JOURNAL OF ECONOMIC DEVELOPMENT
Volume 26, Number 1, June 2001

Human Capital and Efficiency: The Role of Education and Experience in Micro-Enterprises of Ghana's Wood-Products Industry

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Increasing efficiency and creating new employment via micro-enterprises emerges as a viable solution to four problems in developing countries - unemployment, migration from rural to urban areas, inefficient use of resources and lack of international trade capabilities. 242 micro-enterprises from Ghana's wood-product industry are used in the analysis. Schooling and on-the-job training explain efficiency dispersions among micro-enterprises. Accordingly, a proper training program can complement human capital creation by schooling and on-the-job-training to improve efficiency. Such program can also increase the awareness about international markets to create new employment opportunities.

I. Introduction

There is mounting evidence that large scale capital-intensive enterprises did not perform well during the early economic development attempts of the developing countries.[1] Furthermore, even today, a developing country may not have sufficient capital and skill endowments to progress with a large-scale industrial development. On the other hand, although it is underutilized, micro-enterprises possess the required skill endowments for a sustainable growth (Lall *et al.* (1994, p.40)). Because of their size, they can also adjust easily to changing market conditions (International Trade Centre (1992)). Yet, until recently, micro-enterprises - small and labor intensive - have been neglected. They are often left out of the framework of development.

This paper sheds light on the feasibility of a strategy to target and support the micro-enterprises for a sustainable market-oriented economic growth. To do so, we assess the economic performance of micro-enterprises based on a detailed data set. Specifically, three major questions are addressed: (1) what is the economic performance level of micro-

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1. For the experiences of the sub-Saharan African countries see Johnston (1981), Lall (1992), and James (1995).

enterprises? (2) Is it possible to improve economic performance and make the micro-enterprises more efficient by an appropriate training program? (3) Can the employment be increased without sacrificing efficiency? To answer these questions, we develop a three-step procedure: First, we calculate the technical efficiency level for each enterprise.[2] Second, we assess technical efficiency levels. To account for the possible technical efficiency variations within the industry, we closely examine the human capital level of each micro-enterprise and its impact on technical efficiency. Human capital, which is accumulated by schooling and training, is one of the key inputs in a production process (Shapiro and Muller (1977), Becker (1993)). In particular, we examine the relationship between technical efficiency and the entrepreneur's stock of information; managerial training and competence (Pack (1974)); and schooling level (Fane (1975), Azhar (1991)). Also, we take into account the extent of the supervision of the workers as a measure of how well the human capital of the entrepreneur is reflected upon the workers of the enterprise (Page (1980)).

Finally, we search for ways to improve the technical efficiency of the micro-enterprises. In particular, we derive an optimal on-the-job training time for an apprentice to master the profession before opening an independent shop, and the optimal apprentice/master ratio in a micro-enterprise for effective supervision of the workers. 242 micro-enterprises from Ghana's wood-product industry are used in the analysis.

Section II describes the models utilized in the estimation of the technical efficiency levels and in determining the relationship between human capital and technical efficiency. Section III provides summary statistics for the micro-enterprises of the wood-products industry of Ghana. Section IV includes estimation results and their evaluations. Section V summarizes the findings and briefly discusses a strategy for improving the performance, becoming competitive to participate in export market, and increasing the employment.

II. The Model

The technical efficiency is the ratio of actual output level to maximum potential output level attainable from a given input with a frontier technology. We derive technical efficiency level of each enterprise by using the following stochastic frontier production function model:[3]

2. Micro-enterprises in a traditional industry are not likely to reallocate their resources into other industries. Thus, even if relative prices were changed substantially following the reforms, there would be no significant reallocation, and in turn no allocative efficiency gain would be expected (Page (1980, p.338)).

3. It is assumed that the correlation between v_i and u_i is zero. i = 1,2,..., 242, and represents enterprise-i. v_i captures the random effects of measurement errors and exogenous shocks, which cause the placement of deterministic portion to vary across enterprises, and u_i indicates the technical inefficiency relative to the stochastic production frontier by the one-sided error component. For details of the stochastic production frontier, see Farell (1957), Leibenstein (1966), Aigner, Lovell and Schmidt (1977), and Meusen and Van den Broeck (1977).

$$\ln OUT_i = b_0 + b_1 \ln LABOR_i + b_2 CAP1_i + b_3 CAP\,2_i + \sum_{j=1}^{j=7} \boldsymbol{a}_j REGj_i + \boldsymbol{e}_i \ ,$$

$$where, \boldsymbol{e}_i = v_i - u_i, \quad with\, v_i \sim N(0, \boldsymbol{s}_v^2)\, , u_i \sim \left| N(0, \boldsymbol{s}_u^2) \right|. \qquad (1)$$

The measure of output, denoted by OUT, is the value of the total production expressed in one hundred thousand Ghanaian cedis. The natural logarithm is denoted by “ln”. Labor and capital are the inputs. LABOR denotes the number of workers at each enterprise including the owner, supervisors, and apprentices. We use two dummy variables to represent three different types of machines and tools that an enterprise is using. CAP1 is one for the usage of no machines and zero otherwise; and CAP2 is one for the usage of small machines and tool and zero otherwise. The default capital level is for the usage of large machines and tools. REG1 to REG7 are regional dummy variables to account for regional differences in production. The eight regions are Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Northern, Volta, and Western respectively. The default region is the Western region.

Having calculated the technical efficiency for each enterprise by employing the procedure suggested by Jondrow, Lovell, Materov, and Schmidt (1982), we model technical efficiency as a function of human capital. To do so, we use the following equation:

$$\begin{aligned} \ln TE_i = {} & \boldsymbol{a}_0 + \boldsymbol{a}_1 SCHOL_i + \boldsymbol{a}_2 TRAIN_i + \boldsymbol{a}_3 \ln EXPER_i + \boldsymbol{a}_4 \ln TECED_i \\ & + \boldsymbol{a}_5 (\ln TECED_i)^2 + \boldsymbol{a}_6 \ln APPRE_i + \boldsymbol{a}_7 (\ln APPRE_i)^2 + \boldsymbol{a}_8 REGIS_i \qquad (2) \\ & + \boldsymbol{a}_9 MEMBE_i + \boldsymbol{a}_{10} (REGIS_i * MEMBE_i) + e_i \end{aligned}$$

TE_i is the technical efficiency level for the i-th micro-enterprise. SCHOL is the dummy variable for schooling. It takes the value of one for ‘ middle school and above schooling’ and zero otherwise. TRAIN is another dummy variable for the type of technical training the owner has undergone before opening a shop. It is one for apprenticeship and zero otherwise. EXPER is the number of years the owner has been operating the shop.

TECED is the length of the training program in number of years before entering the business. TECED is a proxy for on-the-job training and also for the entrepreneur’ s stock of information as a result of training. APPRE is the ratio of the number of apprentices and workers/supervisor and owner in the shop. The motivation here is to capture the extent of the supervision of the workers as a measure of how well the human capital of the master carpenters is reflected upon the workers. Second order polynomial functional form is assumed to model the relationships between technical efficiency and both TECED and APPRE. By doing so, we calculate optimum levels for these indicators, if they exist.

To account for possible spillover of trade association membership on human capital, we look at the membership status of the entrepreneurs. We also examine possible technical efficiency differences between micro-enterprises officially registered with the government of Ghana as business firms and those not registered. REGIS is a dummy variable for registration. It is one for officially registered micro-enterprises and zero otherwise. MEMBE is a dummy variable to indicate membership in a trade association. It is one for members and zero otherwise. This last variable is used to account for possible human capital enriching spillover effects among the trade association's members. To determine if an interaction effect exist between REGIS and MEMBE, we also included an additional variable, product of REGIS and MEMBE. Finally, e_i is the error term to capture random effects of measurement errors and exogenous shocks.

III. Ghana's Wood-Products Industry and Data

Ghana's Economic Recovery Program that began in 1983 is recognized as one of the most successful policy reforms in sub-Saharan Africa (Chhibber and Leechor (1993, p.24), Rodrik (1993, p.88)). Despite Ghana's relative economic success, government and international donor officials are becoming dissatisfied with the nation's formal business sector's response, in particular, with the level of private investment, to changes in the economic environment (Aryeetey (1994, p.1211)). The United States Agency for International Development (USAID) and other international donor agencies have cited the benefits of fostering more meaningful roles for micro-enterprises in a sustainable market-oriented economic growth (USAID (1992, p.i)). Based on the dynamic growth experience in a number of Southeast Asian countries, Chhibber and Leecher (1993) recommended that Ghana embark on a more aggressive export program. This program will include both traditional and non-traditional exports. Doing so could result in Ghana becoming a middle-income country by the early 2000s (Chhibber and Leechor (1993, p.25), Lall, Naveretti, Teitel, and Wignaraja (1994, p.30)).

The wood products industry has been targeted by the Government of Ghana and by several international donor agencies as a promising industry for the nation's non-traditional export program, (USAID (1992, p.11)). The industry is located in both urban and rural areas, and a significant number of people are involved in the sector (Anyane-Ntow and Richmond (1995, p.vii)). Next to gold, the wood-processing industry has been identified by USAID as having the best potential for export expansion with significant impact on Ghana's economic growth.

Empirical implementation of our model is based on a data set, which consists of detailed enterprise level variables relating to the micro-enterprise sector of Ghana's wood products industry. The variables were obtained from a unique questionnaire.[4] The data are observations for 242 micro enterprises located in eight different governmental regions in Ghana.[5] We concentrate on the micro-enterprises involved in the 'furniture and furniture

4. As a basis for a comprehensive project to determine the competitiveness of the micro-enterprises in Ghana's wood-products industry, a detailed questionnaire was administered in Summer (1994). For details, see Anyane-Ntow and Richmond (1995).

5. There were 503 questionnaires filled by the micro-entrepreneurs. Yet, only 48 percent of the enterprises were deemed to have sufficiently accurate data to be included in the analysis: The micro-enterprises with no information on price level and quantity of production (146 micro-enterprises) which are not furniture or furniture parts producers (81 micro-enterprises), with a significant deviation from the industry's norms, in terms of their

parts production' for two reasons. The first is for practical purposes: It is more reasonable to estimate a production function for a homogeneous product line. Second is for economic reasons: Within the wood-products industry, furniture and furniture part producers have the highest value added. Table 1 presents the main characteristics of the micro-enterprises. In summary, the micro-enterprises in our sample employ labor with limited schooling, utilize small machines and tools, apply traditional technologies, and use wood - an indigenous factor of Ghana.

IV. Results

The stochastic production frontier is estimated by the maximum likelihood method. Table 2 summarizes the results. The following three results emerge from the estimation. (i) The geographical location of a micro-enterprise is not a significant factor in its production process. The only exception is region seven, namely Volta. The micro-enterprises in this region have a significantly less favorable production process; (ii) the coefficient of lnLABOR is positive and statistically significant. More specifically, it is estimated as 0.69. In other words, a one percent increase in labor force results in a 0.69 percent increase in the output level; and (iii) compared to using large machines, using small or no machines have a negative impact on the production. Yet, these differences, 0.11 and 0.13 respectively for using small and no machines versus using large machines, are not statistically significant.

As summarized in Table 3, the technical efficiency levels of the micro-enterprises are heavily concentrated within the range of 31-70%. Seventy percent of the enterprises are within this range, and thirty percent are above the 70% level. Fifteen percent of the enterprises have technical efficiency levels above 90%. This sector of the industry has an average technical efficiency level of 62%.[6]

Thus, in line with our earlier assertion that allocative efficiency is not a likely option for the micro-enterprise sector of the industry, it becomes very important to assess and find ways to improve the sector's technical efficiency. The overall purpose of our focus on technical efficiency is to make the sector more competitive. It is well documented that large efficiency dispersions within an industry cannot be attributed to a single factor (Fecher *et al.* (1993), Gokcekus (1995)). Accordingly, we estimate the technical efficiency-human capital model (Equation (2)) by Ordinary Least Squares method, to closely examine the impact of different aspects of human capital on technical efficiency. Table 4 shows the estimation result.

The estimated coefficients of the micro-enterprise specific characteristics provide interesting insights. The micro-enterprises with owners who have more schooling have a significantly higher technical efficiency level. Similarly, an owner who obtained technical education as an apprentice has significantly higher technical efficiency. The coefficient is positive and statistically significant.[7] Our proposed performance enhancing strategies, which

size and labor productivity (24 micro-enterprises).

6. Throughout this paper, references to "average" are references to arithmetic means.

7. We examine the possible impact of membership and business registration. Neither of these characteristics has a

are briefly discussed in the next section, are based in part on these two findings.

According to the estimated coefficients of lnTECED and $(\text{lnTECED})^2$, the optimum number of years for technical education as an apprentice is calculated as 5.94 years, or approximately 6 years. This is the third building block for our proposed strategy. Therefore, we examine it in more detail. To do so, the technical efficiency levels are derived for a hypothetical entrepreneur - with middle school or more schooling, who received technical education as an apprentice, is a registered member of a trade association, has the industry's average apprentice/master ratio, and the number of years in the business. We limit our analysis to a TECED range of 1 to 9 years, since 95% of the micro-entrepreneurs are within this range.

As Table 5 presents, each additional year as an apprentice has a marginally decreasing but positive effect until the sixth year on the enterprises' technical efficiency. For example, working two years as an apprentice instead of one year increases technical efficiency by 10.6 percentage points. The marginal impact of each consecutive year as an apprentice becomes 4.4, 2.0 and 1.0 percentage point, respectively. Then, after the sixth year, each additional year as an apprentice has a small but negative effect on technical efficiency.

To demonstrate the impact of schooling on technical efficiency, we derive the technical efficiency level for the same hypothetical entrepreneur with one exception: This time we make the assumption that the owner's schooling is below the middle school level. This example magnifies the findings that schooling has a positive effect on technical efficiency level. Furthermore, it is shown that in the latter stages of the apprenticeship, schooling has a bigger impact. Table 5 also illustrates this point.

Again, for a hypothetical entrepreneur, we derive technical efficiency levels at different APPRE ratios. We limit our analysis for the range of 1 to 9 for APPRE, since 96.0% of the enterprises are within this range. Unlike the relationship between TECED and technical efficiency, initially technical efficiency goes down slightly until the ratio of 2.18 and then goes up. Yet, the difference in technical efficiency level for the ratio of 1 to the ratio of 9 is 2.0 percentage points.

V. Conclusion

Three main findings are detailed in this paper. First, the average technical efficiency level for the micro-enterprises in Ghana's wood-products industry is 62%, with twenty-two percent of the micro-enterprises above an 80% level, and only one enterprise below a 30% technical efficiency level. Second, both the schooling and on-the-job training of an entrepreneur have a positive and statistically significant effect on technical efficiency; changes in the apprentice/master ratios, which are between zero and nine, have no significant effect on technical efficiency; and membership in a trade association and registration have no significant effect on technical efficiency. Third, the optimal on-the-job training time for an apprentice to master the profession before opening an independent shop is six years.

statistically significant effect on technical efficiency. However, an entrepreneur who is both registered and a member of trade association has significantly lower technical efficiency than the others.

According to the Heckscher-Ohlin factor endowment theory, a country has a comparative advantage in products, which intensively use that country's abundant factor of production (Ethier (1995, p.130)). Clearly, micro-enterprises in woods-product industry - labor and wood intensive - fit to this description as potential exporters. Competitive advantage theory, however, argues that nations' endowments are dynamic and could be upgraded, created, and specialized. In other words, nations need to assist their domestic industries by developing new pools of advanced factors and new pools of specialized factors (Porter (1980, 1985), Yoffie and Gomes-Casseres (1994)).[8]

Based on our findings, an effort with an emphasize on schooling will have a positive impact on the economic performance of the micro-enterprises. Yet, schooling is not susceptible to change in the short-run. Therefore, we focus short-term strategies involving micro-enterprises for improving the technical efficiency levels. It may appear that there is not much technical efficiency to gain from a strategy that focuses on variables that the micro-enterprises can improve, e.g., technical education and apprentice/master ratio.

Forty one percent of the entrepreneurs have three or less years of technical education as an apprentice. This is the range within which each incremental change might cause on the average a 5.7 percentage point ([10.6+4.4+2]/3) technical efficiency improvement. The potential problem here is that it might not be feasible to force an apprentice to stay as an apprentice more than what he has planned. Yet, a proper training program may be used as an alternative solution.

Eighty three percent of the shop owners are association members. Therefore, a training program in collaboration with the trade association would embrace the majority of the micro-enterprises and apprentices. It is also argued that for an effective training program the participation of the local institutions is the key for success (International Trade Centre (1991)).

The technical training should emphasize basic furniture making and quality and standardization aspects of furniture making. Lack of standardization is pointed out as one of the major obstacles for a successful exporting campaign. To empower the association a certification requirement might be enforced, which will be earned by completing a specified number of training workshops. Also, shop owners should be informed on how to have access to the international markets.

The training program needs to be customized. Accordingly, the emphasis on training workshops for entrepreneurs with high technical efficiency levels will place on technological improvement and export readiness. At the same time, the emphasis for entrepreneurs with lower technical efficiency levels should be geared towards improving their technical efficiency levels.

There is a two-percentage point technical efficiency level difference for the range of 2-9 apprentice/master ratio. Yet, this difference is not statistically significant. This indicates that master carpenters don't have difficulty in supervising their apprentices regardless of the number of apprentices working under their supervision. When we consider the size of a shop

8. Storper (1995) provides a detailed review of the competitiveness policy options with a special emphasize on the technology-regions connection.

- the relatively small space it covers, and the straight- forwardness of the production process, this becomes more understandable. The result also indicates that this sector has the additional capacity to absorb more participants thereby increasing employment, particularly in the rural areas. Encouraging shop owners to hire more apprentices and providing them with informative sessions on how to teach certain skills to their apprentices in a more systematic and standardized way will have three positive effects: better prepared apprentices as future' s masters, a higher standardization among the shops, and increased employment.

Our findings suggest that the potential returns are high for developing labor and managerial skills of micro-enterprises - mostly neglected segment of the economy. It will also be a worthwhile effort to address the issue of how to sustain economic dynamism. In particular, it is important to understand how to increase accessibility to financial institutions or creating new mechanisms for self-sufficiency.

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Table 1 Summary Statistics for Micro-enterprises in Furniture and Furniture Parts Industry

	EDUCA	TECED	AGE	MEMBE	TRAPP	REGIS	EXPER	P. TIME	APPRE	SUPER	MACHI	QUANT.	PRICE
Average	0.21	4.30	33.33	0.83	0.86	0.43	8.82	0.22	3.39	1.8	1.9	11.1	91
Std. Dev.	0.40	2.19	7.39	0.37	0.34	0.49	7.88	0.41	3.05	2.5	0.3	39	173.1

Regional Distribution

	Ashanti	B. Ahofa	Central	Eastern	G. Accra	Northern	Volta	Western	TOTAL
Number	135	42	8	20	1	11	6	19	242
Percent	55.8%	17.4%	3.3%	8.3%	0.4%	4.5%	2.5%	7.9%	100.0%

Source: Authors' own calculations. * where, EDUCA = formal education of middle school or higher (%); TECED = number of years for technical education as an apprentice; AGE = age of the owner; MEMBE = membership in a trade association (%); TRAPP = technical education as apprentice (%); REGIS = officially registered enterprises (%); P.TIME = working as part-time (%); APPRE = apprentice/master ratio; SUPER = number of supervisors; MACHI = machines and tools owned (1 for big machines, 2 small machines, and 3 for no machines); QUANT = number of furniture or furniture parts produced; PRICE = average unit price in 100,000 cedis. For more details, see Section III.

Table 2 Maximum Likelihood Estimate of the Stochastic Production Frontier

Variable	Coefficient	Std. Error	T-Ratio
Constant	4.112		
ln LABOR	0.691	0.108	6.399
CAP1	0.130	0.745	0.174
CAP2	0.106	0.765	0.138
REG1	0.118	0.227	0.520
REG2	0.306	0.259	1.180
REG3	0.191	0.606	0.316
REG4	0.298	0.272	1.098
REG5	0.561	413.0	0.001
REG6	0.261	0.335	0.781
REG7	1.543	0.751	2.054
s_u / s_v	0.885	0.987	0.896
$\sqrt{(s_u^2 + s_v^2)}$	1.172	0.298	3.935
Log L	341.815		
# of obs.	242		

Table 3 Frequency Distribution of Technical Efficiency

Range	Total	Percentage
< 30 %	1	0.0%
31-40%	40	16.5%
41-50%	41	16.9%
51-60%	51	21.1%
71-80%	19	7.9%
81-90%	16	6.6%
> 90%	36	14.9%
Average	242	61.8%
Std. Dev.		20.3%

Table 4 Ordinary Least Squares Estimate of Technical Efficiency-human Capital Model

Variable	Coefficient	Std. Error	T-Ratio
Constant	0.966		
SCHOL	0.140	0.066	2.123
TRAIN	0.231	0.076	3.018
EXPER	0.062	0.029	2.163
ln(TECED)	0.393	0.227	1.728
$\ln(TECED)^2$	0.110	0.075	1.470
ln(APPRE)	0.051	0.064	0.796
$\ln(APPRE)^2$	0.032	0.030	1.064
REGIS	0.145	0.133	1.093
MEMBE	0.076	0.097	0.782
REGIS*MEMBE	0.258	0.143	1.807
# of obs	242		
R^2	0.079		

Table 5 Effects of Technical Education on Technical Efficiency

TECED (years)	TE (%) EDUCA = 1	Marginal Change*	TE (%) EDUCA = 0	Marginal Change
1	43.0		37.4	
2	53.6	10.6	46.6	9.2
3	58.0	4.4	50.4	3.8
4	60.0	2.0	52.2	1.8
5	61.0	1.0	52.9	0.7
6	61.1	0.1	53.1	0.2
7	61.0	0.1	52.9	0.2
8	60.0	1.0	52.6	0.3
9	59.9	0.1	52.1	0.5

* Marginal Change = percentage point change in technical efficiency as a result of an increase in TECED by one.