Efficiency of microenterprises in the Nigerian economy

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Abstract

This study investigates the efficiency of microenterprises in the Nigerian economy, using cross sectional data collected on 180 microenterprises selected from block-making, metal-fabricating and sawmilling occupational groups. Quantitative estimates obtained from the stochastic frontier production function indicate a wide variation in technical and allocative efficiencies within and across occupational groups and across operational scales. The wide variation in the level of efficiency is an indication that there is ample opportunity for these enterprises to raise their level of efficiency.

The level of education of enterprise owners was found to be highly significant in affecting the level of efficiency of the microenterprises. This implies that education is an important policy variable, and could be used by policy makers to improve both technical and allocative efficiency in the sampled enterprises. Hence, education policy that would encourage operators of microenterprises in the country to undergo literacy and training programmes would lead to substantial increase in efficiency of production and hence in the volume of output at the current level of technology. Finally, rising age of enterprise owners was found to lead to decline in the mean efficiency. Therefore, government policy should focus on ways to attract and encourage young entrepreneurs who are agile and able to put in more efforts at raising the level of efficiency.

1. Introduction: Microenterprises in the Nigerian economy

Microenterprises are important components of the Nigerian economy, comprising a significant proportion of the country's informal sector. Before Nigeria's political independence, only a small number of industries existed in the country, mostly concerned with the processing of agricultural goods for domestic and export markets. Like many other developing economies, Nigeria has taken several policy steps to develop its manufacturing sector. One such major step was the implementation of the structural adjustment programme (SAP) in 1986, to correct structural imbalance within the economy.

The introduction of SAP marked the beginning of the deregulation of the economy and its transformation from an inefficient and import-dependent economy to one that is diversified, dynamic, efficient and export-oriented. SAP was aimed at achieving efficiency in both the private and public sectors of the economy, with the manufacturing sector expected to play a central role in this transformation. Hence, one of the objectives of SAP was to enhance the productive efficiency of the manufacturing sector, particularly against the background of declining oil revenue required to support factor accumulation and imports.

Prior to 1986, the performance of the Nigerian manufacturing sector followed closely the pattern of growth of the external sector. This was a reflection of the manufacturing sector's high dependence on the external sector for both income and productive inputs. Oil revenue provides the driving force for domestic demand and investible funds for the manufacturing sector. Thus after experiencing a phenomenal increase in performance between the mid 1970s and the 1980s, the Nigerian manufacturing sector witnessed stagnation and for the most part declined after 1983. Iwayemi (1994) gave two reasons for this development: First, a weak demand arising from the sharp fall in real income as a result of economic recession and high product prices, and second, low export market penetration owing to poor quality control and high cost of production arising from the high cost of imported inputs.

Olaoye (1985) identified low productivity growth as one of the constraining features of the Nigerian manufacturing sector. Between 1986 and 1990, the federal government introduced several economic measures to restructure the Nigerian economy in a variety of ways in an attempt to increase the efficiency of both public and private enterprises. The deregulation of the Nigerian economy, which is a major instrument of SAP, was aimed at altering the incentive structures faced by the manufacturing sector. Such policies include payment and trade liberalization, interest rate liberalization, appropriate pricing of public goods, and the reduction of the public industrial sector to enhance efficiency. These policies either directly targeted the manufacturing sector or have an indirect impact on the sector through their effects on the overall economy. The general equilibrium effects of these policies have both expected and unexpected impacts on the performance of the manufacturing sector.

The policy blueprint of SAP adequately reflected the government philosophy of minimum administrative control of economic activities and the wide scope for free market forces in the economy, a greater role for the private sector, and more emphasis on efficiency and productivity, as well as economic self-sufficiency and self-reliance.

To achieve prosperity and overcome stagnation, there is need to increase growth in all sectors of the economy, for such growth is the most efficient means of alleviating poverty and generating broad-based economic growth. Resources must be used much more efficiently, with more attention paid to eliminating waste. This will lead to increase in productivity and incomes. The success in achieving broad-based economic growth will depend largely on the ability to efficiently utilize the available resources.

A definition of microenterprises

For the purpose of this study, microenterprises are defined as the unorganized, privately owned manufacturing/production enterprises whose workforce ranges between two and ten employees. The size factor is the important limiter in the definition of microenterprises, so that what constitutes a microenterprise varies from country to country, depending on the economy. In Nigeria, however, most microenterprises fit our description of 2–10 workers. Such enterprises range from block-making, carpentry and metal-fabricating concerns to sawmilling, soap-making and tailoring, among others.

Rather than engage in direct production, the Nigerian government has shifted emphasis to providing the right atmosphere and infrastructure for private enterprises to function properly. The action of the government recognized that these private enterprises are very important in bringing about industrial and economic transformation. Oyejide (1975) states that industrialization appears to be the main hope of most developing countries that desire to increase their per capita income levels.

The evolving policy environment

Nigerian development policies have followed distinct phases in the history of the country. The pre-1970 era marked a period of import substitution. The emphasis on planning at that time was on the development of microenterprises and assembly plants. The enterprises/projects in the plan included small-scale machine tools, kitchen utensils and other artisan groups. The second period spans the oil boom period of 1970–1980. The huge inflow of petroleum dollars removed, albeit temporarily, the resource constraint facing the country. The direct participation of government in production activities became pronounced. Infrastructure facilities were expanded and several multinational corporations came into the country to take advantage of the new oil wealth, currency over-valuation, tariff protection and the huge Nigerian internal market (Adejugbe, 1995). The Third National Development Plan (1975–1980), launched in the second half of the plan period, however, shifted emphasis to heavy industrial projects, especially in the steel and petroleum refining subsectors.

The period of 1982–1985 was perhaps a "dark" period in the development of microenterprises in particular and the industrial sector in general. The collapse of oil prices starting from 1982 pushed the economy into deep recession. With the slump in the international oil market, there was a sharp decline in the output performance of the industrial sector. This poor performance exposed the inherent weaknesses of the sector, which had largely been sheltered from competition by the import substitution industrialization policy Nigeria adopted after independence in 1960.

The post 1986 period witnessed a change in the underlying philosophy of the industrialization policy in Nigeria. A new industrialization policy launched in 1988 stated the goals of industrialization in Nigeria as: generating greater employment opportunities, promoting manufactured exports, raising the level of technological capability and skill efficiency, promoting the inflow of foreign investments, and increasing private sector participation in industry.

The over-valuation of the exchange rate in the 1970s made the importation of capital and producer goods cheap and favourable against local goods, while at the same time, the position of the final consumer goods production was entrenched by higher tariffs (Iwayemi, 1994). Tables 1–4 present some indicators of performance of the manufacturing and other sectors of the economy, with Table 1 showing the annual growth rate of different sectors of the Nigerian economy between 1980 and 1996.

Table 1: Average annual sectoral growth rates, 1980 and 1996

	1980–1986	1987–1992	1993–1996
Agriculture	0.5	3.8	2.9
Industry	-5.1	4.5	-1.8
Manufacturing	-1.8	4.9	2.1
Mining	-5.9	4.4	4.9
Services	0.2	6.3	3.4

Source: Calculated from Central Bank of Nigeria Statistics Bulletin (1997).

With the implementation of SAP in 1986, the index of production of the manufacturing sector witnessed rapid growth, especially between 1987 and 1993 when SAP policies were vigorously pursued. This declined between 1992 and 1995, before rising again in 1996 (Table 2). To clearly depict the picture of microenterprises within the manufacturing sector, Table 3 shows that the majority of the enterprises have reduced their dependence on imported inputs. More than half of the subsectors had by 1995 derived over 50% of their raw materials locally.

Table 2: Index of manufacturing production in Nigeria, 1986–1996 (1985 = 100)

Year	Index	Percentage change
1986	78.2	-
1987	130.8	67.3
1988	135.2	3.4
1989	154.3	14.1
1990	162.9	5.6
1991	178.1	9.3
1992	189.5	- 4.8
1993	145.5	- 14.2
1994	144.2	- 0.9
1995	136.3	- 5.5
1996	137.7	1.0

Source: Central Bank of Nigeria, Annual Report and Statement of Account (1997).

Table 3: Local sourcing of raw materials by enterprises in Nigeria (%)

S/N	Sector	1988	1989	1990	1991	1992	1993	1994	1995
1	Food, beverages and tobacco	62.9	62.9	72.4	65.4	67.1	63.6	57.5	63.0
2	Wood, wood products and furniture	NA	NA	74.0	80.3	81.3	79.0	85.0	90.0
3	Textiles weaving, apparel, carpets and leather products	54.8	62.0	66.8	67.0	67.0	68.0	65.2	67.2
4	Pulp, paper and paper products	28.7	40.0	45.4	39.0	32.9	31.2	34.1	38.7
5	Non-metallic mineral products	86.7	79.0	78.0	83.4	72.7	65.6	73.3	72.7
6	Chemicals/pharmaceuticals	36.2	37.5	47.5	42.0	40.5	46.5	53.4	43.7
7	Plastic and rubber products	50.5	22.3	31.5	36.6	43.8	30.2	43.0	52.6
8	Electrical/electronics	NA	31.5	28.0	35.5	33.4	31.1	38.8	32.5
9	Basic metal, iron and steel, and fabricated metal production	34.9	42.0	22.3	24.9	43.0	43.3	39.4	55.7
10	Motor vehicles and miscellaneous assembly	NA	38.5	34.9	25.5	37.4	41.1	39.4	43.4

Note: There is no available information on block-making enterprises.
Source: Manufacturers' Association of Nigeria, Biannual Report, various issues.

Table 3 shows that the index of manufacturing production declined sharply between 1985 and 1995. On the average, the enterprises within the manufacturing sector operated at less than half of their installed capacity during the review period. One explanation for this could be that the deregulation of the economy made imported raw materials very expensive, and most manufacturing companies could not afford them.

Table 4: Capacity utilization by enterprises (%)

S/N	Sector	1988	1989	1990	1991	1992	1993	1994	1995
1	Food, beverages and tobacco	37.8	32.5	36.7	32.6	45.3	37.8	29.2	31.5
2	Wood, wood products and furniture	NA	NA	NA	67.8	49.1	34.8	59.7	52.1
3	Textiles, weaving, apparel, carpets and leather products	39.7	41.0	51.1	35.4	50.1	43.5	40.3	37.6
4	Pulp, paper and paper products	38.3	41.0	30.1	30.4	35.2	32.6	24.7	23.5
5	Non-metallic mineral products	50.0	33.5	47.1	45.1	37.4	32.6	37.4	35.6
6	Chemicals/pharmaceuticals	37.9	24.0	32.7	31.0	30.4	31.1	26.5	26.3
7	Plastic and rubber products	38.7	34.5	41.9	48.9	42.5	41.1	34.7	34.2
8	Electrical/electronics	NA	26.5	26.7	28.7	34.6	24.2	20.9	20.8
9	Basic metal, iron and steel, and fabricated metal production	28.3	17.5	35.5	35.5	24.3	25.5	25.5	22.5
10	Motor vehicles and miscellaneous assembly	NA	23.5	23.1	13.8	24.1	25.9	14.9	23.6

NA = Not available
Note: There is no available information on block-making enterprises.
Source: Manufacturers' Association of Nigeria, Biannual Report, various issues.

2. The research problem, objectives and hypotheses

Much empirical evidence suggests that poverty and unemployment are of great concern to policy makers in developing countries. This is particularly relevant against the backdrop of forecasts by the World Development Report (1990) on development indicators that sub-Saharan Africa's economic growth rate would hardly exceed its population growth rate during the 1990s. The WDR estimated the annual growth rate to be 3% for the modern sector, 4% for the rural sector (farm and non-farm) and 4.5% for the informal sector. Clearly, the informal sector, consisting largely of microenterprises, offered the greatest potential for employment generation. This potential would not be actualized, however, if productivity and efficiency were not increasing within the informal sector. This in turn requires a good knowledge of the current efficiency or inefficiency inherent in the subsector, as well as the factors responsible for this level of efficiency/inefficiency.

As a developing country, Nigeria has immense potential for better economic growth in both short and long runs than it is currently recording. The need for the efficient allocation of productive resources cannot be overemphasized. Every factor of production should be efficiently and effectively mobilized to close the gap between actual and potential national outputs. Therefore, any attempt to identify determinants of efficency of productive resources would help in achievung growth at macro level. Besides, economic difficulties in most developing countries today, including Nigeria, make the financing of inputs/capital accumulation infeasible. Hence, the focus on industrial growth is shifting to issues of efficiency in the use of the available quantum of productive inputs.

The efficient allocation of resources at individual firm levels has implications for investment and employment at the national level. It also has implications for technical and technological progress resulting in supply shifts. Needless to add that gross national product (GNP) and per capita income will also be expected to rise, which will help to serve import substitution purposes by supporting domestic demand. Finally, the measurement of efficiency is important for the following reasons. First, it is a success indicator and performance measure by which production units are evaluated. Second, it is only by measuring efficiency and separating its effects from the effects of the production environment that one can explore hypotheses concerning the sources of efficiency differentials. Identification of sources of inefficiency is essential to the institution of public and private policies designed to improve performance. Third, the ability to quantify efficiency provides decision makers with a control mechanism with which to monitor the performance of the production system or units under control. In some cases, theory provides no guidance—or sends conflicting signals—concerning the impact of some phenomena on performance. In such situations, empirical measurement provides qualitative as well as quantitative evidence (Coelli, 1996).

There are very few firm-level studies of efficiency in the developing economies, especially Nigeria. Many of the studies that currently exist are macro in nature and generally rely on multi-country or cross-country data rather than firm-level survey data. Therefore, policy formulation has been hampered by a lack of relevant empirical studies at firm level. The policy question therefore is: *What is the firm's current level of efficiency and what factors influence this level?* The challenge of this study is to estimate the current level of technical, allocative and economic efficiency as well as the factors that influence the level of efficiency of these microenterprises. The outcome of the study would serve as a guide to public policy design and implementation. It is thus important to understand clearly the factors that are responsible for efficiency differentials at individual firm levels. Some of these factors will lend themselves to policy manipulation while others will not.

Objectives of the study

The general purpose of this study is to determine empirically the efficiency of Nigerian microenterprises, with a focus on metal-fabricating, sawmilling and block-making enterprises. Specifically the study:

- Estimates technical and allocative efficiencies of the microenterprises.
- Identifies and analyses the determinants of efficiency in the sampled microenterprises.
- Estimates and analyses efficiency differences between zones and firms' characteristics.
- Assesses the variations in levels of efficiencies as a result of simulated changes in selected policy variables.

The motivation for this study is that microenterprises in Nigeria are very important in achieving the much-needed industrialization and in raising per capita income. Oyejide (1975) states that government policy has always been aimed at increasing the rate of growth of the economy through industrialization, thereby increasing the contribution of the industrial sector to the gross domestic product, thus diversifying the economy. Hence, the informal sector forms the focus of this study.

Study hypotheses

To guide the study in arriving at meaningful results, the following null hypotheses were tested:

- The selected microenterprises are efficient and have no room for efficiency growth.
- There is no significant difference in the efficiencies of selected enterprises across scales of operation.
- There is no significant difference in the efficiencies of selected enterprises across vocational groups and geographical zones.
- No policy variable significantly influences the efficiency of selected microenterprises.

3. Literature review, theoretical framework and analytical approach

Over the last one and a half decades, Nigerian microenterprises have been exposeoxternal ompetition through the liberalization policy. Between 1986 and 1990, the Nigerian government introduced several economic measures to restructure the economy in a variety of ways in order to increase the efficiency of both public and private enterprises. For different reasons, development economists generally argue that trade protection brings down the level of industrial sector efficiency. The first reason is that if a market is characterized by entry barriers, the absence of foreign competition allows local firms to enjoy monopoly power and excess profits. The consequence is that domestic producers usually fail to produce at minimum cost (economic inefficiency), and/or to get the maximum possible output from their input bundles (technical inefficiency). The second reason is that if the market is characterized by Chamberlinean (1933) competition, trade protection usually attracts inefficiently small producers, causing increases in production costs. Hence, the lack of competitive pressure generally induces costs to rise above the minimum levels, owing to imperfect agency relationships within the firm. Also, resources are wasted through rent-seeking activities undertaken to obtain advantages for the firm against actual or potential competitors.

Microenterprises and the liberalized Nigerian economy

Trade liberalization is expected to have several advantages for domestic firms. Exposure to foreign competition can improve a firm's performance and is viewed as a means of learning superior production and management techniques, as a liberalized economy is expected to facilitate the flow of technical information. In addition, openness, coupled with a liberal incentive structure, should inspire greater foreign investment inflow, and hence technology inflow into the economy.

Economists have identified some main mechanisms through which policies like trade liberalization can affect efficiency in an economy. These include the following:

- To compete effectively against international producers, domestic firms must adopt newer and more efficient technology or use the same technology with less inefficiency in order to reduce costs (Nishimizu and Robinson, 1988). It is a fact that if domestic firms are heterogeneous and characterized by different degrees of inefficiency, the exit of the less efficient firms will result in lower average costs and higher efficiency. The firms that remain in the industry will be forced to adjust in two ways: first, by expanding the scale of production and exploiting economies of scale, and second, by reducing technical inefficiencies. These two adjustments will reduce the average industry cost and increase efficiency (Krugman, 1984).

- For developing economies, it may be difficult to replace imports of intermediate and capital goods with domestically produced goods. The imported inputs may include differentiated intermediate goods that are not available domestically. Therefore, increased availability of such imported intermediate and capital goods enables local researchers to obtain more insights from inspecting and using these goods, and this increased knowledge in turn leads to better efficiency.
- It is recognized that higher volumes of imports and exports increase international technical knowledge spillovers. This may occur through suggested improvement to the production process from foreign purchase (Griliches and Jorgenson, 1969). While trade policy such as liberalization may enhance efficiency, the net effect of liberalization on productivity depends on the specifics of the demand shifts that accompany liberalization, ease of entry or exit, and the nature of the competition.

Empirical evidence abounds that higher productivity growth is generally associated with the production of tradeable goods. In addition, differences in firm-level efficiency are typically greater in industries protected from international competition (Roberts and Tybout, 1997). These patterns may reflect limited access to foreign technology and expertise, as well as problems in acquiring imported intermediate and capital goods under protectionist trade regimes (Pack, 1988; Roberts and Tybout, 1997).

Theory of production and productive efficiency

The economic theory of production provides the analytical framework for most empirical research on productivity and efficiency. Productive efficiency means the attainment of a production goal without waste. Beginning with this basic idea of “no waste”, economists have built up a variety of theories of efficiency. The fundamental idea underlying all efficiency measures, however, is that of the quantity of goods and services per unit of input. Consequently, a production unit is said to be technically inefficient if too little output is being produced from a given bundle of inputs. There are two basic methods of measuring efficiency—the classical approach and the frontier approach. The classical approach is based on the ratio of output to a particular input, and is termed partial productivity measure.

Dissatisfaction with the shortcomings of this approach led economists to develop advanced econometric and linear programming methods for analysing productivity and efficiency. The frontier measure of efficiency implies that efficient firms are those operating on the production frontier. The amount by which a firm lies below its production frontier is regarded as the measure of inefficiency. The earliest work on the frontier approach dates back to Farrell (1957).

Stochastic frontier production function

Technical and allocative efficiency, as defined in the following sections, are measured in relation to the production frontier. Both concepts relate the output to a given set of inputs.

Technical efficency

The production frontier can be viewed as composed of those parts of a firm's production functions that yield maximum output for a given set of inputs. It is possible that a firm with its scale of operation may not be able to reach the frontier, that is, the production function for the industry. On the other hand, there may be firms whose outputs are closer to the frontier, given their levels of inputs. The notion of how close the individual production plans are to the maximum levels, as defined by the frontier and given input levels, is the measure of technical efficiency for each firm.

Consider a firm using *n* inputs (x_1, x_2, ...x_n) to produce a single output *y*. Efficient transformation of inputs into output is characterized by the production function *f*(x), which shows the maximum output obtainable from various input vectors.

The stochastic frontier production function assumes the presence of technical inefficiency of production. Hence the function is defined by

$$Y_i = f(x_i,\beta) \exp(V_i - U_i) \qquad i = 1,2\ldots,n \qquad (1)$$

where V_i is a random error, which is associated with random factors not under the control of firm or the decision maker, while U_i is the inefficiency effects. This model is such that the possible production Y_i is bounded above by the stochastic quantity, $f(x_i, \beta)$ $\exp(V_i - U_i)$, hence the term stochastic frontier. The random error V_i is assumed to be independently and identically distributed as $N(0,\sigma^2_v)$ random variables independent of the U_is, which are assumed to be non-negative truncations of the $N(0,\sigma^2_v)$ distribution (i.e., half-normal distribution) or have exponential distribution.

Technical efficiency of an individual firm is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology. That is,

$$\text{technical efficiency (TE)} = Y_i/Y_i^*$$

$$= f(x;\beta)\exp(V_i\dagger- U_i) \,/\, f(x,\beta)\exp(V_i)$$
$$= \exp(-U_i) \qquad (2)$$

where Y_i is the observed output and Y_i* is the frontier output.

Allocative efficency

Allocative efficiency reflects the ability of a firm to use inputs in optimal proportions, given their respective prices. A production process is said to be allocatively efficient if it equates the marginal rate of substitution between each pair of inputs with the input price ratio. Departure from this optimal condition can be explained by (a) underutilization or overutilization of inputs resulting from the failure to minimize cost exactly because of some institutional, structural or managerial problems, and (b) uncontrolled random exogenous shocks such as uncertainty in input and output prices, quality of inputs, etc. Allocative efficiency is modelled as

$$\frac{Mp_{xi}}{Mp_{x1}} = Ki\frac{W_i}{W_1}e^{ui} \qquad i = 1,2,...,n \qquad (3)$$

where factors of proportionality, K_i, are firm and input specific, U_i are random errors, and MP_{xi} are marginal products of X_i and W_i input prices. Hence, exact cost minimization is a special case when $K_i = 1$ (i = 1,2,...,n), and K_i represents allocative inefficiency in the input pair (1, i). When $U_i = 0$ for all i, the production process is allocatively efficient. On the other hand, if $U_i>0$ for some i, input X_i is relatively underutilized, given W_i and W_1. Similarly, input X_i is overutilized if $U_i<0$.

Dual technology approach to efficiency modelling

An alternative method of estimating the frontier production function is the cost or profit function. This is to reflect the alternative behavioural objectives, such as cost minimization. The dual form of technology in stochastic frontier production modelling can be illustrated as follows:

Consider a firm using *n* inputs $X = (X_1, X_2,...X_n)$, available at fixed prices $W = (W_1, W_2,....W_n)>0$, to produce a single output *y* that can be sold at fixed price P>0. Efficient transformation of inputs into output is characterized by the production function *f(x)*, which shows the maximum output obtainable from various input vectors. Alternatively, an equivalent representation of efficient production technology is provided by the cost function,

$$C(y,w) = \min x\{w,x/f(x)>y,X>0\} \qquad (4)$$

which shows the minimum expenditure required to produce output *y* at input prices *W*. Equivalently, a third representation of efficient production technology is provided by the profit function,

$$\pi (P,W) = \text{Max}_{y,x}\{P_y\text{-}W, X/f(x)>y,x>0, y>0\} \qquad (5)$$

which specifies the maximum profit available at output price *P* and input prices *W*.

In economic literature (e.g., Forsund et al., 1980; Battese, 1992), the functions *f(x)*, *C(y,w)* and $\pi(P,W)$ are typically referred to as frontiers, since they characterize optimizing behaviour on the part of an efficient producer, and thus place limits on the possible values of their respective dependent variables.

Suppose the firm is observed at production plan (y^0, x^0); the plan is said to be technically efficient if $y^0 = f(x^0)$ and technically inefficient if $y^0 < f(x)^0$. A measure of the technical efficiency of this plan is provided by the ratio $0 \leq y^0/f(x^0) \leq 1$. Technical inefficiency is due to excessive input usage, which is costly, and so $w,x^0 \geq C(y^0, W)$. The plan (y^0,x^0) is said to be allocatively efficient if $f_i[(x^0)/f_j(x^0) = W_i/W_j]$ and allocatively inefficient if $f_j[(x^0)/f_j(x^0) \neq W_i/W_j]$. Allocative inefficiency results from using inputs in the wrong proportions, which is costly, and so $W,X^0 > C(y^0,w)$. Since cost is not minimized, profit is not maximized, and so $(Py^0\text{-}W'x^0) \leq \pi (P,W)$. The observed expenditure $W'X^0$ coincides with minimum cost $C(y^0,w)$ if, and only if, the firm is both technically and allocatively efficient. If $W'X^0 > C(y^0,w)$, this difference may be due to technical inefficiency alone, allocative inefficiency alone or some combination of the two. It also follows that observed input usage X^0 coincides with cost-minimizing input demand $X(y^0,w)$ if, and only if, the firm is both technically and allocatively efficient.

Development in stochastic frontier production functions analyses

Following the pioneering but independent works by Aigner et al. (1977), Battese and Corra (1977), and Meeusen and van den Broeck (1977), serious consideration has been given to the possibility of estimating the frontier production function, in an effort to bridge the gap between theory and empirical work. In the last decade, various models have been proposed for the inefficiency effects in stochastic frontier production functions. Khumbhakar et al. (1991) specified a stochastic frontier production function in which the technical inefficiency effects were assumed to be a function of the values of other observable explanatory variables. In addition, their model considered allocative and scale efficiencies. Battese and Coelli (1995) also proposed a stochastic frontier production function for panel data, in which the technical inefficiency effects were specified in terms of various explanatory variables, including time. Huang and Lui (1994) specified a non-neutral stochastic frontier production function in which the technical inefficiency effects were specified in terms of various firm-specific variables and interaction among these variables and the input variables in frontier. Reifschneider and Stevenson (1991) also proposed a stochastic frontier model in which the technical inefficiency effects were dependent on other variables.

A number of empirical studies have identified the sources of technical inefficiency, in addition to predicting technical efficiencies for the firms. One of the early empirical studies in stochastic frontier production function was Pitt and Lee's (1982) analysis of the sources of technical inefficiency in the Indonesian weaving industry. They estimated a stochastic frontier production function by the method of maximum likelihood and the predicted technical efficiencies were then regressed upon some variables, including size, age and ownership structure of each firm, and were shown to have significant effect on the degree of technical inefficiency of the firms. Many subsequent empirical studies have investigated the sources of technical inefficiency in different industries using the same two-stage analytical method. Other studies, by Khumbhakar et al. (1991), Reifschneider and Stevenson (1991), Huang and Lui (1994), Battese and Coelli (1993), and Battese et al. (1996), have questioned the theoretical consistency of this two-stage analytical technique. They have proposed the use of stochastic frontier specifications that incorporate models for the technical inefficiency effects and simultaneously estimate all the parameters involved.

4. Research methodology

The discussion of the methodology of the research begins with the description of the area of study, the method of sample selection and the technique for data collection. It then describes the estimation of the various models and defines the variables.

Study area, sampling technique and data collection

The microenterprises of interest for this study are the concrete block-making, metal-fabricating and sawmilling/wood processing enterprises, which were chosen because they produce physical goods and fairly homogeneous products within each of the groups.

This study covered three locations in Nigeria. For the purpose of the study, the country was conveniently divided into three zones—North, Southwest and Southeast. Both purposive and random sampling techniques were used to select the cities and firms included in the study. The cities were selected to ensure the relative spread of respondents: Kaduna and Abuja from the North, Akure and Ibadan from the Southwest, and Enugu and Port Harcourt from the Southeast. Sampling frames for each of the three cities were developed on the basis of data collected from the National Association of Small-Scale Enterprises. From each of the zones and vocational groups, 20 firms were randomly selected, giving a total of 60 firms per zone. Selection was done in such a way as to include different scales of operation in order to ensure heterogeneity among the sampled firms as well as to allow for analysis across scales of operation in order. A structured questionnaire was administered to collect the necessary data.

Cross-sectional data collected allowed estimation of technical, allocative and economic efficiencies for the enterprises. The data included information on physical quantities of production inputs as well as output for each group of firms, along with information on prices of inputs and outputs. To identify factors that influence efficiency, data were collected on factors such as the age and level of education of business operators/decision makers. Information was also collected on other aspects such as capital investment, experience at work, years of training, etc. The technical and allocative efficiencies for individual enterprises were estimated on vocational group basis and compared across groups and across zones.

Analytical models

For our empirical analysis, both Cobb–Douglas (1928) and translog stochastic frontier production functions were estimated and the estimated functions were statistically tested to select the function that best describes the data. It is pertinent to note that the Cobb–Douglas frontier is the restricted form of the translog frontier, in which the second-order terms in the translog function are restricted to be zero. The results of estimated models shows that the Cobb–Douglas frontier models provide better representation of the data for all the zones and vocational groups. Hence, only the estimates from the Cobb–Douglas models are presented in this paper.

Technical efficiency estimation

For our empirical analysis, the Cobb–Douglas frontier production function specifies the technology of the enterprises. The model is defined by:

$$ln\ Y_i = f(x_i,\beta)\ \exp(V_i - U_i) \qquad i = 1,2,\ldots\ldots,n \qquad (6)$$

where *l*n represents the natural logarithm; the subscript *i* represents the ith enterprise; and *Y* represents the value of output, which is measured in monetary unit (naira). *X* represents the quantity of inputs used in production by ith enterprise, and varies between *i* and *n* inputs. The V_i 's are assumed to be independent and identically distributed random errors, having $N(0,\sigma_v^2)$ distribution, independent of the U_is. The U_is are technical inefficiency effects, which are assumed to be non-negative random variables.

The technical efficiency of the individual firm is defined in terms of the ratio of observed output to the corresponding frontier output, conditional on the levels of input used by the firm. Hence the technical efficiency of firm *i* is expressed as:

$$Te_i = ln\ Y_i / ln\ Y^* = f(X_i;\ \beta)\ \exp(v_i\text{-}u_i)/f(X_i;\ \beta)\ \exp(v_i) = \exp(-u_i) \qquad (7)$$

Allocative efficiency estimation

The estimated stochastic cost frontier is defined by the Cobb–Douglas cost frontier:

$$C_i = g(W_i;\ \alpha)\ \exp(L_i + P_i),\ i = 1,2,\ldots\ldots,n \qquad (8)$$

where C_i represents the total input cost of the ith enterprise; *g* is a suitable function, such as Cobb–Douglas function; w_i represents input prices employed by the ith enterprise in production and measured in naira; and α is the parameter to be estimated.

L_i and P_is are random errors and assumed to be independent and identically distributed truncations (at zero) of the $N(\mu,\sigma^2)$ distribution. P_i provides information on the level of allocative efficiency of the ith firm. This is calculated as the ratio of the predicted minimum cost to the observed cost. This is expressed as:

$$\text{Allocative efficiency} = \exp\ (P_i)$$

Both technical and allocative efficiency measures are bounded by zero and one. Hence, efficiency estimates would range between zero and one.

Determinants of efficiency

Technical and allocative efficiencies are assumed to be determined by firm specific variables, and may be expressed as:

$$\mu_i = \delta_0 + \Sigma\delta_i z \qquad (9)$$

where δ_s are unknown parameters to be estimated and the z_s represent the factors that could influence efficiency of the enterprises.

Hypothesis testing

The first hypothesis in this study, which specifies that the sample enterprises are technically and allocatively efficient, was tested using the generalized likelihood-ratio test statistic, which is defined by

$$\lambda = -2\, ln\, [L(H_0) / L(H_1)] \qquad (10)$$

where $L(H_0)$ is the value of the likelihood function for the frontier model, in which the parameter restrictions specified by the null hypothesis, H_0, are imposed, and H_1 is the value of the likelihood function for the general frontier model. If the null hypothesis is true, the λ has approximately chi-square (or mixed square) distribution with degrees of freedom equal to the difference between the parameters estimated under H_1 and H_0, respectively.

The second and third hypotheses are tested using the analysis of variance (ANOVA) test statistic, while the last hypothesis was tested using the ratio of the estimated coefficient of the policy variables to the standard error. In testing the hypotheses for the efficiency differential among scales of operation, enterprises in each group were classified into small, medium and large scale, based on size of firm as reflected in the size of total capital outlay.

The maximum likelihood estimates for the parameters of the stochastic frontier model and the predicted technical and economic efficiency were obtained by using the computer programme, FRONTIER 4.1, in which the variance parameters are expressed in terms of

$$\gamma = \sigma^2 / \sigma_s^2 \text{ and } \sigma_s^2 = \sigma^2 + \sigma_v^2 \text{ (Coelli, 1996).} \qquad (11)$$

List of variables

Output, input and cost variables are identified for each of the three types of manufacturing enterprises. Other variables relate to policy influences.

Block-making enterprises

Output
Number of blocks produced

Inputs
No. of loads of sand (in tips)
Quantity of cement in (kilograms)
Quantity of water (in litres)
Working hours (in person-days)
Other costs
Total material cost (in naira)
Depreciation on equipment (in naira)
Age of business operator/decision maker (in years)
Level of education of business operator/ decision maker (in years)

Cost variables
W_1 = Expenses on salary and wages
W_2 = Expenses on sand
W_3 = Expenses on water
W_4 = Expenses on cement
W_5 = Other costs
W_6 = Depreciation cost on equipment

Input shares
$S_1 = W_1/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$S_2 = W_2/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$S_3 = W_3/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$S_4 = W_4/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$S_5 = W_5/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$S_6 = W_6/(W_1 + W_2 + W_3 + W_4 + W_5 + W_6)$
$C = W_1 + W_2 + W_3 + W_4 + W_5 + W_6$ (C is Total cost)

Metal-fabricating enterprises

Output

Number of petrol/kerosene tanks constructed

Inputs

Total labour (in person-days)
Material cost (in naira)
Other costs (in naira)
Depreciation on equipment (in naira)
Age of business operator/decision maker (in years)
Level of education of operator/decision maker (in years)

Cost variables

W_1 = Expenses on salary
W_2 = Cost of depreciation on equipment
W_3 = Material cost
W_4 = Other costs

Input shares

$S_1 = W_1 / (W_1 + W_2 + W_3 + W_4)$
$S_2 = W_2 / (W_1 + W_2 + W_3 + W_4)$
$S_3 = W_3 / (W_1 + W_2 + W_3 + W_4)$
$S_4 = W_4 / (W_1 + W_2 + W_3 + W_4)$
$C = W_1 + W_2 + W_3 + W_4$ (C is Total cost)

Sawmill enterprises

Output

Number of planks processed from logs

Inputs

Total labour (in person-days)
Depreciation on equipment (in naira)
Material cost (in naira)
Other costs
Age of business operator/decision maker (in years)
Level of education of operator/decision maker (in years)

Cost variables

W_1	=	Expenses on salary
W_2	=	Cost of depreciation on equipment
W_3	=	Material cost
W_4	=	Other costs

Input shares

S_1	=	$W_1 / (W_1 + W_2 + W_3 + W_4)$
S_2	=	$W_2 / (W_1 + W_2 + W_3 + W_4)$
S_3	=	$W_3 / (W_1 + W_2 + W_3 + W_4)$
S_4	=	$W_4 / (W_1 + W_2 + W_3 + W_4)$
Total cost (C)	=	$W_1 + W_2 + W_3 + W_4$

Policy variables/Determinants of efficiency

δ_1	=	Education level of operator/decision maker
δ_2	=	Number of employees
δ_3	=	Level of investment
δ_4	=	Age of operator
δ_5	=	Age of business

5. Model results and discussion

This section discusses the results obtained from the estimated models outlined above. The analysis and discussion are presented in three levels. The first part deals with maximum likelihood estimates and efficiency estimates, second is the presentation on the determinants of efficiency, and third is the tests of various stated hypotheses.

Maximum likelihood estimates of the frontier production function

Maximum likelihood estimates for parameters of the preferred frontier models (the Cobb–Douglas frontier model) are presented below. In order to select the model that better describes the data, the log likelihood functions of the two frontier models (translog frontier and the Cobb–Douglas frontier) were compared and the model with the higher magnitude of the log likelihood function provides the better model for the data. The Cobb–Douglas frontier models had higher values in all the cases than the translog models and thus the Cobb–Douglas frontier was selected. Tables 5 to 10 show the results of the maximum likelihood estimates, with the computed log likelihood functions for the preferred Cobb–Douglas frontier models.

Table 5: Cobb–Douglas frontier production functions: Block-making enterprises

Variable		Abuja/Kaduna		Akure/Ibadan		Enugu/Port Harcourt	
	Parameter	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Constant	β_0	4.574	3.261	2.347	0.016	3.051*	0.912
Ln(Labour)	β_1	0.231*	0.087	0.324*	0.114	0.349*	0.015
Ln(sand)	β_2	0.320*	0.194	0.305*	0.075	0.276*	0.057
Ln(cement)	β_3	0.392*	0.113	0.432*	0.103	0.305*	0.095
Ln(water)	β_4	0.104*	0.015	0.207	0.315	0.114*	0.0025
Ln(others)	β_5	0.029	0.196	0.124*	0.095	0.097*	0.015
Ln(depreciation)**	β_6	-0.017	0.018	-0.211*	0.013	-0.011	0.013
Variance ratio	γ	0.673	0.247	0.624	0.052	0.854	0.306
Total variance	σ^2	0.718	0.195	0.772	0.097	0.433	0.133
Log likelihood function		-109.207		-95.437		-105.213	

*Significant at 5% level.
** Although capital consists of basically three components, depreciation (which is the flow component), interest payment and dividends, for this study the relevant component of capital among the sample enterprises is depreciation.

Table 6: Cobb–Douglas frontier production functions: Metal-fabricating enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	β_0	0.354	0.114	4.231	0.164	0.271	0.100
Ln(Labour)	β_1	0.597*	0.206	1.176*	0.347	0.434*	0.129
Ln(Material)	β_2	0.607*	0.296	0.449*	0.063	0.329*	0.114
Ln(Depreciation)	β_3	-0.113	0.124	-0.306	0.315	0.342*	0.195
Ln(Others)	β_4	0.003*	0.001	0.010*	0.007	0.011*	0.003
Variance ratio	γ	0.653	0.096	0.742	0.018	0.851	0.247
Total variance	σ^2	0.794	0.247	0.836	0.241	0.632	0.203
Log likelihood function		-113.221		-117.126		-105.217	

*Significant at the 5% level.

Table 7: Cobb–Douglas frontier production functions: Sawmill enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	β_0	2.635	0.174	0.954	0.014	1.742	0.432
Ln(Labour)	β_1	0.362*	0.116	0.329*	0.132	0.483*	0.172
Ln(Planks)	β_2	0.304*	0.143	0.322*	0.079	0.247*	0.096
Ln(Material)	β_3	0.254*	0.095	0.297*	0.072	0.352*	0.143
Ln(Depreciation)	β_4	0.152	0.108	0.107*	0.095	0.177	0.103
Variance ratio	γ	0.759	0.144	0.741	0.211	0.695	0.205
Total variance	σ^2	0.541	0.127	0.612	0.201	0.573	0.172
Log likelihood function		-123.742		-127.422		-125.221	

*Significant at 5% level.

Table 8:: Cobb–Douglas frontier production functions: Block-making enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	α_0	1.426	0.121	3.079	0.281	2.146	0.193
Ln(c)	α_x	0.906*	0.082	0.217*	0.106	0.325*	0.075
Ln(W_1)	α_1	0.331*	0.117	0.435*	0.114	0.279*	0.113
Ln(W_2)	α_2	0.241	0.205	0.201*	0.096	0.317*	0.112
Ln(W_3)	α_3	-0.207*	0.083	-0.276	0.435	-0.197	0.087
Ln(W_4)	α_4	0.635*	0.046	0.136*	0.006	0.234	0.074
Ln(W_5)	α_5	-0.220	0.342	-0.227*	0.025	-0.241*	0.118
Ln(W_6)	α_6	0.107*	0.084	0.279*	0.136	0.093	0.075
Variance ratio	γ	0.877	0.313	0.724	0.255	0.652	0.217
Total variance	σ^2	0.954	0.276	0.902	0.093	0.742	0.145
Log likelihood function		-86.543		-95.647		-73.521	

*Significant at the 5% level.

Table 9: Cobb–Douglas frontier cost functions: Metal-fabricating enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	α_0	0.954	0.104	3.075	0.179	1.423	0.774
Ln(c)	α_x	0.356*	0.113	0.847*	0.200	0.427*	0.149
$Ln(W_1)$	α_1	0.249*	0.130	0.326*	0.112	0.265*	0.114
$Ln(W_2)$	α_2	0.563*	0.097	0.196*	0.097	0.279*	0.105
$Ln(W_3)$	α_3	-0.146*	0.327	-0.207	0.215	0.354*	0.112
$Ln(W_4)$	α_4	0.331*	0.015	0.112*	0.032	0.192*	0.0015
Variance ratio	γ	0.632	0.116	0.643	0.074	0.753	0.253
Total variance	σ^2	0.794	0.092	0.921	0.134	0.635	0.225
Log likelihood function		-87.241		-76.935		-77.920	

*Significant at the 5% level.

Table 10: Cobb–Douglas frontier cost functions: Sawmill enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	α_0	0.987	0.214	1.275	0.112	1.051	0.732
Ln(c)	α_x	0.314*	0.117	0.241*	0.093	0.351*	0.174
$Ln(W_1)$	α_1	0.403*	0.192	0.301*	0.100	0.278*	0.015
$Ln(W_2)$	α_2	0.351*	0.173	0.393*	0.014	0.399*	0.057
$Ln(W_3)$	α_3	0.179*	0.0034	0.107	0.123	0.227*	0.054
$Ln(W_4)$	α_4	-0.012	0.013	-0.015	0.012	-0.0032	0.037
Variance ratio	γ	0.724	0.127	0.635	0.277	0.692	0.311
Total variance	σ^2	0.773	0.243	0.542	0.203	0.617	0.098
Log likelihood function		-92.443		-87.831		-101.221	

*Significant at the 5% level.

The selection of the Cobb–Douglas frontier models has also solved the problem of degrees of freedom normally encountered in the translog model estimation. Hence, the discussion below is based on the results of the estimated Cobb–Douglas functions.

The estimates for the γ parameter in the Cobb–Douglas frontier functions for each of the zones are quite large and significant, ranging between 0.63 and 0.88. These values indicate that the estimated models are highly significant since they show the relative magnitude of the variance associated with the frontier model.

Block-making enterprises

The coefficients of the variables are very important in the analysis of the data. These coefficients represent percentage change in the dependent variables as a result of percentage change in the independent variables. For both the Abuja/Kaduna and the Akure/Ibadan zones, cement has the highest coefficient with a value of 0.392 for Abuja/Kaduna and 0.432 for Akure/Ibadan. For the Enugu/Port Harcourt zone, the highest coefficient comes from labour. While depreciation on equipment has a negative value for all the zones, every other variable in the zones has a coefficient positive. The positive coefficients imply that any increase in the variable would lead to an increase in output in the block-making enterprises, while any increase in the value of a variable with a negative coefficient would lead to decline in output.

Given the estimated cost functions, two of the six production inputs (expenses on water and other costs) have negative coefficients, while the remaining inputs have positive coefficients for the block-making industry for the two zones. It is also important to note that expenses on cement have the highest coefficient for the zones in the cost functions.

Metal fabricating enterprises

The maximum likelihood estimates of the preferred Cobb–Douglas frontier production functions for the metal fabricating enterprises show that the coefficient of material cost is highest for the Abuja/Kaduna and Akure/Ibadan zones, while the highest coefficients for Enugu/Port Harcourt zone come from labour. However, all variables, except depreciation, are highly significant. This indicates that these variables in the metal fabricating enterprises are important factors that would influence the level of output in the industry. While the coefficients of labour, material cost and other costs in the model are positive, the coefficient of depreciation cost is negative. Any increase in the value of those inputs with positive coefficients would lead to increase in the volume of output, while any increase in the value of the variables with negative coefficient would lead to decline in the level of output. The increase or decrease in the output level would depend on the magnitude of the coefficient.

For the estimated Cobb–Douglas cost frontier models, the highest coefficient for the three zones is total cost.While the coefficient of material cost is negative in the Akure/Ibadan zone, it is the coefficient of depreciation cost that is negative in the Abuja/Kaduna zone. Every other variable in the zones has aa positive coefficient.

The returns-to-scale parameter shows that there are increasing returns to scale in the block-making and metal-fabricating industries for the three zones. The implication of increasing returns to scale is that the sampled firms in the industries could make use of the advantage of economies of scale to raise their level or scale of production. This is evidence that more resources, both human and capital, can be used for raising the production levels and incomes of the enterprises as a contribution to economic development. Hence, government economic policies should continue to address ways of encouraging these enterprises to raise their current levels of operation.

Sawmilling Enterprises

The maximum likelihood estimates of the stochastic frontier production function for the enterprise indicate that the coefficients of all inputs of production carry positive signs for all the study locations. It is also important to note that the three major production inputs, labour, planks and materials, were highly significant at the 5% level. The implication of this result is that the significant inputs would have important influence on the output of the enterprises. Given that the coefficients of the inputs carry positive sgns, an increase in the level of any of these inputs in production would lead to significant increases in the level of any output of the enterpsiese. While labour has the highest coefficient for all locations, value of depreciation has the least coefficient for all the locations. The maximum likelihood estimates of the cost frontier function show that three of the four variable (expenses on salary, cost of depreciation of equipment and other material costs) in the model were highly significant at the 5% level. This implies that these variables have important influence on cost structure of the enterprises and hence the profitability.

Efficiency estimates

Block-making enterprises

For the Abuja/Kaduna zone, the computed technical efficiency varies between 0.35 and 0.83, with a mean value of 0.75. For the Akure Ibadan zone, the computed technical efficiency varies between 0.25 and 0.79, with a mean value of 0.77. In Enugu/Port Harcourt, the technical efficiency estimate varies between 0.19 and 0.85, with a mean technical efficiency of 0.72. This result shows that the highest mean technical efficiency comes from Akure/Ibadan zone. For allocative efficiency, the highest value comes from the Akure/Ibadan zone (0.63), followed by the Enugu/Port Harcourt zone (0.60), while the Abuja/Kaduna zone has the lowest mean allocative efficiency (0.59). For all three zones, however, the majority of the enterprises are in the 0.41 and 0.70 technical efficiency range. These values indicate a wide variation in the level of technical efficiency.

Metal-fabricating enterprises

For these enterprises, the computed technical efficiency for the Abuja/Kaduna zone ranges between 0.27 and 0.84, with a mean value of 0.72. For the Akure/Ibadan zone, the range is between 0.37 and 0.82, with a mean value of 0.71, and for the Enugu/Port Harcourt zone, the technical efficiency ranges between 0.31 and 0.92, with a mean of 0.80. For the allocative efficiency, the highest value is from the Enugu/Port Harcourt zone (0.78), while Abuja/Kaduna and Akure/Ibadan have 0.61 and 0.67, respectively. However, for the three zones, most of the sampled firms fall within the 0.5 to 0.80 efficiency range.

While technical efficiency expresses the ability to derive maximum output from a given set of inputs, allocative efficiency describes the ability of a producer to use minimum cost in producing a given level of output. Therefore, it is possible for a producer to be technically efficient and not allocatively efficient. The results in this analysis indicate that the enterprises with the highest technical efficiency estimates also have the highest allocative efficiency in each of the zones.

Sawmilling enterprises

For this industry, both technical and allocative efficiencies vary across the three zones. The highest mean technical efficiency comes from the Akure/Ibadan zone, with a mean technical efficiency of 0.78, while Abuja/Kaduna and Enugu/Port Harcourt have mean technical efficiency of 0.71 and 0.68, respectively. For allocative efficiency, the highest mean value (0.67) also comes from the Akure/Ibadan zone, with Abuja/Kaduna and Enugu/Port Harcourt having 0.64 and 0.65, respectively.

Frequency distribution of technical and allocative efficiency estimates

Tables 11–16 present the frequency distribution of technical and allocative efficiency estimates for the block-making, metal-fabricating and sawmilling enterprises in the three zones.

Table 11: Technical efficiency estimates: Block-making enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	0	1	1
0.30–0.40	1	1	1
0.41–0.50	2	2	3
0.51–0.60	7	4	6
0.61–0.70	6	6	4
0.71–0.80	3	6	4
0.81–0.90	1	0	1
0.91–1.00	0	0	0
Total	20	20	20

Table 12: Technical efficiency estimates: Metal-fabricating enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	1	0	0
0.30–0.40	0	2	1
0.41–0.50	2	5	3
0.51–0.60	6	3	3
0.61–0.70	7	5	7
0.71–0.80	2	4	3
0.81–0.90	2	1	3
0.91–1.00	0	0	0
Total	20	20	20

Table 13: Technical efficiency estimates: Sawmill enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	0	1	1
0.30–0.40	1	1	2
0.41–0.50	3	1	2
0.51–0.60	7	2	6
0.61–0.70	6	8	5
0.71–0.80	2	7	3
0.81–0.90	1	0	1
0.91-1.00	0	0	0
Total	20	20	20

Table 14: Allocative efficiency estimates: Block-making enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	1	1	1
0.30–0.40	2	1	2
0.41–0.50	3	2	4
0.51–0.60	8	10	7
0.61–0.70	4	3	3
0.71–0.80	2	3	3
0.81–0.90	0	0	0
0.91–1.00	0	0	0
Total	20	20	20

Table 15: Allocative efficiency estimates: Metal fabricating enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	0	1	0
0.30–0.40	1	2	1
0.41–0.50	4	4	2
0.51–0.60	8	5	7
0.61–0.70	4	6	8
0.71–0.80	3	2	1
0.81–0.90	0	0	1
0.91–1.00	0	0	0
Total	20	20	20

Table 16: Allocative efficiency estimates: Sawmill enterprises

Efficiency level	Abuja/Kaduna zone Frequency	Akure/Ibadan zone Frequency	Enugu/Port Harcourt zone Frequency
< 0.30	0	1	0
0.30–0.40	1	1	1
0.41–0.50	3	4	1
0.51–0.60	9	6	9
0.61–0.70	4	6	7
0.71–0.80	3	2	1
0.81–0.90	0	0	1
0.91–1.00	0	0	0
Total	20	20	20

Hypotheses testing

The test of the first null hypotheses, that the sampled microenterprises are technically and allocatively efficient, was carried out using Equation 10. In carrying out this test, the log likelihood function of the Cobb–Douglas frontier model is compared with that of the average production function. The average production function assumes that the microenterprises being evaluated are fully efficient, given their technology. If this assumption is true, then the data will be better analysed using the average function rather than the frontier function, which assumes the presence of inefficiency in the production system of the enterprises. The results of these tests are presented in tables 17–22.

Analysis of technical efficiency difference among zones in each group of enterprises, using the analysis of variance test (ANOVA), shows that there is no significant difference in the technical efficiency estimates between the three zones at 5% level of significance (tables 21 and 22).

Table 17: Test of hypothesis on technical efficiency: Abuja/Kaduna zone
Ho: Microenterprises are fully technically efficient ($\gamma = 0$).

Group	Log likelihood function Frontier model	Average function	λ	Critical value*	Decision
Metal-fabricating enterprises	-113.221	-207.345	188.248	11.91	Reject Ho
Block-making enterprises	-109.207	-136.432	53.6	11.91	Reject Ho
Sawmill enterprises	-123.742	-138.575	16.81	11.91	Reject Ho

*This value is obtained from Table 1 of Kodde and Palm (1996), which gives critical values for tests of null hypotheses involving parameters having values on the boundary of the parameter space. If the null hypothesis H0 : $\gamma = 0$, is true, then there are five other δ – parameters that are not present. Hence, the degrees of freedom for the appropriate critical value in Table 1 of Kodde and Palm (1996) is q+1 where q = 5.

Table 18: Test of hypothesis on technical efficiency: Akure/Ibadan zone
Ho: Microenterprises are fully technically efficient ($\gamma = 0$).

Group	Log likelihood function Frontier model	Average function	λ	Critical value*	Decision
Metal-fabricating enterprises	-117.126	-125.432	16.61	11.91	Reject Ho
Block-making enterprises	-95.437	-133.217	75.56	11.91	Reject Ho
Sawmill enterprises	-127.422	-159.332	63.82	11.91	Reject Ho

Table 19: Test of hypothesis on technical efficiency: Enugu/Port Harcourt zone
Ho: Microenterprises are fully technically efficient ($\gamma = 0$).

Group	Log likelihood function Frontier model	Average function	λ	Critical value*	Decision
Metal-fabricating enterprises	-105.217	-123.142	35.85	11.91	Reject Ho
Block-making enterprises	-105.213	-118.343	26.26	11.91	Reject Ho
Sawmill enterprises	-125.221	-133.604	16.77	11.91	Reject Ho

Table 20: Test of hypothesis on allocative efficiency: Abuja/Kaduna zone
Ho: Microenterprises are fully allocatively efficient ($\gamma = 0$)

Group	Log likelihood function Frontier model	Average function	Critical value*	λ	Decision
Metal-fabricating enterprises	-87.241	-99.258	24.03	11.91	Reject Ho
Block-making enterprises	-86.543	-97.247	21.49	11.91	Reject Ho
Sawmill enterprises	-92.443	-103.417	21.95	11.91	Reject Ho

Table 21: Test of hypothesis on allocative efficiency: Akure/Ibadan zone
Ho: Microenterprises are fully allocatively efficient (γ = 0).

Group	Log likelihood function Frontier model	Average function	Critical value	λ	Decision
Metal-fabricating enterprises	-76.935	-89.325	24.78	11.91	Reject Ho
Block-making enterprises	-95.647	-114.258	37.22	11.91	Reject Ho
Sawmill enterprises	-87.831	-109.149	42.64	11.91	Reject Ho

Table 22: Test of hypothesis on allocative efficiency: Enugu/Port Harcourt zone
Ho: Microenterprises are fully allocatively efficient (γ = 0).

Group	Log likelihood function Frontier model	Average function	Critical value	λ	Decision
Metal-fabricating enterprises	-77.920	-107.229	58.62	11.91	Reject Ho
Block-making enterprises	-73.571	-104.205	61.27	11.91	Reject Ho
Sawmill enterprises	-101.221	-125.337	48.22	11.91	Reject Ho

The results of the tests show that the first null hypotheses of full technical and allocative efficiencies for the enterprises are rejected. Hence ,inefficiency is present in the production activities of the enterprises included in the study. For the second and third hypotheses, an analysis of variance (ANOVA) test was used to find whether there are significant differences in technical and allocative efficiencies across zones and scales of operation. The results are presented in tables 23 and 24.

The test of significance using ANOVA also shows that there are no significant differences between the small, medium and large-scale microenterprises among the three occupational groups. The *f* statistic was computed in order to indicate whether there are significant differences between the technical and allocative efficiency estimates across scales of operation and across zones. The result of the analysis of variance indicates that there is no significant difference in the technical efficiency estimates for the three zones and the three groups of enterprises at the 5% level of significance.

Table 23: Test of significance differences on scale of operation (small, medium and large scale)

Variation	SS	df	F	F crit
Metal-fabricating enterprises				
Between group	0.059	2	4.577	3.354
Within group	1.383	177		
Total	1.442	179		
Block-making enterprises				
Between group	0.061	2	5.542	3.057
Within group	1.276	177		
Total	1.337	179		
Sawmill enterprises				
Between group	0.053	2	5.23	3.641
Within group	1.375	177		
Total	1.438	179		

Table 24: Test of significance differences in efficiency between zones

Source of variation	d.f	F	F crit
Metal-fabricating enterprises			
Between group	2	1.450	3.047
Within group	177		
Total	179		
Block-making enterprises			
Between group	2	1.379	4.05
Within group	177		
Total	179		
Sawmill enterprises			
Between group	2	1.472	3.27
Within group	177		
Total	179		

The foregoing analysis indicates a wide variation in both technical and allocative efficiency of the sampled enterprises within and across occupational groups and zones. The wide variation in the level of efficiency is an indication that there is ample opportunity for these industries to raise their level of efficiency, depending on the policy variables that influence efficiency. For this study, we therefore identified and estimated the determinants of efficiency that could be used as policy variables. The results of the analysis are presented below.

Determinants of efficiency

In the analysis of the determinants of efficiency, the computed technical and allocative efficiencies were modelled to depend on some identified variables. The coefficients with their corresponding standard errors of the estimated models are presented below.

The estimated coefficients of the explanatory variables for the determinants of efficiency are of interest because they have important policy implications. The results in tables 25–30 show that most of the coefficients of the determinants of efficiency are significant. This means that the variables included as determinants of efficiency are very relevant in explaining the level of individual technical and allocative efficiency.

Table 25: Determinants of technical efficiency: Block-making enterprises

Variables		Abuja/Kaduna		Akure/Ibadan		Enugu/Port Harcourt	
	Parameter	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Constant	δ_0	1.774	0.122	1.432	0.076	0.352	0.114
Age of operator	δ_1	-0.204*	0.031	-0.243*	0.101	-0.197*	0.072
Age of business	δ_2	0.196	0.273	0.477*	0.198	0.203*	0.015
Level of education	δ_3	0.362*	0.115	0.336*	0.035	0.314*	0.092
No. of employees	δ_4	0.224*	0.114	0.206*	0.011	0.234*	0.237
Level of investment	δ_5	0.393*	0.091	0.172	0.147	0.205*	0.004

*Significant at 5%.

Table 26: Determinants of technical efficiency: Metal-fabricating enterprises

Variables		Abuja/Kaduna		Akure/Ibadan		Enugu/Port Harcourt	
	Parameter	Coefficient	Std error	Coefficient	Std error	Coefficient	Std error
Constant	δ_0	-3.774	0.102	1.076	0.035	1.212	0.910
Age of operator	δ_1	-0.176	0.215	-0.428*	0.125	-0.147*	0.012
Age of business	δ_2	0.243*	0.0097	0.307*	0.137	0.219*	0.0057
Level of education	δ_3	0.371	0.104	0.521*	0.232	0.143*	0.0054
No. of employees	δ_4	0.225*	0.011	0.243*	0.015	0.116*	0.0051
Level of investment	δ_5	0.178	0.123	0.157	0.274	0.214*	0.015

*Significant at 5%

Table 27: Determinants of technical efficiency: Sawmill enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	δ_0	1.059	0.357	1.214	0.043	1.252	0.293
Age of operator	δ_1	-0.141*	0.014	-0.271*	0.082	-0.171*	0.073
Age of business	δ_2	0.149	0.188	0.204*	0.095	0.297*	0.0113
Level of education	δ_3	0.275*	0.015	0.291*	0.103	0.226*	0.042
No.of employees	δ_4	0.135*	0.35	0.232*	0.075	0.278*	0.018
Level of investment	δ_5	0.214*	0.097	0.247*	0.003	0.249*	0.073

*Significant at 5%.

Table 28: Determinants of allocative efficiency: Block-making enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	λ_0	0.875	0.094	0.971	0.331	1.250	0.361
Age of operator	λ_1	-0.133	0.209	-0.246*	0.097	-0.184*	0.013
Age of business	λ_2	0.426*	0.211	0.215*	0.207	0.427*	0.0149
Level of education	λ_3	0.521*	0.076	0.543*	0.095	0.284*	0.053
No. of employees	λ_4	0.471*	0.097	0.163*	0.081	0.149*	0.136
Level of investment	λl_5	0.205*	0.086	0.305*	0.112	0.354*	0.015

*Significant at 5%.

Table 29: Determinants of allocative efficiency: Metal-fabricating enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	λ_0	-1.942	0.097	2.079	0.142	0.972	0.015
Age of operator	λ_1	-0.210*	0.111	-0.226*	0.072	-0.117*	0.011
Age of business	λ_2	0.347*	0.126	0.354	0.214	0.241*	0.109
Level of education	λ_3	0.585*	0.074	0.601*	0.200	0.209*	0.075
No. of employees	λ_4	0.244*	0.086	0.429*	0.114	0.278*	0.195
Level of investment	λ_5	0.426*	0.035	0.273*	0.093	0.564*	0.016

*Significant at 5%.

Table 30: Determinants of allocative efficiency: Sawmill enterprises

Variable	Parameter	Abuja/Kaduna Coefficient	Abuja/Kaduna Std error	Akure/Ibadan Coefficient	Akure/Ibadan Std error	Enugu/Port Harcourt Coefficient	Enugu/Port Harcourt Std error
Constant	λ_0	-1.274	0.133	2.417	0.201	3.544	0.975
Age of operator	λ_1	-0.142	0.107	-0.231*	0.101	-0.307*	0.011
Age of business	λ_2	0.341*	0.015	0.279*	0.0011	0.314*	0.112
Level of education	λ_3	0.275*	0.095	0.243*	0.175	0.228*	0.107
No.of employees	λ_4	0.142	0.103	0.195	0.227	0.371*	0.015
Level of investment	λ_5	0.195	0.126	0.147	0.105	0.243*	0.016

*Significant at 5%.

Determinants of technical efficiency

For the block-making enterprises, only age of operator has a negative coefficient for each of the zones; while every other variable has a positive coefficient, with most of the variables being significant at the 5% level. The positive coefficient implies that any increase in the value of the variable would lead to an increase in the level of technical efficiency. A negative coefficient indicates that any increase in the value of the variable would lead to decrease in the level of technical efficiency. For the metal-fabricating enterprises, all the variables also have positive coefficients except the age of operator, which has a negative coefficient for the three zones. Most of the variables are highly significant at 5% level (as indicated in tables 25–30).

It is important to stress that education appears to be the most highly significant determinant in all the zones. The implication of this finding is that while all the variables here appear to be important determinants of efficiency, education of operators seems to be the most important determinant of technical efficiency in the block making enterprises in the three zones. Hence, any government policy that would improve the level of education/enlightenment of the operators of microenterprises considered in this study would likely lead to significant increase in the level of technical efficiency.

The results also suggest that the level of efficiency tends to decline with the increasing age of operator, as this variable has a negative coefficient in all models and in all zones. Hence younger operators of microenterprises in the study areas tend to have higher levels of technical efficiency. A possible reason for this could be that people in this group of operators are likely to be more agile and aggressive in business than the older operators. Therefore, government industrial policy should be designed to encourage younger people, especially unemployed youths, to go into vocational training, since this will bring about desired increases in efficiency.

Determinants of allocative efficiency

The results of the analysis of determinants of allocative efficiency are very interesting and have important policy implications. For all the zones and for all groups of enterprises, education appears to be the most significant determinant in the estimated model. Also, the coefficients for education in all the models are positive and highly significant at the 5% level. This result indicates that education is the most important determinant of allocative efficiency among the microenterprises in the study area. Hence any policy that would increase the level of education/enlightenment of the operators of these microenterprises would lead to better performance in terms of allocative efficiency.

Other determinants of efficiency that have positive coefficients and are highly significant in the three groups of enterprises and the three zones are number of employees and level of investment. This implies that policies that would improve the values of these variables would lead to an increase in allocative efficiency in the industry, all things being equal. For the three zones and the three industries, however, age of operator has negative coefficients. This result is similar to the case of technical efficiency. Hence, it could be concluded that older operators are less technically and allocatively efficient than younger operators. Government policies should address increased capital injection into microenterprises to raise the levels of investment and employment of youth.

In order to know the magnitude of change in the level of efficiency as a result of changes or variations in the determinants of efficiency, a simulation analysis was performed on the identified policy variables. The results are presented below.

Analysis of simulated policy variables

Our analysis then went a step further to simulate the impact of selected policy variables on efficiency of the microenterprises. The identified policy variables are the determinants of efficiency that could be influenced by policy implementation to improve the current level of observed efficiencies. The simulation is done with an increase in the value of variables from between 5% and 20%. The identified policy variables are: education level, number of employees, level of investment, age of operator and age of business. The results of the simulations are presented in tables 31–39.

Table 31: Effects of of policy changes on mean efficiency, Abuja/Kaduna zone: Metal-fabricating enterprises

Variable	Technical efficiency (Mean = 0.72)			Allocative efficiency (Mean = 0.61)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.74	0.76	0.79	0.64	0.67	0.73
Number of employees	0.73	0.74	0.77	0.62	0.63	0.66
Level of investment	0.73	0.74	0.76	0.63	0.65	0.70

Age of operator	0.71	0.70	0.68	0.60	0.59	0.57
Age of business	0.73	0.74	0.77	0.62	0.64	0.68

Table 32: Effects of of policy changes on mean efficiency, Abuja/Kaduna zone: Block-making enterprises

Variable	Technical efficiency) (Mean = 0.75)			Allocative efficiency (Mean = 0.59)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.77	0.79	0.82	0.61	0.64	0.68
Number of employees	0.76	0.77	0.79	0.62	0.64	0.69
Level of investment	0.77	0.79	0.83	0.60	0.61	0.63
Age of operator	0.74	0.73	0.71	0.50	0.58	0.56
Age of business	0.76	0.77	0.79	0.61	0.63	0.67

Table 33: Effects of of policy changes on mean efficiency, Abuja/Kaduna zone: Sawmill enterprises

Variable	Technical efficiency) (Mean = 0.71)			Allocative efficiency (Mean = 0.64)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.72	0.73	0.75	0.65	0.66	0.68
Number of employees	0.71	0.72	0.73	0.65	0.65	0.66
Level of investment	0.72	0.73	0.74	0.65	0.65	0.66
Age of operator	0.70	0.70	0.69	0.63	0.63	0.62
Age of business	0.72	0.72	0.73	0.65	0.66	0.68

Table 34: Effects of of policy changes on mean efficiency, Akure/Ibadan zone: Metal-fabricating enterprises

Variable	Technical efficiency (Mean = 0.71)			Allocative efficiency (Mean = 0.67)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.73	0.76	0.81	0.70	0.73	0.79
Number of employees	0.73	0.73	0.76	0.69	0.71	0.76
Level of investment	0.72	0.73	0.74	0.68	0.70	0.72
Age of operator	0.69	0.67	0.62	0.66	0.65	0.62
Age of business	0.73	0.74	0.77	0.69	0.71	0.74

Table 35: Effects of of policy changes on mean efficiency, Akure/Ibadan zone: Block-making enterprises

Variable	Technical efficiency (Mean = 0.77)			Technical efficiency (Mean = 0.71)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.79	0.80	0.84	0.66	0.68	0.74
Number of employees	0.78	0.79	0.81	0.64	0.65	0.66

Level of investment	0.78	0.79	0.80	0.65	0.66	0.69
Age of operator	0.78	0.79	0.82	0.62	0.61	0.58
Age of business	0.79	0.82	0.87	0.64	0.65	0.67

Table 36: Effects of of policy changes s on mean efficiency, Akure/Ibadan zone: Sawmill enterprises

Variable	Technical efficiency (Mean = 0.78)			Allocative efficiency (Mean = 0.67)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.79	0.80	0.82	0.68	0.69	0.71
Number of employees	0.79	0.80	0.81	0.68	0.68	0.69
Level of investment	0.79	0.80	0.82	0.68	0.68	0.70
Age of operator	0.77	0.76	0.74	0.66	0.64	0.63
Age of business	0.79	0.79	0.81	0.68	0.69	0.71

Table 37: Effects of of policy changes s on mean efficiency, Enugu/Port Harcourt Zone: Metal-fabricating enterprises

Variable	Technical efficiency (Mean = 0.80)			Allocative efficiency (Mean = 0.78)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.81	0.82	0.84	0.79	0.80	0.81
Number of employees	0.80	0.81	0.82	0.79	0.80	0.82
Level of investment	0.81	0.82	0.83	0.80	0.81	0.85
Age of operator	0.79	0.79	0.78	0.78	0.77	0.76
Age of business	0.81	0.81	0.82	0.79	0.80	0.82

Table 38: Effects of of policy changes on mean efficiency, Enugu/Port Harcourt Zone: Block-making enterprises

Variable	Technical efficiency (Mean = 0.72)			Allocative efficiency (Mean = 0.60)		
	+5 %	+ 0%	+20%	+5%	+10%	+20%
Level of education	0.73	0.74	0.77	0.61	0.62	0.63
Number of employees	0.73	0.74	0.75	0.60	0.61	0.62
Level of investment	0.73	0.73	0.75	0.61	0.62	0.64
Age of operator	0.71	0.71	0.70	0.59	0.59	0.58
Age of business	0.73	0.74	0.75	0.61	0.62	0.65

Table 39: Effects of of policy changes on mean efficiency, Enugu/Port Harcourt zone: Sawmill enterprises

Variable	Technical efficiency (Mean = 0.68)			Allocative efficiency (Mean = 0.65)		
	+5%	+10%	+20%	+5%	+10%	+20%
Level of education	0.69	0.70	0.73	0.66	0.67	0.68
Number of employees	0.69	0.70	0.72	0.66	0.67	0.69
Level of investment	0.69	0.70	0.73	0.66	0.67	0.68
Age of operator	0.67	0.66	0.64	0.64	0.63	0.61
Age of business	0.69	0.70	0.72	0.66	0.67	0.69

In the Abuja/Kaduna zone, the results of the simulations of policy variables show that the level of mean technical and allocative efficiencies would increase significantly with rising levels of education. The results also indicate a rising level of mean efficiency with increasing number of employees, level of investment and age of business. However, a rising age of operator would lead to a decline in the means of both technical and allocative efficiency for each of the three enterprises. It is important to note that of all the policy variables, education has the highest significant influence on both technical and allocative efficiency for this zone (tables 31–33).

For the Akure/Ibadan zone, percentage increase in the level of education has also proved to lead to increasing levels of both technical and allocative efficiency. Also, percentage increases in the number of employees, level of investment and age of business would each lead to rising levels of both technical and allocative efficiency for the three microenterprises. A rising age of operators would lead to decline in both technical and allocative efficiency for each of the three groups of enterprises (tables 34–36).

A percentage increase in the mean level of education in the Enugu/Port Harcourt zone would lead to rising levels of mean technical and allocative efficiency. Also, a percentage increase in the mean value of number of employees, level of investment and age of business would individually lead to rising mean technical and allocative efficiency. However, a percentage rise in the mean age of operators would lead to declining mean technical and allocative efficiency.

6. Conclusion

The result of the analyses of this study has a number of policy implications. First,the wide variation in the level of efficiency indicates that there is ample opportunity for these enterprises to raise their level of efficiency, depending on the policy variables that influence efficiency.

Second, the high level of significance of the education variable implies that education is an important policy tool with potential to improve both technical and allocative efficiency in the sampled enterprises. Hence, education policy that would encourage operators of microenterprises in the country to undergo literacy and training programmes could lead to substantial increase in efficiency of production and hence in the volume of output at the current level of technology.

Finally, given that a rising age would lead to decline in the mean efficiency, government policy should focus on ways to attract and encourage young entrepreneurs who are agile and aggressive in business drive. This group of entrepreneurs would be able to put in a lot of efforts at raising the current level of efficiency, given a conducive policy environment.

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