WILLINGNESS TO PAY FOR RICE TRAITS IN KURUNEGALA AND HAMBANTOTA DISTRICTS: AN APPLICATION OF A SPATIAL HEDONIC PRICING MODEL

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ABSTRACT

The common understanding by the research community is that farmers like to adopt high-yielding varieties. While this is true in general, we often see that some high-yielding varieties are not accepted by farmers. The reasons for such can be many. In this study, an attempt is made to verify whether there are any other traits that farmers seek in a paddy variety. We select several traits including those related to yield and production aspects as well as ultimate consumer preferences, and assess their relative importance by way of willingness to pay. This is achieved by estimating a Hedonic Pricing model. We further hypothesise that there are spatial relations in the willingness to pay for such traits and incorporate that into the analysis which resulted in a Spatial Hedonic Pricing Model. Data for the study was collected by using a pre-tested questionnaire from 148 farmers in Kurunegala and Hambantota districts. The estimated function confirms that there is a spatial relationship in paddy prices by a significant spatial correlation coefficient in the order of 0.35. Therefore, the estimated marginal willingness to pay values is corrected for the spatial correlation. These estimates provide us insights on characteristics other than yield such as empty seed percentage of seed paddy, disease resistance, and demand conditions of the ultimate consumer(types of rice), that farmers consider in choosing paddy varieties.

Key words: *Rice traits, Spatial hedonic pricing model, Willingness to pay*

INTRODUCTION

Rice is the staple food of Sri Lankans. More than 70 percent of Sri Lankans earn their living from farming and 56 percent of people (around 897,000 farmer families) are engaged in paddy cultivation (Anon, 2011). Further, vast extents of land are used to cultivate paddy. Within 2010/2011 Maha season, 1,724,365 acres had been sown, and 1,462,546 acres had been harvested, which led to a yield of 95,517,000 bushels (Anon, 2011). With the ever increasing population and the expected rise in demands with this growth in population, attention on developing paddy sector is quite important. In doing so, developing paddy varieties that can provide a higher yield in different conditions play a significant role. Rice Research and Development Centre develop and introduce a series of paddy varieties, which are developed purposively. As the common understanding about the farmers' preference for seeds of a particular paddy variety is the amount of yield it generates, the development of a large number of high-yielding varieties during and after the times of green revolution had been the trend. However, the choice of varieties by farmers may not solely depend on yield but also on other characteristics related to resistance qualities of rice, maintaining

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cultivation & post harvest processing, plant characteristics and market demands. One criticism of modern rice breeding programs in other parts of the world as well is that they have not incorporated desirable consumption attributes and non-yield production traits into new varieties (Dalton, 2004). Literature show evidence on significant relationships between farmers' subjective preferences on grain milling and cooking attributes with adoption behaviour (Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993). Therefore, it is imperative that the relative importance farmers place on these characteristics be understood in order to develop varieties, which will be adopted by farmer community. Identifying this research gap, Dalton (2004) looked at farmer preferences for different rice traits. In that study, the relative importance of these traits is assessed in terms of the Willingness to Pay (WTP) estimates obtained. However, spatial econometric literature points out that such WTP estimates by a Hedonic method can be biased if the spatial correlation is not taken into consideration. Therefore, this study was carried out with the objective of estimating willingness to pay for rice traits corrected for spatial correlation.

MATERIALS AND METHODS

Theoretical Framework

Willingness to pay is the maximum amount a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired. To make resource allocation decisions based on economic values, the net economic benefit from a good or service should be measured. For individuals, this is measured by the amount that people are willing to pay, because measures of economic value are based on what people want; their preferences.

In consumer theory, demand functions are derived by considering a model of preference maximizing behaviour coupled with underlying economic constraints. Under usual circumstances, the consumer chooses the good that satisfies his needs or expectations, or that provides him with a higher utility (Horna *et al.,* 2005). Hedonic demand theory is a method that makes use of revealed preferences to estimate the demand or value. It decomposes the product being studied into its constituent characteristics to obtain estimates of the contributory value of each characteristic. The basic idea is to use the systematic variation in the price of a good that can be explained by characteristics of the good. This is the starting point to assess the WTP for the characteristics of interest. These models are usually estimated through regression analysis. We apply this same concept to seed paddy prices to assess whether the systematic variation in the price can be explained by a set of constituent characteristics related to paddy varieties. The hedonic model can be state as;

$$P = X\beta + \varepsilon \quad (1)$$

Where,

P = Vector of prices
β = Vector of coefficients to be estimated
X = Matrix of independent variables
ε = Vector of disturbances

Markandya (2006) has mentioned multicollinearity, heteroskedasticity, spatial autocorrelation and biasness in heterogeneous markets as main econometric problems in applying the Hedonic Pricing Model. Thus, in order to avoid this combination of exogenous variables with lower variance inflation factors were chosen.

The main objective of estimating a hedonic price function is to obtaining Marginal Willingness to Pay (MWTP) estimates. The MWTP is the increase in price of one Kilogram of seed paddy when a trait's utility increases by one unit, which is needed in order to assess the preferences for each trait (characteristic). As shown in Kim *et al.,* (2003), a spatial

multiplier effect needs to be accounted to accurately compute the MWTP in a spatial lag model. For a uniform change in the amenity across all observations, the MWTP then follows as (For a case of linear-log form of the Hedonic model estimated):

$$MWTP = \frac{\beta}{\overline{X_k}}\left[\frac{1}{(1-\rho)}\right] \quad (3)$$

Where,

β = Regression coefficient of trait concerning
$\overline{X_k}$ = Mean value of preferences for k^{th} trait
ρ = Spatial correlation coefficient

Therefore, when the modeller is interested in measuring the ''true'' effect of these constituent characteristic, the spatial autocorrelation needs to be removed, similar to a first-difference approach in time series (Kim *et al.,* 2003). Therefore, the spatial effect was included into the Hedonic Pricing Model in (1) as an auto regressive component;

$$P=\rho WP+X\beta+\varepsilon \quad (2)$$

Where,

W = Spatial weight matrix
ρ = Spatial correlation coefficient

This model assumes that the spatially weighted sum of value placed by neighbours (spatial lag) enters as an explanatory in the specification of price formation of equation. That is,

$$P_1 = \rho(W_{12}P_2 + W_{13}P_3 + \cdots + W_{1N}P_N) + X\beta + \varepsilon_1$$

We make use of the spatial weight matrix to link observations *i* and *j*. We make only few of the *Wij* are non zero because spill over effects take place between neighbours in close proximity. Therefore, because of the spatial lag included in the model, the magnitude of a value (price) for farmer is allowed to depend on the magnitudes of the values placed by other farmers in the neighbourhood defined by the weight matrix, W. Therefore, if $\rho = 0$, then there is no spatial correlation. To define neighbours in the matrix, W, GPS coordinates of centroids of Grama Niladari (GN) divisions were used.

The Econometric Model

A Spatial Hedonic Model (3) was derived by joining Hedonic Pricing Model with Spatial Autoregressive Model. Preference for rice traits to be included in the X matrix were obtained by a likert scale (1= strongly disagree, 2 = Disagree, 3 = Agree or Disagree, 4 = Agree, 5 = Strongly Agree). Socio economic variables related to the households were also incorporated in order to control for these. A semi log model was fitted and the variables included in the model are given in equation (4).

$$P_i = \beta_0 + \beta_1(EDU)_i + \beta_2(EXP)_i + \beta_3(EXT)_i + \beta_4(LND)_I + \beta_5(RR)_i + \beta_6(SMB)_i + \beta_7(NAD)_i + \beta_8(KS)_i + \beta_9(YLD)_i + \beta_{10}(FER)_i + \beta_{11}(DIS)_i + \beta_{12}(EMP)_i + \beta_{13}(VGR)_i + \beta_{14}(NUT)_i + \rho WP_i + \varepsilon_i \quad (4)$$

Where,

P = Price of 1kg of seed paddy
$\beta_{0,..,}\ \beta_{14}$ = Regression coefficients
EDU = *ln* education level
EXP = *ln* years of experience
EXT = *ln* number of visits of extension officer to farmer
LND = *ln* extension cultivated in acres
RR = Farmers who cultivate Red Rice (Yes = 1, No = 0)
SMB = Farmers who cultivate Samba (Yes = 1, No = 0)
NAD = Farmers who cultivate Nadu (Yes = 1, No = 0)

KS	=	Farmers who cultivate Kira Samba (Yes = 1, No = 0)
YLD	=	*ln* weighted preference for increase in yield
FER	=	*ln* weighted preference for using less amount of fertilizer
DIS	=	*ln* weighted preference for higher disease resistance
EMP	=	*ln* weighted preference for lower percentage of empty seeds in seed paddy
VGR	=	*ln* weighted preference for higher stem vigour
NUT	=	*ln* weighted preference for higher nutrition level
ρ	=	Correlation between neighbour-hoods/neighbourhood effect
W	=	Spatial weight matrix which define neighbours
ε	=	Disturbance team
i	=	i^{th} respondent

Study Area and Data

The project areas of intervention are randomly selected from rice cultivating areas in Kurunegala in the Low Country Intermediate Zone (LCIZ) and in Hambantota district of Low Country Dry Zone (LCDZ). Kurunegala is the third and Hambantota is the fourth in extent of sawing, harvesting and in amount of paddy production in Sri Lanka. Primary data were collected using a cluster sampling technique. The administrative maps of the two study areas: Kurunegala and Hambantota districts were collected and district secretariat (DS) divisions were marked as clusters. Data collecting points within those clusters were randomly selected. The total sample size was 148. Sixty two respondents were from 20 Grama Niladhari (GN) divisions of Hambantota district and 86 respondents were from 24 GN divisions of Kurunegala district. This proportioning of the sample among the two districts was decided based on the percentage of paddy cultivation extent in 2010/2011 Maha season to the total extents of each district. Data collection was carried out using a pretested questionnaire.

RESULTS AND DISCUSSION

Descriptive statistics

All respondents are engaged in wetland paddy cultivation. Majority of them were males (93.24%). Average age of most farmers was found to be between 51 to 65 years (43.91%) while the majority (77.7%) is educated up to secondary education. Ninety two percent of farmers had the membership of a farmer organization. Most of the respondents (59.46%) were involved full time in paddy cultivation. Ten percent of the respondents has cultivated paddy in fields with less than 1 acre. Ninety six percent of farmers' cultivated extent was less than or equal to 5 acres (Table 01).

Results of the Spatial Hedonic Model

Results in Table 02 show that out of the paddy traits considered, YLD, DIS and EMP are significantly different from zero. However, the negative sign received for DIS is counter intuitive, because naturally, when a variety is highly resistant to diseases, the expectation is for farmers to prefer these varieties. However, the high disease conditions observed during the Maha season in 2010/2011 may have influenced farmers' preference scores. Consumer preferences were proxied by incorporating dummy variables for types of rice. A positive and significant coefficient for red rice indicated that when farmers are paying for seed paddy, they take the primary demand for rice into consideration. That is, farmers place implicit values on the demand conditions in buying seed paddy. Important note here is that not only preferences related to yield, but also preferences related to other attributes such as disease resistance and percentage of empty seeds in paddy are important for farmers. One other important

finding is the significant coefficient of the spatial correlation. This confirms that Hedonic pricing Models such as these should incorporate the spatial relationships. As noted in equation (3), the MWTP is influenced by the presence of spatial correlation. If not considered, the spatial effects will bias the MWTP estimates.

The use of the spatial model allows calculation of marginal effects in terms of direct and indirect effects. Direct effects measures the marginal effect of a change in a unit of independent variable of farmer *i*, on the outcome variable of the same farmer. However, indirect effect measures the marginal effect on the outcome of farmer *i*, by a unit change in an independent variable of farmer *j* . Total effect is the sum of the two. Results revealed that preference for higher yield is with the highest positive direct effect (18.98%) with compared to preferences for other traits, while preference for using less amount of fertilizer showed the highest positive indirect effect (9.28%). This implies that a neighbouring farmer's preference for a seed with low fertilizer requirement has a positive impact of what a farmer is willing to pay for seed.

Marginal Willingness to Pay (MWTP)

The MWTP is calculated (Table 03) on the assumption that a change from one preference level to another adjacent level is similar for all levels. For example, a change from disagree to strongly disagree is treated similarly to a change from agree to strongly agree. The results show that the highest willingness to pay is for YLD and EMP. When the agreement for the statement: "higher yield was considered when purchasing seed paddy", increases marginally, the willingness to pay increase by Rs. 5.92. Similarly, when agreement with the statement: "low empty seed percentage of seed paddy was considered", increases on the margin, the willingness to pay increases by Rs. 5.08.

Table 01: Descriptive statistics of the sample

Description of the sample		No
Gender	Male	138
	Female	10
Age level	>20	0
	21-35	14
	36-50	48
	51-65	65
	66<	21
Education level	1-5	31
	6-11	115
	12<	2
Time involved	Full-time	88
	Part-time	60
Cultivated land extent (acres)	<1	15
	1 – 3	102
	3 – 5	23
	5<	6
Grants	With	112
	Without	36

Table 02: The coefficient estimates and, direct, indirect and total effects of each variable

Variable	Coefficient	z-probability	Direct effect	Indirect effect	Total effect
EDU	10.23	0.08**	10.512	5.049	15.561
EXP	5.73	0.20	6.219	3.015	9.234
EXT	5.89	0.28	6.304	3.183	9.488
LND	-1.38	0.70	-1.687	-0.795	-2.482
RR	16.17	0.09 **	17.165	8.480	25.645
SMB	-18.95	0.06**	-19.513	-9.283	-29.189
NA	-22.94	0.019 *	-23.922	-11.678	-35.600
KS	11.92	0.39	12.057	6.003	18.061
YLD	18.43	0.017 *	18.606	-2.285	28.272
FER	-4.45	0.25	-4.563	9.283	-6.848
DIS	-8.38	0.05 **	-8.606	-4.307	-12.913
EMP	13.35	0.001 *	13.889	6.873	20.762
VGR	0.08	0.98	0.089	0.025	0.114
NUT	-4.48	0.30	-4.483	-2.169	-6.652
Rho	0.35	$4x10^6$ *			

*Note: *significant at 0.05 level, **significant at 0.1 level*

$R^2 = 16.04\%$

Table 03: The calculated MWTP for rice traits

Variable	MWTP
YLD	5.92
FER	-4.16
DIS	-3.31
EMP	5.08
VGR	0.03
NUT	-3.63

CONCLUSIONS

This study show that in estimating hedonic pricing models, bias results from ignoring spatial correlation. This is evident from the significant spatial correlation coefficient in the present data set. Apart from high yielding ability of paddy varieties, farmers place positive implicit values on characteristics such as disease resistance, percentage of empty seeds in paddy, and higher stem vigour of the rice plant. It was also evident that farmers place considerable importance in demand conditions by ultimate consumers. Therefore, future work on hedonic price analyses should incorporate a spatial analysis to remove the effect of

spatial correlation from the willingness to pay estimates. Further, in development of new varieties, it is important to consider farmer preferences on other characteristics of the rice plant without merely assuming provision of higher yields are sufficient. Further researches of this nature are warranted with large samples to verify these findings in other areas of the country.

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