International Business Management 1 (4): 79-82, 2007
ISSN: 1993-5250

An Economic Analysis of Index of Management Efficiency for Large Scale Road Transport in Eastern States of Nigeria

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Abstract: An index of management efficiency in road transport production is formed for each of 5 important cities in Eastern part of Nigeria for transport of large enough size for the functions of management and labour to be separated. The index is introduced as a variable in the production function and reveals distinct differences between the cities in the scope of improving management efficiency.

Key words: Index, management efficiency, road transport, production

INTRODUCTION

The concept of an aggregate production function is based on the assumption that all firms will produce the same quantity of good if they use the same quantity of inputs. This can only be true if all firms have the same degree of control over productive resources which assumes that the efficiency of management is the same in all the firms to which the production function relates. Since this is unlikely to be true, where the outcome of management decision is uncertain (and this is particularly true of transport), the estimated coefficients of the production function will be biased unless variations in management efficiency are allowed for.

In Nigeria, there is no separation between management and operative functions on small scale transporters, but on relatively large scale these functions are performed by different people. It is these larger transport firms which are the subject of the investigation reported below. Whereas small transport firms rely heavily on government aid and have to adhere to official policy to obtain it, the larger scale transporters do not and are therefore much freer to decided their production policies. Hence, there is more scope among them than among small transporters for variations in management efficiency to affect production. The purpose of the investigation is to discover whether variations in management efficiency on large scale transports do, in fact, have a significant effect on transportation productivity, having first developed an appropriate measure of management efficiency.

According to neo-classical theory, management has 2 aspects: Supervision and entrepreneurship. The former is rewarded by normal profits whilst the latter, which involves, decision-making under conditions of uncertainty, is rewarded by super normal profits, (Marshall, 1989). The marginal productivity of entrepreneurship has no meaning in economics because the supply is independent of the output of the product under its control. Hence it cannot be treated as a factor in production function.

Griliches (1957) and Doll (1974) suggest that, the management coefficient in the Cobb-Douglas function should be omitted from the sum of factor coefficients which denotes the return to scale, since all transporters might be able to double their output with double inputs of all other factors, but bad transporters require more input to achieve a given output. Then, increasing returns to scale will prevail if managerial capacity is not fully utilized and decreasing returns thereafter (Heady, 1962). According to this reasoning, if management efficiency affects output, the inclusion of an appropriate measure of efficiency should improve the fit of the production function, so we have first fitted the function without management variable and then with a management index to see if the fit is, in fact, improved by the inclusion of the management variable.

MATERIALS AND METHODS

The analysis that follows was based on a cluster sample of road transport production undertaken in year 2005. The sample covered 120 transport firms of more than 20 seaters buses in an area based on 5 distinct cities I the Eastern part of Nigeria for which the criteria for the division were road network, population density and commerce. These 5 areas

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were Port-Harcourt, Imo, Aba, Bayesa and Anambra. In each of these cities three government registered motor partks were randomly selected and eight buses of at least 20 seaters in the area were randomly chosen from each.

Detail were recorded of physical inputs and costs of various categories of fixed capital and labour among others on each of the transport firms and these provide the basis for the present study in which inputs are expressed per number of vehicle. Engine Oil (O) and Fuel (F) are expressed in litre of vehicle input, labour in man-hours and fixed capital because of it heterogeneity, is expressed in terms of its annual costs. All fixed capital, apart from vehicle, is combined into a single variable which we have called Improvements (I) for which only service costs are used. The annual cost of vehicle is calculated as follows:

$$K = D + X + G + F + O + M + W - A + I$$

Where:

K = Annual operating cost

D = Estimated annual depreciation

$$\text{Thus, } D = \frac{V\text{-}S}{E} \quad (1)$$

V = Initial cost of the vehicle at year 200 prices

S = Estimated scrap value at year 2000 prices

E = Expected life of the asset in years

X = Annual tax and insurance

G = annual cost of building/garage to house the vehicle

F and O = Annual cost of fuel and oil respectively

M = Annual cost of repairs and maintenance

W = Annual wage of the operator

A = Annual Administrative expenses.

i = Average annual cost of interest payment at 6% per annum which is the price charged by the Nigerian Bank notably community Banks for credit.

RESULTS AND DISCUSSION

The models: Three production functions were tested against the observations. They were linear, Cobb-Douglas and Constant Elasticity of Substitution (CES) functions.

A linear function would imply that, returns to scale were always constant whereas neither of the other function is so restrictive in this respect and hence might be considered to be preferable on these grounds alone. Nevertheless all 3 functions were fitted and the results compared.

Table 1: Estimated input coefficients and related statistics for large scale road transport

	Port-Harcourt	Imo	Aba	Bayesa	Anambra
Constant	0.005	0.072	1.286	0.063	0.206
L	0.747***	0.338***	0.033	0.621***	0.294
	(1.632)	(1.270)	(0.095)	(3.332)	(1.083)
K	0.378**	0.304***	0.345***	0.236***	0.281***
	(4.250)	(7.438)	(8.817)	(11.537)	(6.465)
F	0.199	0.275	0.037	-0.019	0.128
	(2.915)	(3.790)	(0.265)	(-0.419)	(1.431)
O	0.113	-0.009	0.086	0.549	0.0043***
	(1.066)	(2.986)	(1.140)	(2.141)	(0.074)
I	0.181	0.265**	0.022	10.0006**	0.112
	(0.873)	(0.332)	(0.300)	(-0.012)	(3.031)
R^2	0.78	0.87	0.91	0.88	0.79
F-statistic	15.641***	21.072***	39.329***	33.037***	16.540***

Figures in brackets are t-values. ***: Significant at the 1% level, **: Significant at the 5% level, *: Significant at the 10% level. Source: Computer Printer-out of SPSS (2006)

The Cobb-Douglas function gave a markedly better fit then the CES function in terms of the sum of the square residuals. The iterative method used to estimate the parameters of the CES function showed that the derived marginal products of the underlying variable do not differ significantly from those estimated with the Cobb-Douglas function. The substitution parameter in the CES function was also very small implying that the elasticity of substitution was close to unity. Hence the Cobb-Douglas function was apparently appropriate.

The linear function was fitted with and without the management variable. While the fit was good in both cases, the Cobb-Douglas function was distinctly better in respect of goodness of fit and the significance of the coefficients. In the interest of brevity, therefore, only the results for the Cobb-Douglas function are reported.

Model 1: A single-equation mode was used in which inter cities road transport Yield (Y) was regressed on Labour (L), Vehicle (I), Fuel (F), Oil (O) and Improvement (I).

$$Y = aL^{\alpha}K^{\beta}F^{i}O^{\delta}I^{\epsilon}U \quad (1)$$

The estimated coefficients and their standard errors are given in Table 1 which shows that, although the coefficient of determination, R^2, is quite high is all cases, only eleven coefficients are significant at certain percent level out of a total for all registered parks of 25. The correlation matrix shows a high intercorrelation between labour and improvement in the services.

This collinearity could lead to inaccuracy of the estimates as could the omission of important variables and variations between transport firms in the degree of control over their inputs. Management might be expected to be an important factor and variations in management efficiency between transport firms could be considerable.

Hence, an attempt has been made to qualify management efficiency so that account can be taken of it in the fitted function.

Model 2: In the analysis of transport production functions, management is not usually included as a separate variable because no completely satisfactory objective measure has been found. Nevertheless, some attempts have been made to quantify the contribution of management. A simple procedure is to utilize the residuals (deviations of observed values from fitted values) as a basis for an objective management rating (Bessel, 1960; Aworemi, 2003).

The justification for using the residual index is that all other factors are assumed to be paid the value of their marginal products, but this is not necessarily true. In any case, the residual may not be ascribable solely to management, but may be due partly to other excluded variables such as type of vehicle or public policies (Timmer, 1970; Aworemi, 2003). A logical alterative measure of management efficiency is to relate profit in each observation to the average profit of the whole sample. This is consistent with the assumption of economic rationality but, unfortunately, it is very difficult to obtain a complete homogenous sample so that higher profits can reasonably be attributed solely to higher management efficiency. If the sample is not homogenous it is always possible that some other included variables attribute to profitability also.

Some studies have used subjective indices as a proxy for management. Hoch (1962) and Mundlak (1971) partitioned the observations into groups on the basis of a relevant criterion and used the analysis of covariance of the production function to test the value of the intercept. Other investigators have used on index of farming practices and techniques in terms of deviations from recommended practices (Kahlon and Acharya, 1976; Massell, 1976) whilst Griliches (1963, 1964), Chaudhuri (1969) and Herd (1971) used an index of education as a proxy fro management quality. Apart from their subjective nature, such indices might measure management potentiality rather than actual management input (Heady and Dillon, 1961). In traditional transport, where managers and labouers are one and the same, education is not a reliable proxy for management and may be regarded also as an indicator of labour quality. However, so far as the relatively large transport firms in Nigeria are concerned this is not so, both because of the higher degree of specialization between labour and management and because they technically advanced.

The management index used in the present investigation was derived by regressing transport output (Y) on educational level (X_1) and years of experience (X_2). Linear, quadratic and log-linear functions were tested and in all selected cities the linear model provided the best fit (Table 2).

Table 2: Estimated coefficients of education and experience and related statistics in the large scale road transport

	Port-Harcourt	Imo	Aba	Bayesa	Anambra
Constant	2.659	4.077	5.428	5.01	5.226
X_1	0.403***	0.244***	0.144*	0.02	0.018
	(3.673)	(3.383)	(1.902)	(0.649)	(1659)
X_2	0102***	0.058**	0.211*	0.026***	0.033***
	(4.353)	(2.83)	(1.798)	(3.097)	(4.072)
R^2	0.48	0.36	0.40	0.36	0.49
F-statistic	9.563	5.88	5.606	6.0	9.947***

Figures in brackets are t-values. ***: Significant at the 1% level, **: Significant at the 5% level, *: Significant at the 10% level. Source: Computer Printer-out of SPSS (2006)

Table 3: Estimated coefficient and related statistics in large scale transport firm after including management index

	Port-Harcourt	Imo	Aba	Bayesa	Anambra
Constant	0.004	0.086	0.041	0.281	0.101
L	0.822**	0.382	0.531**	0.347***	0.458***
	(2.478)	(1.523)	(2.229)	(8.160)	(6.879)
K	0.380***	0.285***	0.406***	0.211***	0.258***
	(4.6668)	(6.558)	(14.97)	(42.59)	(24.07)
F	0.191	0.210**	0.114*	0.054	0.083***
	(1.408)	(2.381)	(1.899)	(1.272)	(3.454)
O	0.052	0.018	0.0295	0.054*	0.017
	(1.413)	(0.262)	(0.611)	(2.106)	(0.452)
I	0.155***	0.131***	0.091*	0.037***	0.078***
	(3.407)	(3.091)	(1.913)	(3.328)	(8.359)
MI	0.261***	0.57*	0.122***	0.059***	0.079***
	(4.174)	(1.805)	(5.127)	(17.566)	(16.827)
R^2	0.89	0.88	0.95	0.96	0.95
F-statistic	27.834***	26.79***	88.956***	149.361***	117.019***

Figures in brackets are t-values. ***: Significant at the 1% level,**: Significant at the 5% level, *: Significant at the 10% level, Source: Computer Printer-out of SPSS (2006)

X_1 is a dummy variable ranking the level of education as 1 for non-educated transporters, 2 for primary-educated transporters, 3 for secondary-educated transporters and 4 for more highly-educated transporters. Experience is measured as the number of years that the transporter had held or acquired the vehicle, up to 2 generations. The estimated coefficients are non-significant at the 10% level and both education and experiences are shown to be positively correlated with the transport outputs with education being a highly significant variable in the Port-Harcourt and Imo cities.

The index of management efficiency obtained by relating the educational level and years of experience for each transport firm weighted by the regression coefficients to the weighted average over the whole sample. That is:

$$M_1 = \frac{b_1x_1 + b_2x_2}{b_1\bar{x}_1 + b_2\bar{x}_2} \qquad (2)$$

Where, b_1 and b_2 are the regression coefficients of education and experience, respectively $\bar{x}_1$ and $\bar{x}_2$ are the mean values of these 2 variables.

The next step was to refit the production function including the management index in addition to those variables which were included in model 1. The results are given in Table 3. It depicts, by comparison with Table 1, that in all selected cities the fit is improved and the management coefficient is significant at the one percent level in all selected cities except the Imo.

CONCLUSION

Evidently an index educational level and years of experience is an appropriate proxy for managerial ability on large transport firms in Nigeria: Transporter with long experience and a good education are most productive.

This finding is consistent with developed transportation elsewhere rather than with small scale transport. It is not altogether surprising since transport in this transport size category is non-traditional.

The production elasticities of the derived index of management efficiency are all positive. The elasticity is particular high in the Post-Harcourt and Aba cities n both of which there are increasing returns to scale, so further improvements in experience and education would be likely to bring about an increase in output.

On the other hand, production elasticity of management is low in Bayesa and Anambra indicating that management efficiency has little scope for improvement. This is confirmed by the fact that decreasing returns to scale prevail in both cities. The production elasticity of management in Imo is lower than in the other two cities (Bayesa and Anambra) and returns to scale are not strongly increasing, indicating that, management efficiency is near its maximum and further education and experience will not effect large improvements.

These findings are consistent with expectation because the large transport firms in Bayesa and Anambra and operated by long-established transporting families who were larger vehicle owner and whose level of education is relatively high. In Port-Harcourt, Imo and Aba, on the other hand, most large transporters have not had long experience in transport management and their level of education is lower on average.

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