A Test for Relative Efficiency in the Smallholder Tea Sub-sector in Kenya

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ABSTRACT

Despite availability of tea growing technologies to all Kenya tea farmers, green leaf production in smallholder sub-sector remains low. Tea in Kenya is grown in the East of the Rift Valley and the West of the Rift Valley regions. It is assumed that tea farms behave according to a certain decision rule termed as profit maximization. The objective of this study was to estimate the profit function for tea farms in the two regions and to compare/test the relative economic efficiency between them. A profit function model was fitted on 212 smallholder farms. The dependent variable was gross margin per farm per year. The independent variables were: number of tea bushes per farm per year, cost of fertilizer (Kshs.) per hectare per year, labour wage rate (Kshs.) per man-day in each farm and a dummy variable where D=1 for east Rift and D=0 for west Rift. The results depicted that the coefficients of the number of bushes, fertilizer cost/ha/year and labour wage rate/man-day were all positive and significant at 1 percent level. It had been hypothesized that there is no efficiency difference between East of the Rift Valley and West of the Rift Valley in tea production. Hence the coefficient of the region dummy would be zero. The results rejected the hypothesis of equal efficiency between the two regions at 10 percent level. Further more, the positive sign of the dummy variable indicates that East Rift Valley tea farms are more economic efficient, at all observed prices of the variable inputs given the distribution of the fixed factors of production. It is concluded that East Rift Valley is more successful in responding to the set of prices it faces (Price efficiency) and /or has higher quantities of fixed factors of production including entrepreneurship (technical efficiency).

1.0 INTRODUCTION

The question of how efficiently farmers use farm resources in peasant agriculture is of considerable interest to researchers, farmers and policy makers. It is argued that the success of policies for raising agricultural productivity in low income countries depends upon the quality of decision making by farmers (Pachico, 1980). Efficiency refers to the degree to which producers are achieving the greatest possible output given the available resources and techniques (Pachico, 1980; Wolgin, 1973).

The tea sector is the leading foreign exchange earner in Kenya, accounting for 20 percent of the total export earnings (Kenya, 1997). The current level of tea production is 267 thousand metric tones. The objective of the Kenya Government is to produce 280 thousand metric tones by the end of year 2001 (Kenya, 1997). If this objective is to be realized, the greater part of the production is expected from the smallholder sub-sector which has been producing approximately 60 percent of made tea. However, productivity in the sub-sector has been relatively lower than in the estate sub-sector over the years. For example, in 1998, the national average yield for the sub-sector was only 2,075 kg/ha. of made tea compared to 3,954 kg/ha of made tea in the estate sub-sector. To raise the level of tea productivity among the smallholder sub-sector in the midst of the rapidly changing economic scenario: liberalized agricultural sector, upsurge of the general inputs price level, escalating unemployment, inevitably increased density of population and dwindling land sizes, the issue of efficiency in resource use becomes unavoidable. The government of Kenya emphasises efficient use of strategic inputs particularly fertilizers and adoption of intensive technologies of tea production to enhance smallholder yields (Kenya, 1997). For example one can measure the efficiency of the tea farmers in the East of the Rift Valley and the West of the Rift Valley. One can thereafter determine how much a given region could be expected to increase its output through appropriate reorganization without absorbing additional resources. One can also determine which region of farms is more economically efficient than the other because it is more successful in responding to the set of prices it faces (Price efficiency) and/or because it has higher quantities of fixed factors of production, including entrepreneurship (technical efficiency). The purpose of this study therefore was to assess the relative economic efficiency between East Rift and West Rift tea production regions.

Doll and Orazem (1973) argue that economic efficiency refers to the combinations of inputs that maximize individual and social objectives. Wolgin (1973) identifies two components of overall economic efficiency: technical or engineering efficiency and allocative or price efficiency. A farm is considered more technical efficient than another, if, given the same quantities of measurable inputs, it consistently produces a larger output. A farm is price efficient if it maximizes profits i.e. it equates the value of the marginal product of each variable input to its price (Lau and Yotopoulos, 1971). Economic efficiency combines both technical and price efficiency. Suppose two farms have varying degrees of technical and price efficiency but facing identical prices. The farm with the higher profits within a certain range of prices is considered the relatively more economic efficient farm.

2.0 METHODOLOGY

Primary data used in this study were gathered from smallholder tea farms in Kirinyaga and Nyambene in East Rift Valley and Nandi and Nyamira Districts in West Rift Valley. Multistage random sampling selection was adopted. First a random selection of the number of buying centers determined in each factory was undertaken after which a proportionate number of farms were randomly selected. The sample total in the four districts was 259. The data collected was on agronomic practices, input use, output, prices and extension in tea enterprise.

The analytical procedure used was the profit function model. According to production theory, efficiency relates basically to the common observation that farm-firms that produce homogeneous outputs such as green leaf, have different factor productivities (Yotopoulos and Nuggent, 1976). This phenomenon could be explained by the fact that different farms face different prices, or, different farms have different endowments of fixed factors of production or different farm-firms use different systematic behavioral rules. The use of profit function specifically allows for differences in the prices of the variable factors of production and in the quantities of the fixed inputs in its attempt to compare economic efficiency between farms in districts or regions. Moreover, the profit function is used in such a way as to allow inter-farm differences in the ability to equate the value of the marginal products of the variable factors to their prices, that is maximize profits. It is an appropriate tool for measuring economic efficiency of both of its components, technical efficiency and price efficiency. However, not much is known about how disturbance terms in general should be introduced into the economic relationships (Lau and Yotopolous, 1971). It is assumed that the error in the profits is due to climatic variations, divergence of the expected output price from the realized output price, imperfect knowledge of the technical efficiency parameter of the farm and differences in technical efficiency among farms within the same region.

Lau and Yotopoulos (1973) used data from Indian Ministry of Agriculture and Food to estimate the profit function for the small and large farms, and to compare the relative efficiency between the two farm groups. The results showed that small scale farmers (i.e. farms of less than ten acres) were more economic efficient than large farms. The results implied that in agriculture the supervisory role of the owner-manager of the farm may be crucial for attaining high levels of economic efficiency. Kilungo (1998) estimated the profit function for the smallholder dairy farmers in Kiambu District of Kenya. The average milk yield was found to be 1930.94 kg per animal per year. Dairy farms with greater yield than the average were categorized as large while those with less than the average were categorized as small. The results showed that, both farm groups were equally efficient. These results were attributed to the use of similar quantities of fixed factors of production, which could even include the non-measurable factors such as diligence and entrepreneurship of the small farmer. The objective of this study was to estimate the profit function for the East of the Rift Valley and West of the Rift Valley tea farms and to compare the relative efficiency between the two regions.

Given a farm-firm with a production function with the usual neoclassical properties:-

$$V = F(X_1,\ldots\ldots,X_m;\quad Z_1,\ldots,Z_n) \qquad \ldots\ldots 1$$

Where: V = output; X = variable inputs; Z = fixed inputs.

Restricted profit function (defined as current revenues less current total variable costs) can be written as follows:

$$P' = {}_pF(X_1,\ldots, X_m; Z_1,\ldots,Z_n) - \sum_{j=1}^{m} q'_j X_j \qquad \ldots\ldots 2$$

Where: P' = Profit; $_p$ = Unit price of output; q' = Unit price of the j^{th} variable.

The fixed costs are ignored, since they do not affect the optimal combination of the variable inputs. Suppose that a farm maximized profits given the levels of its technical efficiency and fixed inputs, the marginal productivity conditions for such a farm are;-

$$_p\,\delta(X; Z) / \delta X_j = q'_j = 1,\ldots\ldots, m \qquad \ldots\ldots 3$$

By using the price of output as the numeraire, we may define $q_j = q'_j/_p$ as the normalized price of the j^{th} input. Equation 3 can then be rewritten as

$$\delta F/\delta X_j = q_j = 1,\ldots., m \qquad \ldots\ldots 4$$

By substituting equation 4 above into equation 2, Yotopolous and Lau (1973) used the profit function intrinsically allowing inter-farm differences in the ability to equate the value of the marginal products of the variable factors to their prices, that is to maximize profits. Within the framework of production theory, they derived an estimating profit function via the Cobb-Douglas production function, which could be used to measure economic efficiency and its components, between regional farm groups. To derive the working profit function model, one can start from a Cobb-Douglas, or for that matter from any other form of a function. However, the analysis was casted in terms of the Cobb-Douglas function

because it appears supperior through tests of alternative functional forms (Lau and Yotopoulos, 1971).

For the Cobb-Douglas case, the logarithmic profit function for each farm group (Lau and Yotopolous ,1971) is given by:-

$$\ln \pi^1 = \ln A^{1*} + (1-\alpha^*) \ln p + \alpha^*_1 \ln q'_L + \beta^*_1 \ln K + \beta^*_2 \ln T \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 5a$$

$$\ln \pi^2 = \ln A^{1*} + (1-\alpha^*) \ln p + \ln\left(A^{2*}/ A^{1*}\right) + \alpha^*_1 \ln q'_L + \beta^*_1 \ln K + \beta^*_2 \ln T \quad \ldots\ldots\ldots \; 5b$$

Where: $\pi^{'s}$ = Money profit; q'_L = Money wage rate per day; p = Price of output; $^{1 \text{ and } 2}$ = Different regions.

If prices of outputs differ only across regions, then region dummy variables can be inserted to capture the effect of differences due to $\left(\ln A^* + (1-\alpha^*)\ln p\right)$. This manipulation also allows for interregional differences in the efficiency parameter in A*. Hence the final estimating equation consists of

$$\ln \pi = \alpha_o + S + \alpha^*_1 \ln q'_L + \beta^*_1 \ln K + \beta^*_2 \ln T \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 6$$

Where: π = Farm profit in money terms: (excluding interest on capital and land rent);
q'_L = Money wage rate per day; K = Interest on fixed capital; T = Cultivable land;
S = Dummy variable for farm groups taking value of 1 for one group and 0 for the other;
α_o = Constant; α^*_1, β^*_1, β^*_2 = Estimation parameters.

Using this model, a test of relative efficiency in the smallholder tea sub-sector was done for East Rift Valley and West Rift Valley regions. The appropriate functional form of the profit function used was of the form:-

$$\text{Log (TGM)} = \beta_0 + \beta_1 \log(\text{NB}) + \beta_2 \log(\text{FC}) + \beta_3 \log(\text{LC}) + D \quad \ldots\ldots\ldots\ldots \; 7$$

Where: TGM = Tea Gross Margin per farm; NB = Number of tea bushes per farmer;
FC = Cost of fertilizer per hectare per year; LC = Labour cost per manday; D = regional dummy variable; β_0 = Constant term; β_1, β_2, β_3 = Estimation parameters.

Tea gross margin is tea gross output value less the total variable cost of tea in the year. Total variable costs of tea was the sum of fertilizer costs, cost of weed control, cost of pest control, cost of disease control and the cost of labour used in the course of the year. A common conceptual problem is how to determine the cost of family labour. The general principle is to value family labour at its opportunity cost; that is the benefit the family must forgo to participate, in tea production. The wage rates for labour in many developing countries may not accurately reflect the opportunity cost of shifting labour from one enterprise to another. However, there are peak seasons at planting, harvesting and plucking,

when most rural workers can find employment in farms. At those seasons, the market wage paid to rural labour is a good estimate of its opportunity cost and its marginal value product. Therefore, the market wage rate could be accepted as the economic value of rural labour (Gittinger, 1982). The problem is that during off peak seasons, there is surplus agricultural labour whose opportunity cost is lower than the market wage rate. In the smallholder tea sub-sector, there are peak seasons of plucking green leaf. During these seasons, farmers hire additional casual labour to supplement family labour. Willing family labour can also find employment in tea farms during this season. Therefore, the market wage paid to casual labour is a good estimate of its opportunity cost. During off peak seasons tea farmers lay off casual labour due to reduced tea plucking. As a result, there is surplus labour. The opportunity cost of labour during this period is less than the wage rate and is not ease to determine. Due to these difficulties, most studies (Lau and Yotopoulos, 1971; Sidhu,1974 etc.) have used the market wage rate as the opportunity cost of family labour. This study also assumed that, most of the tea is plucked during the peak season when the market wage paid to casual labour is a good estimate of the opportunity cost of family labour. Therefore, the wage rate of labour (LC) was the product of total amount of green leaf (kg) in each farm per year and the plucking cost per kilogram divided by the total number of man-days (hired and family) used in the year. Fertilizer cost was computed on per hectare basis. This was because farmers do not buy fertilizer in the input markets. They get fertilizer at the factory point at a uniform price per bag for every factory, which does not reflect interfarm fertilizer price differences. Therefore, fertilizer cost/ha captures interfarm variations adequately. The Number of tea bushes per farmer was the only fixed factor. It was expected to explain profit better than the area under tea. Interest on fixed capital was ignored because in small scale farming, it accrues to all the enterprises on the farm and not on tea alone. The region dummy variable was given a value of 1 for East Rift Valley and 0 for West Rift Valley. The results were as shown below.

3.0 Results and Discussions

The results are summarized in Table 1. The coefficient of multiple regression was 0.642. This coefficient gives the proportion of the total variation in the dependent variable explained by the predictors included in the model. The results showed that the independent variables explained 64 % of the total variation in the short run profit among the smallholder tea sample analyzed. The corresponding measure for the adjusted R- Square was 0.635. Further, the profit function model revealed that the F-value was 93.155 with a significant level of 0.000. Therefore, the hypothesis that all coefficients (except β_0) are equal to zero, should be rejected since the F-value was highly significant. Eigenvalues of the collinearity diagnostics showed that there was no multicollinearity among the predictor variables. The frequencies of standardized residuals were approximately normal. The normal probability plot confirmed this whereby the expected cumulative values were converging on the 45 degree diagonal line. These results lead to the conclusion that the profit function technically fitted the data quite accurately.

Table 1. Profit Function Regression Results for Smallholder Tea Sub-Sector

Log (TGM)				Log Linear Model	
Variable	β	SE β	Beta	t	Sig. t
Constant	-1.032	0.467		-2.212	0.028
Log(NB)	0.925	0.070	0.559	13.279	0.000
Log(FC)	0.297	0.088	0.145	3.363	0.001
Log(LC)	0.731	0.062	0.520	11.872	0.000
D	0.095	0.052	0.081	1.839	0.067

Multiple R = 0.801; R^2 = 0.642; Adjusted R^2 = 0.635; Standard Error = 0.356

ANNOVA

	DF	Sum of Squares	Mean Square	F	Sig .F
Regression	4	47.128	11.782	93.155	0.000
Residual	208	26.307	0.126		
Total	212	73.435			

The results on the test of influence of predictors on short run farm profits indicated that the coefficients of the number of bushes, fertilizer cost per hectare and labor wage rate were positive and significant at 1 percent level. This implied that they positively and significantly influenced tea farm profits. It further meant that there is room for farmers to increase the use of the respective inputs to the optimal level, just at the point where additional input use would reduce the profits. The coefficient of the regional dummy variable was positive and significant at 10 per cent. Since the profit function is transformed into a logarithmic function before estimation, the coefficient of the dummy variable differentiates the two groups of farms i.e. East Rift Valley and West Rift Valley farms. Therefore, the null hypothesis test becomes one of determining whether or not the coefficient of the dummy variable is significantly different from zero. The results, therefore, reject the hypothesis of equal efficiency between the East Rift Valley and West Rift Valley farm groups, at 10 percent level. Further more, the positive sign of the dummy variable coefficient indicates that East Rift Valley farms are more profitable, that is more economic efficient, at all observed prices of the variable inputs, given the distribution of the fixed factors of production.. It is concluded that East Rift Valley is more successful in responding to the set of prices it faces (Price efficiency) and /or because it has higher quantities of fixed factors of production, including entrepreneurship (technical efficiency).

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