CHAPTER V

ESTIMATION OF VARIABLE INPUT DEMANDS AND OUTPUT SUPPLY

5.1. Model Specification

From the general function (12), the normalized restricted translog profit function for each type of rice cultivation techniques (RCT and MMCT) in MHYV Spring rice crop and each kind of rice varieties (MHYV and THQV) in RCT Autumn rice crop in Red River Delta can be written specifically in actual variables as:

$$(36) \quad Ln\Pi^* = \alpha_O + \alpha_L LnP_L^* + \alpha_F LnP_F^* + \frac{1}{2}\gamma_{LL}(LnP_L^*)^2 + \frac{1}{2}\gamma_{FF}(LnP_F^*)^2 + \gamma_{LF}LnP_L^*LnP_F^* + \beta_A LnZ_A + \delta_{LA}LnP_L^*LnZ_A + \delta_{FA}LnP_F^*LnZ_A + \frac{1}{2}\phi_{AA}(LnZ_A)^2$$

Where:

Π^* : Normalized restricted profit from rice production, defined as total revenue less total costs of labor and chemical fertilizer, normalized by output price P_y.

P_L^* : Wage rate per manday normalized by price of rice output P_y. It is expected to have negative effect on profit, variable input demands and supply of output.

P_F^* : Price of chemical fertilizer nutrient per kilogram of NPK, normalized by price of rice output P_y. It is expected to have negative effects on profit, variable input demands and output supply.

Z_A : Rice cultivated land area factor measured in sao. It is expected to have positive effects on profit, variable input demands and output supply.

The parameters α_O, α_L, α_F, β_A, γ_{LL}, γ_{FF}, γ_{LF}, δ_{LA}, δ_{FA} and ϕ_{AA} are to be estimated. The subscribe A stands for rice cultivated land area and L, F denoted the variable inputs of labor and chemical fertilizer, respectively.

The variable input share equations (S_i) of labor and fertilizer are obtained by differentiating the normalized restricted translog profit function (36) as follows:

Labor Share Equation:

(37) $$S_L = \alpha_L + \gamma_{LL} LnP_L^* + \gamma_{LF} LnP_F^* + \delta_{LA} LnZ_A$$

Fertilizer Share Equation :

(38) $$S_F = \alpha_F + \gamma_{LF} LnP_L^* + \gamma_{FF} LnP_F^* + \delta_{FA} LnZ_A$$

Where:

$$S_L = \frac{P_L^* \cdot X_L}{\Pi^*}$$

$$S_F = \frac{P_F^* \cdot X_F}{\Pi^*}$$

X_L, X_F are the quantities of variable inputs of labor and chemical fertilizer, respectively. Other variables, parameters and symbols are as defined earlier.

The model consisting of all the normalized restricted translog profit function (36) and the input share equations (37) and (38) is jointly estimated for each cultivation techniques (RCT and MMCT) in MHYV Spring rice crop and for each rice varieties (MHYV and THQV) in RCT Autumn rice crop.

The estimations are separately made for RCT and MMCT in MHYV Spring rice crop and for MHYV and THQV in RCT Autumn rice crop in order to evaluate the elasticities of variable input demands and output supply.

5.2. Joint Estimation of the Normalized Restricted Translog Profit Function and Variable Input Share Equations

Joint estimation is run by Zellner's SURE estimator. Estimated parameters of normalized restricted translog profit function and variable input share equations for labor and chemical fertilizer are presented in table 35 and 36 for RCT and MMCT in MHYV Spring rice crop, respectively and in table 37 and 38 for MHYV and THQV in RCT Autumn rice crop, respectively.

Before proceeding further, two formal statistical tests for two sets of hypothesis are conducted. The first statistical test is conducted to test the validity of the symmetry and parametric constrains across profit function Π^* and variable input share equations S_i.

The null hypothesis is that parameter of the variable input share equations (37) and (38) are equal to corresponding same parameters in the profit function (36), and that:

$$\gamma_{LF} = \gamma_{FL} \quad , \quad \delta_{LA} = \delta_{AL} \quad , \quad \delta_{FA} = \delta_{AF}$$

This is a joint hypothesis on the validity of imposing 8 restrictions (4 restrictions for each S_i

equation) on the systems of equations (36), (37), and (38). The Wald test and Likelihood ratio test statistics are conducted to test this hypothesis of the validity of the symmetry and parametric constraints across profit function and variable input share equations.

The critical χ^2 (8 D.F.) at 0.01 level of significance is 20.09. The computed χ^2 (8 D.F.) of the Wald and the Likelihood ratio tests for RCT in MHYV Spring rice crop are 36.07 and 33.51, respectively. Thus the null hypothesis is rejected for the case of RCT in MHYV Spring rice crop. For MMCT in MHYV Spring rice crop, the computed χ^2 (8 D.F.) of the Wald and the Likelihood ratio tests are 10.17 (0.03) and 8.46 (0.50). The critical χ^2 (8 D.F.) at 0.30 level of significance is 9.52 and at 0.50 level of significance is 7.34. Thus the null hypothesis is rejected for the MMCT in MHYV Spring rice crop.

For RCT Autumn rice crop, the computed χ^2 (8 D.F.) of the Wald and the Likelihood ratio tests for MHYV are 13.09 and 12.59 (P<0.20) the critical χ^2 (8 D.F.) at 0.20 level of significance is 11.03. Thus the null hypothesis is rejected for the MHYV in RCT Autumn rice crop. For THQV, the computed χ^2 (8 D.F.) of the Wald and the Likelihood ratio tests are 30.38 (P<0.01) and 20.73 (P<0.01), respectively. The critical χ^2 (8 D.F.) at 0.01 level of significance is 20.09. Thus the null hypothesis is also rejected for the THQV in RCT Autumn rice crop.

In short, the above results of these statistics test imply that sampled farmers on average are not maximum profit with respect to normalized prices of the variable inputs.

The second statistical test is carried out to test for the Cobb-Douglas hypothesis. It should be noted that the translog profit function will reduce to the Cobb-Douglas profit function when coefficients of all second order terms equal to zero. Or according to Sidhu and Baanante (1981), for the profit function to be Cobb-Douglas, coefficients of all second order terms should be zero. Testing for this null hypothesis, 11 restrictions are imposed in the systems of equations. The Wald test and Likelihood ratio test statistics are applied to test the null hypothesis that all γ_{ih} , δ_{ik} , ϕ_{kj} are equal to zero.

The computed χ^2 (11 D.F.) of the Wald and the Likelihood ratio tests for RCT in MHYV Spring rice crop are 27.98 and 26.53 (P<0.01), respectively, and for MMCT in MHYV Spring rice crop are 18.59 (P<0.1) and 15.96 (P<0.2), respectively. The critical χ^2 (11 D.F.) at 0.01, 0.1 and 0.2 level of significance are 24.73, 17.28, and 14.63, respectively. Thus the null hypothesis is rejected for the cases of RCT and MMCT in MHYV Spring rice crop.

In RCT Autumn rice crop, the computed χ^2 (11 D.F.) of the Wald and the Likelihood ratio tests of MHYV 38.14 and 35.73 (P<0.01), respectively. For THQV, the computed χ^2 (11 D.F.) of the Wald and the Likelihood ratio tests are 51.32 and 37.23 (P<0.01), respectively. The critical χ^2 (11 D.F.) at 0.01 significant level is 24.73. Thus the null hypothesis is rejected for two cases of MHYV and THQV in RCT Autumn rice crop.

The above results imply that, the Cobb-Douglas functional form is not appropriate for the given data of rice production in this study.

Table 5.1. Estimation of the Normalized Restricted Translog Profit Function and Variable Input Share Equations for RCT in MHYV Spring Rice Crop

Variables	Parameters	Estimated Coefficients	Standard Error	T-ratio
Profit Function				
Intercept	α_O	4.0535	0.1409	28.773***
LnP_L^*	α_L	0.1782	0.1330	1.340
LnP_F^*	α_F	0.2587	0.0877	2.949***
$\frac{1}{2}(LnP_L^*)^2$	γ_{LL}	0.1462	0.0786	1.860*
$\frac{1}{2}(LnP_F^*)^2$	γ_{FF}	-0.0603	0.0538	-1.121
$LnP_L^*.LnP_F^*$	γ_{LF}	-0.0096	0.0445	-0.215
LnZ_A	β_A	1.1609	0.0867	13.392***
$LnP_L^*.LnZ_A$	δ_{LA}	-0.0763	0.0216	-3.542***
$LnP_F^*.LnZ_A$	δ_{FA}	0.0038	0.0106	0.360
$\frac{1}{2}(LnZ_A)^2$	ϕ_{AA}	0.1278	0.0614	2.080**
Labor Share Equation				
Intercept	α_L	0.1782	0.1330	1.340
LnP_L^*	γ_{LL}	0.1462	0.0786	1.860*
LnP_F^*	γ_{LF}	-0.0096	0.0445	0.215
LnZ_A	δ_{LA}	-0.0763	0.0216	-3.542***
Fertilizer Share Equation				
Intercept	α_F	0.2587	0.0877	2.949***
LnP_L^*	γ_{FL}	-0.0096	0.0445	-0.215
LnP_F^*	γ_{FF}	-0.0603	0.0538	-1.121
LnZ_A	δ_{FA}	0.0038	0.0106	0.360

Note: *** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Computed.

Table 5.2. Estimation of the Normalized Restricted Translog Profit Function and Variable Input Share Equations for MMCT in MHYV Spring Rice Crop

Variables	Parameters	Estimated Coefficients	Standard Error	T-ratio
Profit Function				
Intercept	α_O	3.9399	0.1576	24.997***
LnP_L^*	α_L	0.7343	0.1462	5.021***
LnP_F^*	α_F	0.1412	0.1406	1.004
$\frac{1}{2}(LnP_L^*)^2$	γ_{LL}	-0.2701	0.1078	-2.505**
$\frac{1}{2}(LnP_F^*)^2$	γ_{FF}	-0.0373	0.1304	-0.286
$LnP_L^*.LnP_F^*$	γ_{LF}	0.0302	0.0931	0.325
LnZ_A	β_A	1.0779	0.1360	7.924***
$LnP_L^*.LnZ_A$	δ_{LA}	-0.0609	0.0345	-1.769*
$LnP_F^*.LnZ_A$	δ_{FA}	-0.0062	0.0211	-0.295
$\frac{1}{2}(LnZ_A)^2$	ϕ_{AA}	0.1967	0.0859	2.289**
Labor Share Equation				
Intercept	α_L	0.7343	0.1462	5.021***
LnP_L^*	γ_{LL}	-0.2701	0.1078	-2.505**
LnP_F^*	γ_{LF}	0.0302	0.0931	0.325
LnZ_A	δ_{LA}	-0.0609	0.0345	-1.769*
Fertilizer Share Equation				
Intercept	α_F	0.1412	0.1406	1.004
LnP_L^*	γ_{FL}	0.0302	0.0931	0.325
LnP_F^*	γ_{FF}	-0.0373	0.1304	-0.286
LnZ_A	δ_{FA}	-0.0062	0.0211	-0.295

Note: *** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Computed.

Table 5.3. **Estimation of the Normalized Restricted Translog Profit Function and Variable Input Share Equations for MHYV in RCT Autumn Rice Crop**

Variables	Parameters	Estimated Coefficients	Standard Error	T-ratio
Profit Function				
Intercept	α_O	4.1439	0.0909	45.562***
LnP_L^*	α_L	0.2288	0.0909	2.515**
LnP_F^*	α_F	0.2178	0.0577	3.776***
$\frac{1}{2}(LnP_L^*)^2$	γ_{LL}	0.1529	0.0623	2.456**
$\frac{1}{2}(LnP_F^*)^2$	γ_{FF}	0.0475	0.0411	1.155
$LnP_L^*.LnP_F^*$	γ_{LF}	-0.0891	0.0367	-2.428**
LnZ_A	β_A	1.1459	0.0742	15.454***
$LnP_L^*.LnZ_A$	δ_{LA}	-0.0880	0.0186	-4.744***
$LnP_F^*.LnZ_A$	δ_{FA}	0.0090	0.0094	0.954
$\frac{1}{2}(LnZ_A)^2$	ϕ_{AA}	0.1098	0.0581	1.889*
Labor Share Equation				
Intercept	α_L	0.2288	0.0909	2.515**
LnP_L^*	γ_{LL}	0.1529	0.0623	2.456**
LnP_F^*	γ_{LF}	-0.0891	0.0367	-2.428**
LnZ_A	δ_{LA}	-0.0880	0.0186	-4.744***
Fertilizer Share Equation				
Intercept	α_F	0.2178	0.0577	3.776***
LnP_L^*	γ_{FL}	-0.0891	0.0367	-2.428**
LnP_F^*	γ_{FF}	0.0475	0.0411	1.155
LnZ_A	δ_{FA}	0.0090	0.0094	0.954

Note: *** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Computed.

Table 5.4. **Estimation of the Normalized Restricted Translog Profit Function and Variable Input Share Equations for THQV in RCT Autumn Rice Crop**

Variables	Parameters	Estimated Coefficients	Standard Error	T-ratio
Profit Function				
Intercept	α_O	4.6835	0.0398	117.562***
LnP_L^*	α_L	0.2234	0.0830	2.690***
LnP_F^*	α_F	0.0621	0.0332	1.871*
$\frac{1}{2}(LnP_L^*)^2$	γ_{LL}	-0.0748	0.1064	-0.703
$\frac{1}{2}(LnP_F^*)^2$	γ_{FF}	0.0757	0.0381	1.986**
$LnP_L^*.LnP_F^*$	γ_{LF}	-0.0219	0.0462	-0.474
LnZ_A	β_A	1.1696	0.0351	33.361***
$LnP_L^*.LnZ_A$	δ_{LA}	-0.0343	0.0089	-3.834***
$LnP_F^*.LnZ_A$	δ_{FA}	-0.0038	0.0049	-0.759
$\frac{1}{2}(LnZ_A)^2$	ϕ_{AA}	-0.1179	0.0402	-2.934***
Labor Share Equation				
Intercept	α_L	0.2234	0.0830	2.690***
LnP_L^*	γ_{LL}	-0.0748	0.1064	-0.703
LnP_F^*	γ_{LF}	-0.0219	0.0462	-0.474
LnZ_A	δ_{LA}	-0.0343	0.0089	-3.834***
Fertilizer Share Equation				
Intercept	α_F	0.0621	0.0332	1.871*
LnP_L^*	γ_{FL}	-0.0219	0.0462	-0.474
LnP_F^*	γ_{FF}	0.0757	0.0381	1.986**
LnZ_A	δ_{FA}	-0.0038	0.0049	-0.759

Note: *** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Computed.

The estimated coefficients of profit functions and variable input share equations for RCT and MMCT in MHYV Spring rice crop are presented in Table 35 and 36 for each set of equations. One could see that 9 of the total 18 coefficients in each corresponding table are statistically significant at 1 percent level or higher. Some estimated coefficients are negative and some others are positive in signs.

Fixed factor coefficient of land β_A is positive as expected and highly significant at 1 percent level for both sets of functions. It presented that, in the study region, rice cultivated land area has positive influences in improving profit for rice production farmers in Spring rice crop.

In RCT Autumn rice crop, the estimated coefficients of profit functions and variable input share equations for MHYV and THQV are listed in Table 37 and 38 for each sets of functions, respectively. From these coefficients, 14 and 11 of 18 coefficients for MHYV and THQV functions, respectively, are statistically significant at 1 percent level or higher. There are some estimated coefficients with negative signs and some others with positive signs.

Fixed factor coefficients of land β_A for two sets of functions for MHYV and THQV in RCT Autumn rice crop are positive as expected and highly significant at 1 percent level. This presented that in the study region in Autumn rice crop the rice cultivated land area has positive influences in improving profit for rice production.

However, firm conclusion could be drawn meaningfully from the elasticities computed using estimated coefficients of profit functions and variable input share equations, input and output prices and level of fixed factors.

5.3. Elasticities of Output Supply and Variable Input Demands

The elasticities of output supply and variable input demands are functions of variable input ratios, variable input prices, level of fixed inputs and the parameter estimates (Sidhu and Baanante, 1981). In this study, the output supply elasticities and elasticities of variable input demands for labor and chemical fertilizer with respect to (1) their prices, (2) quantity of land area, (3) the ratio S_i and (4) the estimated coefficients are derived directly.

These elasticities are evaluated at simple average of the S_i, variable input prices, price of rice output, quantity of land area and estimated coefficients in Table 35, 36, 37, and 38 by using equations (17), (19), (22), (24), (30), (33), and (35). The elasticity estimates of output supply and variable input demands are presented in Table 39 for RCT and MMCT in MHYV Spring rice crop and in Table 40 for MHYV and THQV in RCT Autumn rice crop.

Table 5.5. Elasticities of Output Supply and Variable Input Demands for RCT and MMCT in MHYV Spring Rice Crop

	Price of Rice	Wage Rate	Fertilizer price	Land Area
For RCT				
Rice supply	0.4249	-0.4468	-0.1703	1.0772
Labor demand	1.9379	-1.7675	-0.1703	1.2447
Fertilizer demand	1.5210	-0.3507	-1.1703	1.0271
For MMCT				
Rice supply	0.6752	-0.1713	-0.1426	1.0141
Labor demand	0.7272	-0.5847	-0.1426	1.1465
Fertilizer demand	1.4945	-0.3519	-1.1426	0.9733

Source: Computed (Using equations 17, 19, 22, 24, 30, 33, and 35)

Table 5.6. **Elasticities of Output Supply and Variable Input Demands for MHYV and THQV in RCT Autumn Rice Crop**

	Price of Rice	Wage Rate	Fertilizer price	Land Area
For MHYV				
Rice supply	0.4863	-0.3737	-0.0781	1.0513
Labor demand	1.6622	-1.7933	0.1311	1.2579
Fertilizer demand	0.8269	0.3119	-1.1388	0.9914
For THQV				
Rice supply	0.1315	-0.1251	-0.1332	1.1354
Labor demand	1.1949	-1.1251	-0.0698	1.3810
Fertilizer demand	2.2791	-0.1251	-2.1541	1.1066

Source: Computed (Using equations 17, 19, 22, 24, 30, 33, and 35)

5.3.1. Elasticities of Variables Input Demands

Firstly, the own-price elasticities of variable input demands are studied. From Table 39 and 40, one can see that all own-price elasticities of demand η_{ii} are negative as expected. In MYHV Spring rice crop, own-price elasticities of labor input for RCT are elastic (-1.7675), but for MMCT are inelastic (-0.5847). This may be due to technical aspect, required labor for MMCT is larger than RCT (Table 4.8, chapter IV). Therefore, when price of labor increases, the decrease of labor use for MMCT is less than for RCT. In Autumn rice crop, the own-price elasticities of labor for MHYV and THQV are both elastic with -1.7933 and -1.1251, respectively.

The own-price elasticities of demand for fertilizer are negative as expected. These elasticities for RCT and MMCT in MHYV Spring rice crop are elastic with nearly the same absolute value, while for MHYV and THQV in RCT Autumn rice crop, these elasticities are also elastic, but the absolute value of the elasticity for THQV is highest. It may be mean that, when price of fertilizer increase, the fertilizer demand for THQV is decrease more than for the others.

The cross-price elasticities of variable input demand in MHYV Spring rice crop and in RCT Autumn rice crop are inelastic, and negative, except the cross-price elasticities of demand for labor and fertilizer for MHYV in RCT Autumn rice crop are positive in signs. This may be explained that, there are supplementary situations among these inputs for RCT and MMCT in MHYV Spring rice crop and for THQV in RCT Autumn rice crop, but substitution situation among these inputs for MHYV in RCT Autumn rice crop.

The study on cross-price elasticities of variable input demands for rice production in Red River Delta is not done before, therefore, comparison of these elasticities in the study region is impossible. However, the estimates of inelastic cross-price elasticities of variable input demands from this study are somewhat consistent with the estimates for Mekong Delta of Viet Nam by Dung (1994).

All of the elasticities of variable input demands with respect to the rice price for RCT and MMCT in MHYV Spring rice crop and for MHYV and THQV in RCT Autumn rice crop are positive in signs as expected. Most of these elasticities of demands for labor and fertilizer are larger than one. These imply that when price of rice increases, farmers will do more investment for rice production.

The variable input demand elasticities with respect to fixed factor of rice cultivated land area are all positive in signs. This is mentioned that, when land area for rice cultivation increases, farmers need more labor and fertilizer for their production activities.

5.3.2. Elasticities of Rice Supply

The elasticities of rice supply with respect to prices of variable inputs of labor and fertilizer are smaller than one. These elasticities are all negative in signs as expected, which indicated that when the prices of labor and fertilizer increase the rice supply decreases.

The value of own-price elasticities of output supply are all smaller than one, but for MMCT in MHYV Spring rice crop it is relative larger than for the others. All of these elasticities are positive in signs. It means that, if rice price increases farmers produce and supply more rice for country.

The elasticities of output supply with respect to fixed factor of production of land area are all positive in signs. This indicates that, when the rice cultivated land area expanded, the supply of rice could be expanded, also. The greatest elasticity of rice supply with respect to land area is estimated for THQV in RCT Autumn rice crop with value of 1.1354. It may be explained that, at recent conditions, production of THQV get highest gross return and net return.