (4)$$

Let stochastic gross revenue $\Phi_i = \Phi_i^* + \lambda$

where : Φ_i^* = farmers' expected revenue per hectare, and
λ = risk associated with crop

Then the acreage response and input demand equations are :

$$A^* = A(\Phi^*, \lambda, C, \theta, T) \quad (5)$$

$$X^* = X(\Phi^*, \lambda, C, \theta, T) \quad (6)$$

Upon the substitution of (5.5 – 5.6) back to (5.2), the indirect expected utility function can be derived as follows:

$$V(\Phi^*, \lambda, C, \theta, T) = E\{U[X^*, \theta, T).A^* - C. X^*. A - F]\} \quad (7)$$

The indirect utility function $V(\Phi^*, \lambda, C, \theta, T)$ is continuous and differentiable (Φ^*, λ, C). However, according to Pope and Cramer (1999), homogeneity and symmetry conditions are violated under risk and risk aversion.

III. RESEARCH METHOD

The research was conducted in Jambi Province, because this region is one of the producers of rice in Indonesia. And research carried out from March 2013 until August 2013. Implementation of the study used survey methods and data drawn from secondary data. Data used in this study are the data year 1986-2012 for the province of Jambi. Data from 1986-2012 are used to capture the economic crisis period that varies with the level of economic crisis are high, medium and small.

The Acreage Response Functional Form

Most supply response studies concentrate on the measurement of acreage response due to the high variability of yields. Since production response can always be decomposed of total production, or supply response. When between land and new seeds is possible to any significant extent, yield response may be considerable. On the other hand, because actual production levels reflect the ifluence of uncontrollable variables such as weather, plant disease and infrastructure, basing supply response on production levels is problematic.

The acreage response equation is

$$A_t = \alpha_0 + \alpha_1 \Phi_t + \alpha_2\lambda_t + \alpha_3C_t + \alpha_4 \theta_t + \varepsilon_t \quad (8)$$

where :
A_t = acreage per hectare in year t
Φ_t = expected gross return in year t
λ_t = expected risk in year t
C_t = input prices in year t
θ_t = government farm program in year t
α_0 = intersept
α_1 - α_4 = parameters
ε_t = error term

the variables in equation (7) were defined as follows :

a) The Gross Return Variable (Φ_t)

$$\Phi_t = \Sigma P_t.Y_t.A_t \quad (9)$$

where :
Φ_t = expected gross return in year t
P_t = output price in year t
Y_t = yield per hectare in year t
A_t = acreage per hectare in year t

(b) Farmers' Expected Gross Return [$E(\Phi_t)$]

$$E(\Phi_t) = \alpha_1 \Phi_{(t-1)} + \ldots + \alpha_p \Phi_{(t-p)} + \beta_1 \varepsilon_{(t-1)} + \ldots + \beta_q \varepsilon_{(t-q)} \quad (10)$$

where :
$\Phi_{(t-1)}$ = gross return per hectare in year (t-p), which is an auto-regressive (AR) component,
$\varepsilon_{(t-q)}$ = error term of lagged q year, which is a moving average (MA) component

(c) Risk Variable (λ_t)

$$\lambda_t = [\Phi_t - E(\Phi_t)]^2 \quad (11)$$

(d) Farmers' Expected Risk Variable [$E(\lambda_t)$]

$$E(\lambda_t) = \alpha_1 \lambda_{(t-1)} + \ldots + \alpha_r\lambda_{(t-r)} + \beta_1 U_{(t-1)} + \ldots + \beta_s \varepsilon_{(t-s)} \quad (12)$$

where : $\lambda_{(t-r)}$ = the risk variable in year (t-r), which is an AR component
$\varepsilon_{(t-s)}$ = *error term* of risk associated with production lagged s years, which is MA compenent

In time series analysis, it is important to test the stationary of data. Non-stationary of the time series data has a substantial influence on the final estimated rsults. According to Clark and Spriggs (1989), if a rime series data are not stationary, any shock, even an unexpected policy shock, will cause a permanent response, and the series will not return to the pre shock level without an equal shock in the opposite direction. In contrast, a stationary time series contains only a transitory responses.

The null hypothesis that crop acreage process is a unit root process was tested against the alternative hypothesis that acreage process is stationary around a linear trend. In other test this hypothesis, the equation was defined as follows :

$$\delta(A_t) = \beta_0 + \beta_1T + \beta_2A_{t-1} + \beta_3\delta(A_{t-1}) + \varepsilon_t \quad (13)$$

where :

$\delta(A_t)$ = the difference acreage between year t and year(t-1)
T = *linear time trend*
A_{t-1} = acreage in year t-1
ε_t = the *error term*
β_0 = *intercept*
$\beta_1 - \beta_3$ = parameters

The null hypothesis, in terms of estimated coefficients of equation (12), can be expressed as follows :
$H_0 : \beta_1 = \beta_2 = \beta_3 = 0$
If H_0 is not rejected, then, the crop acreage process is a unit root process.

Moreover, supply response consists of acreage and yield equations for rice. These equations are specifired linearity and estimated by seemingly unrelated regression. Partial adjustment is assumed and thus lagged acreage is included in the model. The acreage equations are :

$$A_t = f(P^*_{t-1}, A_{t-1}, \theta_t, T, \Phi_t) \quad (14)$$

where :
A_t = acreage harvested in year t
P^*_{t-1} = effective farm price deflated by index the variable cost of production in year t-1
θ_t = a varible representing the impact of input subsidy and price support program at year t,
T = linear *trend*
Φ_t = the risk variable in year t

The estimation acreage equations under risk are estimated by ordinary least sqares. The Durbin-Watson value is used to test the hypothesis. These results will be used to see how much risk has impact on acreage planted and also about the structural elsticity of planted acreage with respect to risk.

IV. FINDINGS AND DISCUSSIONS

The main purpose of this study was to identify the supply response of farmers' decision rules for risk and government policy programs. Expected Utility Profit function is used to estimate the hypothetic parameters. This function is subjected to variables with respect to risk and government policy programs to identify the optimal decision and risk efficient strategies. The key functions used to risk analysis are the meta-profit function, the lagged production function, and government program effectiveness.

Estimation of Lagged Production Function

This study investigated the acreage supply response in existing risk in lagged production function. The parameters of the crop acreage under risk were estimated by the ordinary least squares. In order to test the significance of each parameter, the null hypothesis can be expressed as $H_0 : \beta_1 = \beta_2 = \ldots = \beta_n = .0$. the results of estimated parameters of acreage response under risk were listed in Table 2. the Durbin Watson analysis showed that the hypothesis that $\beta_1 = \beta_2 = \ldots = \beta_n = .0$ can be rejected. This implies that at least one of the parameters is not equal to zero.

The acreage response were specified linearly, and estimated at two steps. First, farmers' expected gross revenue per hectare and risk variable were identified. Second, the estimated results were used to predict expected gross revenue per hectare and risk. the expected gross revenue variables were specified as an autoregressive-moving average process of Φt. The result of ARMA (3,3) was expressed as follows:

$$E(\Phi_t) = \Phi_t^* = 12{,}8 + 0{,}8\ \Phi_{t-1} + 0.01\Phi_{t-2} + 0.3\Phi_{t-3} - 0.2\epsilon_{t-1} - 0.02\epsilon_{t-2} - 0.3\epsilon_{t-3} \quad (15)$$

The expected risk variables (λ) were specified as an autoregressive-moving average process of $(\Phi_t - \Phi_t^*)^2$. The result of ARMA (3,3) can be expressed as follows:

$$\lambda = 12{,}3 - 0{,}5\ \lambda_{t-1} + 0.4\lambda_{t-2} + 0.5\lambda_{t-3} - 0.03U_{t-1} + 0.7U_{t-2} - 2.7U_{t-3} \quad (16)$$

Moreover, it suggests from empirical results that economic time series are rarely stationary and thus there is no reason that their associated error will be stationary.
In order to estimate a unit root (stationary) for acreage response process, the Dickey-Fuller test was used to check the hypothesis that $H_0 : \beta_1 = \beta_2 = \ldots = \beta_n = .0$. the results can be seen in Table 1.

Table 1. Dickey-Fuller Test for Acreage Response

	Results
F-test	36,981
Critical Value	4,03
Judgement	reject H_0
Implication	no unit root

These results indicated that rice data have no unit roots. So the data for these variables were not differenced before the acreage response was estimated. After the acreage response equation was specified, the estimated parameters were reported in Table 2.

From Table 2., the positive parameter on the expected gross revenue, Φ_t*, was significant at 5% significance level. This indicates that as farmers' expected revenue for rice increases, the rice acreage will increase.

Table 2. Estimations of Acreage Response Under Lags

	Parameters	Std. Error
Intercept	-7,6341	
Φ_t *	0,0031***	0,0009
λ	-0,0048**	0,0013
C_1	0,0023	0,0067
C_2	0,0012	0,0011
θ_1	0,0936*	0,0493
θ_2	0,0508**	0,0241
T	0,0021	0,0912
R^2	0,8923	
D.W.	2,7824	

Φ_t* = expected gross revenue
Λ = expected risk
θ_1 = fertrilizer price
θ_2 = pesticide
$ή_1$ = price support program
$ή_2$ = input subsidy
T = linear time trend
R^2 = adjusted R^2
D.W. = Durbin-Watson statistics

The parameter on the risk variable, λ, was greater than zero although it is not significant at the 1% significance level. This indicates that farmers are risk averse, and the risk associated with gross revenue increases, the acreage curve will shift to the left.

The paramter of support price programs, $ή_1$, was greater than zero although it is significant at the 10% significance level. This indicates that support price program have caused any distortions in acreage decisions by shifting the rice acreage response curve to the right.

The Impact of Fertilizer and Pesticide Use on Crop Yields

In order to test trade distorting effect of fertlizer and pesticide subsidy program, it is necessary to analyze the impact of fertilizer and pesticide use on crop yields since this program already showed positive impact on yield increasing and encourage to use.high yield variety that need more fertilizer and pesticide use per hectare in previous year and time trend, and assumed to be linear in its equations:

$$Y_t = \beta_0 + \beta_1 ђ_{t-1} + \beta 2\Phi_{t-1} + \beta_3 T + \epsilon_t \quad (17)$$

where :

Y_t = rice crop yield in year t
$ђ_{t-1}$ = fertilizer use per hectare inyear t-1
Φ_{t-1} = pesticide use per hectare in year t-1
T = time trend variable
β_0 = intercept
$\beta_1 - \beta_3$ = parameters
ϵ_t = error term

The OLS method was used to estimate the rice yield parameters. The estimated equation was as follows:

$$\delta(A_t) = 4851{,}3 + 0{,}087\,T + 0.371A_{t-1} + 1.081\,\delta\,(A_{t-1}) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$
$$(21{,}9) \quad (0{,}038) \quad (0{,}141) \quad (0{,}2104)$$
$$D.W. = 0{,}5912 \qquad R^2 = 0{,}8971$$

From the equation above, fertilizer and pesticide use per hectare had a positive influence on rice yield since its parameter was positive and significant at the 5 percent significance level. This indicates that increased fertilizer and pesticide use increases rice yield. And the parameter on time trend variable was significantly different from zero at the 1 percent significance level. It indicates that technical change has significant impact on rice yield.

The input subsidy program encourages farmers to use more fertilizer and pesticide which increases yields. Since, by using fertilizer, total output of rice is the product of acreage planted. Therefore, the impact of input subsidy program will encourage farmer to increase their output, and shift the output supply curve to the right. Hence, the input subsidy program causes trade distortion by shifting output supply curve to the right.

V. CONCLUSIONS AND FUTHER RECOMMENDATIONS

In this study, theoretical and empirical models associated with suply response under risk are reviewed. This study presented a framework for analyzing supply response decisions under risk. The importance of considering risk in rice crop framework was illustrated by simulating the acreage models at various price support levels for rice. The model simulation is used ro evaluate the effectiveness of government programs. And finally to see the impact of risk on supply response.

The first, the lagged production function was postulated for empirical estimation of expectation variables. The estimated parameters showed that risk variables played an important role for farmers in making decisions. The result also showed that farmers are risk averse. Therefore, government policies have to consider risk management, and dynamic considerations.

Finally, in order to evaluate the effectiveness of this policy especially in government farm program, the risk variables will again give an effect and impact on final result. For instance, eliminating risk will increase the acreage which it means the supply curve will shift to the right.

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