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Original Article

Analysis and Determinants of the Performance of Ivorian Manufacturing Companies

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Abstract *- This study aims to analyze the performance of Ivorian manufacturing companies. To do so, we adopted a two-step approach, the first of which consisted of determining the efficiency scores of individual companies and the second of analyzing the determinants of this efficiency through a Tobit model. Using a stochastic production approach (SFA) of the Translog type, we determined the efficiency of the companies. Given the censored nature of efficiency, we adopted a Tobit model for the analysis of the determinants. The analysis shows that the Ivorian manufacturing sector is globally inefficient. The efficiency rate is unevenly distributed, ranging from 10% to 92%, with an average of between 53% and 54%. Furthermore, the analysis of the determinants shows that investment, exports, the labor-capital ratio, and the size of the company positively influence the efficient use of the different tools available to companies. However, the relationship linking efficiency to firm size is not linear; beyond a threshold, firm size hinders the efficient use of factors.*

Keywords *- Performance, Determinant, Manufacturing firms, Technical efficiency.*

I. CONTEXT AND RESEARCH PROBLEM

Côte d'Ivoire is considered a success story in Africa. It has recorded strong growth rates in its Gross Domestic Product (GDP) since its exit from the crisis, ranging from 10.7% in 2012 to 6.23% in 2019. Despite the consequences of the coronavirus pandemic, it recorded a GDP growth of 1.81% in 2020. This increase has enabled it to position itself as the fourth most efficient economy in the world and the second in Africa, according to the World Bank (2017). It is still qualified by the World Bank as "the main economic lung of French-speaking West Africa", in its report "At the gates of paradise", with a GDP per capita (of 5,443.2 USD [Dollar American]) among the highest in the region.

Although the Ivorian economy is mainly driven by agriculture (22% of GDP, more than 50% of export earnings, and two-thirds of sources of employment and income in 2012 according to the World Bank, 2017), its industrial base is relatively advanced compared to other African countries. It is considered the eighth industrial power in Africa, according to the World Bank (2017).

Historically, the Ivorian industrial system has experienced rapid development during the first twenty (20) years following its independence in 1960. With the will of the entrepreneurial state of the first republic, the Ivorian industrial system has become one of the most modern in sub-Saharan Africa. The country is becoming a benchmark in the West African sub-region and presents itself as the densest and best-endowed manufacturing industrial fabric with industrial growth of 9% on average per year between 1960 and 1980 (World Bank, 2015), and an investment rate of 22% on average according to the United Nations Industrial Development Organization (UNIDO, 2015). This growth dynamic was halted by successive socio-political and economic crises over the following three decades. After these three years of economic crisis (1994-1998) and socio-political instability (1999-2011), the Ivory Coast has regained its place among the once occupied continental leaders. Behind South Africa, Egypt, Nigeria, Tunisia, Morocco, Algeria, and Sudan, it presents itself as the eighth African industrial power (UNIDO, 2015). Its industrial sector contributes 23% to the national GDP and stands as one of the most diversified in the Economic Community of West African States (ECOWAS) (UNIDO, 2015).

However, this high proportion of the industrial sector in overall production derives mainly from the petroleum industry (with an average growth rate of 0.4% per year) and seems to mask the real state of performance and competitiveness. of the manufacturing sector. In its report on global competitiveness, the World Economic Forum presents the Ivorian manufacturing sector as being less and less competitive at the global level. It went from the 91st most competitive country with a competitiveness index of 56.16 in 2015 to the 118th country with an index of 48.15 in 2019. More specifically, the Ivorian manufacturing system shows a decrease in its production relative to the period leading up to the political crisis. Overall, the value-added share of the manufacturing sector in industrial production has decreased: it fell from 22% in 1999 to 12% in 2010 (UNIDO, 2015). Unlike Côte d'Ivoire, other economies in the sub-region recorded an increase in production: Ghana by 380% between 2000 and 2002; Nigeria by 91% between 2002 and 2006; Burkina Faso by 125%; between 2001 and 2006 ...

Faced with this poor performance observed in the Ivorian manufacturing sector, it appears important to conduct a study on the performance of these companies. Indeed, the manufacturing sector plays a central role in the development of developing economies (Tybout, 2000), it allows countries to industrialize, create employment opportunities, facilitate trade and thus improve the sophistication of a country's exports by shifting the allocation of resources from dependence on low-value commodities to high-value manufactured goods. In addition, the need for efficiency analysis has become more pressing in a world where companies are confronted with the scarcity of resources. With the desire to maintain a stable market, especially in an environment characterized by intense competition inside and outside the country (resulting from the liberalization of imports), companies must be competitive, efficient in their operations, which should increase their chances of survival.

Thus, it appears essential to ask the following questions: What is the level of efficiency of Ivorian manufacturing companies? What are the determining factors of this efficiency? What policies should be implemented in order to improve the Ivorian manufacturing sector?

The main objective of this study is to analyze the performance of Ivorian manufacturing companies. Specifically, it will be: to assess the level of efficiency of companies through the parametric approach of stochastic production functions (SFA); compare the efficiency of manufacturing companies according to different criteria such as: by sub-branch; cut; geographical location, to analyze the factors that influence the technical efficiency of these companies. A study of technical efficiency is important for academic research because it contributes to the ongoing debates about efficiency and its determinants. It also enables policymakers to improve their understanding of the factors that influence efficiency, thereby helping them to formulate policies aimed at boosting business productivity.

Our study of the performance of the manufacturing industry in Côte d'Ivoire was structured as follows: the first section will be devoted to the empirical review, the second will examine the methodological framework. The third section presents the analysis and interpretation of the study results.

II. LITERATURE REVIEW

Efficiency analysis has received considerable attention from different disciplines such as engineering and economics. It is at the heart of the company's existence. This attention has mainly been directed to the analysis of decision-making units such as hospitals, educational institutions, manufacturing industries, and farms.

Research has uncovered a myriad of factors that are perceived to affect a company's level of efficiency. Based on observations made on emerging firms in the Taiwanese electronics industry, Chen and Tang (1987); examine technical efficiency in dealing with external competitive pressure. It has been found that companies that are forced to export all their products and therefore to be competitive in world markets tend to be more efficient than those allowed to sell their products in protected local markets. Using a stochastic approach, they show that export-oriented companies are 6 to 11% closer to the production frontier than companies oriented towards the domestic market. For Lundvall and Battese (2000), technical efficiency is systematically linked to the size and age of firms in their study of efficiency. Based on an estimate of a translog-type SFA for 235 manufacturing companies in Kenya from data from the Investment Climate Survey of the Regional Enterprise Development Program (RPED) over the period 1992-1993. In particular, they found that: Firm size had a significant positive effect for firms in the food, wood, textiles, and metals sectors. However, age was less systemic and insignificant in all sectors except textiles. A few years later, Isaksson and GRANÉR (2009) studied the link between the efficiency of firms and the status of exports for the manufacturing sector of the same country over the period 1992-1994. After using the same analytical approach (SFA), they found that the average technical efficiency of the Kenyan manufacturing sector was 55% and that exporting companies were consistently more efficient than non-exporters. In particular, they found that the average technical efficiency of exporting companies was above 10% in the textile sector and 67% in the wood sector.

Chirwa (2001) conducts a study on the evaluation of the impact of privatization on the technical efficiency of enterprises. From panel data between 1970 and 1997, he determined the technical efficiency scores using a DEA approach of the "inter-temporal frontier" type. It emerges that: Privatization in Malawi increases technical efficiency in enterprises. Other similar studies have been carried out in the neighboring country with different approaches. Indeed, Asid (2010) sought to establish the technical efficiency of manufacturing firms in Malaysia over the period 1986 to 1995. By adopting an SFA approach, he shows that, on average, technical efficiency increases monotonously. And steady by 0.01 percentage point each year at a decreasing rate. As for Mahadevan (2002), he analyzes the productivity growth performance of manufacturing industries in the same country (Malaysia) using a panel of data from 28 industries from 1981 to 1996. Applying the non-parametric method (DEA) for the calculation of the Malmquist index of the growth of total factor productivity in technical change, change in technical efficiency, and change in scale efficiency. It was found that: the annual growth of total factor productivity of the Malaysian manufacturing sector was low (0.8%), the change in technical efficiency was 0.5%, and the change in the efficiency of the scale was 0.1%. For Mahadevan, this weak growth in these productivities was due to weak gains in terms of technical change and technical efficiency of industries operating near the MUJADDAD region.

Watanabe and Tanaka (2007), in order to compare the deterministic and stochastic methods of measuring efficiency on Chinese industry over the period 1994-2002 at the provincial level. After the simultaneous use of two approaches, one deterministic and the other stochastic with the same factors of production (capital, labor, and materials [coal]) and industrial production as output, they3. show that the level of efficiency was biased when using a deterministic approach. Thus, the use of the border stochastic eliminates the problem of overestimating industrial inefficiency levels in Shandong, Sichuan, and Hubei. They also found that the industrial structure of a province has important effects on its level of efficiency. Also, in the Asian continent, Mujaddad and Ahmad (2016) analyzed the energy equivalent of Pakistan's large-scale manufacturing sector. They used a DEA double bootstrap technique under the assumption of constant returns to scale and variable returns to scale. Data were collected from 101 industries over the periods 1995-1996 and 2000-2001. The input variables included: capital, labor, industrial cost, non-industrial cost, and the output variable was a contribution to GDP. Under constant return to scale, results indicated that the average efficiency improved from 0.23 in 1995-1996 to 0.42 in 2000-2001. Under Variable Return to Scale, the average efficiency rating fell from 0.31 in the first period to 0.49 in the second. Still, in Pakistan, Tahir (2012) assessed the efficiency of 49 manufacturing companies in the country in a more recent period compared to its predecessor (2006-2010) using the DEA. In the variable returns to scale model, they find that a single firm is considered technically efficient, while the average overall technical efficiency ranges from 0.64 to 0.99.

Other studies on the effectiveness have been carried out on the African continent. Ajibefun and Adebiye (2003) conducted a study on the determinants of the technical and allocative efficiency of 180 Nigerian micro enterprises selected from the professional groups of block making, metal products manufacturing, and sawing. After using an SFA approach, they show a wide variation in technical and allocative effectiveness within, between professional groups, and between operational scales. It also appears that the level of education of the business owner is positively correlated with efficiency, while age was negatively correlated with efficacy. A specific analysis of the efficiency of the country's manufacturing sector was conducted by Oladeebo (2012) using the SFA. He finds that companies that had invested a lot in technology were more efficient technologies. However, she noted that the inefficiency of the firms was directly attributable to the characteristics of the firm. In particular, the study found that efficiency increased with firm size and declined for locally-owned versus foreign-owned firms. She also found that the skill intensity of workers also increased efficiency. A similar study on efficacy was carried out in Cameroon by Ngeh (2014). After using the same SFA approach to estimate the technical efficiency of Cameroon's manufacturing industries. He found that the average technical efficiency was between 10.3 and 24.1%. It also indicates that companies with more than 20 years of existence are the most efficient, with an average technical efficiency of 35.97%.

III. PRESENTATION OF DATA AND METHODOLOGY

A. Presentation of data

The data available to us comes from the Financial Data Bank (BDF) of the Ivorian INS. They contain information on company characteristics such as production, capital, and expenditure on raw materials (all measured in CFA francs) as well as other information such as the number of employees and age of the company. (in years). The data cover the six branches of the manufacturing sector over the period 2014-2017.

B. Methodology

a) Production Function (SFA)

In our study, we will use the parametric stochastic production frontier method to assess the performance of manufacturing firms. Parametric approaches have, in fact, a solid statistical basis and allow statistical tests of model validity to be carried out. In addition, the stochastic-type parametric approach makes it possible to distinguish model random error (statistical error) from inefficiency, unlike the non-stochastic parametric approach.

Indeed, According to Coelli and Battese (1995), this stochastic approach is suitable for developing countries, in which we observe strong instabilities due to political tensions, floods, health crises…. This approach makes it possible to capture mainly measurement errors and shocks (having a white noise character) that escape the company. As for the deterministic approach, it considers that these effects are entirely under the control of the company, therefore attributes the gap between the observed production and the frontier to inefficiency.

The stochastic production frontier model was introduced by Aigner et al. (1977) and Meeusen and Broeck (1977). Since then, it has become a popular subfield in econometrics. Its specification can be defined as follows: Suppose the production function of the manufacturing industry in an error-free and efficient world defined by :

$$Q_{i,t} = f(Z_{i,t}, \beta) \quad (1.1)$$

or $Z_{i,t}$ are the factors of production, with i representing the company number i and t the time.

A fundamental element of stochastic frontier analysis is that each firm produces less than it could due to some degree of inefficiency. More precisely :

$Q_{i,t} = f(Z_{i,t}, \beta)\xi_{i,t}$ (1.2) or $\xi_{i,t}$ is the efficiency level of firm i at time t and belongs to]0;1]. If $\xi_{i,t}$ = 1, the company achieves optimum performance with the technology integrated into the production function $f(Z_{i,t}, \beta)$. When $\xi_{i,t} < 1$ the firm does not make better use of the different factors of production $Z_{i,t}$ given the technology incorporated in the production function $f(Z_{i,t}, \beta)$. Since the output is assumed to be strictly positive (that is to say $Q_{i,t} > 0$), the degree of technical efficiency is assumed to be strictly positive (that is to says $\xi_{i,t} > 0$). If we want to take into account the various random shocks to which production is subject, the production function is defined as follows:

$$- \ Q_{i,t} = f(Z_{i,t}, \beta)\xi_{i,t} \exp(v_{i,t}) \ (1.3)$$

We switch to the natural logarithm on either side of the equation for linearization. We then get:

$$- \ \ln(Q_{i,t}) = \ln(f(Z_{i,t}, \beta)) + \ln(\xi_{i,t}) + v_{i,t} (1.4)$$

Assuming that there are k inputs and a Cobb Douglas-type production function, we have:

- $\ln(Q_{i,t}) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(Z_{j,i,t}) + v_{i,t} - u_{i,t} (1.5)$; With $u_{i,t} = -\ln(\xi_{i,t})$ positive terms. The model defined above is stochastic in the sense that it combines the two random terms $v_{i,t}$ and u(i, t). The advantage of this type of production function is that it explains the deviations observed between optimal production and the production actually obtained by the company. In addition, it takes into account the effects of random factors that are beyond the control of the company.

We assume that the differences are not explained solely by the inefficiency of the company. They are both the result of inefficiency and random elements that are not the responsibility of the company.

To account for the varying effects over time, the term that captures inefficiency is split into two; one-time dependent (η_t) and the other time-invariant (u_i) with ($\eta_t = \exp\{-\eta(t-T)\}$) et $u_{i,t} = \exp\{-\eta(t-T)\}u_i$; with t the current period and T the last period.
The final model is then defined as follows :

$$-\ln(Q_{i,t}) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(Z_{j,i,t}) + v_{i,t} - \exp\{-\eta(t-T)\} u_i (1.6)$$

With $t \in 1,2\ldots T$ et $i \in 1,2\ldots N$ or $Q_{i,t}$: is the production of I'th firm at the t'th period, $Z_{it,}$ :: is a vector (lxk) of the inputs of the i'th firm at the t'th period; $\beta = (\beta_0; \beta_1; \ldots; \beta_k)$: is a vector (lx (k + 1)) of the unknown technological parameters of the production function; t represents the current period and T the last period, N represents the number of companies; the $v_{i,t}$ are assumed to be independent, identically distributed random errors of law $N(0, \sigma_v)$ the u_i are assumed to be independent and identically distributed non-negative semi-normal random variables $|N(\mu, \sigma)|$; u_i and $v_{i,t}$ are independently distributed from each other and Covariates in the model, and η is an unknown scalar parameter.

The exponential specification of the behavior of firm effects over time is a rigid formulation in the sense that technical efficiency must either increase at a rate (η> 0), or decrease at a rate (η<0), or remain constant (η = 0).

Using the parameterization of the model, suggested by Battese et al. (1977), the logarithm of the likelihood function is expressed by:

$$\ln(L(\theta, y)) = -\frac{1}{2}\left(\sum_{i=1}^{N} T_i\right)\{\ln(2\pi) + \ln(\sigma_s^2)\} - \frac{1}{2}\sum_{i=1}^{N}(T_i - 1)\ln(1-\gamma)$$

-

$$-\frac{1}{2}\sum_{i=1}^{N} \ln [1 + (\sum_{t=1}^{T}(\eta_t^2 - 1)\gamma - N\ln[1-\varphi(-z)] - \frac{1}{2}Nz^2$$

$$+\frac{1}{2}\sum_{i=1}^{N}\ln[1-\varphi(-z^*)] + \frac{1}{2}\sum_{t=1}^{T} z_i^{*2} - \frac{1}{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\frac{\epsilon_{i,t}^2}{(1-\gamma)\sigma_s^2}$$

with $\sigma_s = (\sigma_v^2 + \sigma^2)^{1/2}$, $\gamma = \left(\frac{\sigma}{\sigma_s}\right)^2$, $\epsilon_{i,t} = \ln(Q_{i,t}) - \beta_0 \sum_{j=1}^{k} \beta_j \ln(Z_{j,i,t})$;

$\eta_t = \exp\{-\eta(t-T)\}$ et $\tilde{z} = \mu/(\gamma\sigma_s^2)^{1/2}$

φ (): is the distribution function of the reduced centered normal law and

$$z_i^* \frac{\mu(1-\gamma) - \gamma\sum_{t=1}^{T}\eta_t\epsilon_{i,t}}{[\gamma(1-\gamma)\sigma_s^2\{1+(\sum_{t=1}^{T}\eta_t^2 - 1)\gamma\}]^{1/2}}$$

The various parameters of the model are estimated through the partial derivatives of the log-likelihood function with respect to the parameters: β, σ_s^2M, γ et η.

Note that the parameter λ is important; in the sense that it measures the relative variability of the two sources of inefficiency. When □ (λ⟶0), which implies that $\sigma_v^2 \longrightarrow +\infty$ and/or that $\sigma_u^2 \longrightarrow 0$; random shocks dominate in the explanation of inefficiency. Likewise, when $\sigma_v^2 \longrightarrow 0$ then the frontier deviations are essentially hard on technical inefficiency.

The definitions of the variables used are also an important determinant of the results obtained. For this production function, we used as a proxy:

1) The production

Production can be seen as the set of products and by-products, in terms of quantity or value, or as value-added. Depending on the objective, one of the concepts may become more relevant. Thus, if the objective is to analyze the distribution of income between the main factors of production (labor and capital), value-added will be the most relevant concept. In contrast, in structural analysis, the concept of aggregate production is more useful. So we measured production by the value of production.

2) Capital

Data on fixed capital can be broken down into three components such as land and construction, plant and machinery, and other assets.

The gross value of fixed assets was used as a measure of capital. Gross capital figures are more meaningful in the analysis of capitalist production than depreciation figures since depreciation charges rarely represent a decrease in productive capacity.

3) Job

The labor factor can best be represented by the number of hours worked. No direct information on working hours is available. However, they can be estimated from the information available: the average number of employees and the average number of hours worked by each person during the year. The latter is obtained from the number of days worked during the year and the average number of hours worked per day by each person. However, when the number of working hours is the same for each person, the labor factor index obtained from the number of employees does not differ from that obtained from the total number of working hours. The number of employees will therefore be used here as a tool for measuring the labor factor.

In this measure of the labor factor, the assumption of homogeneity of the workforce is often used. This means that all types of labor are equally important. In addition, changes in the composition of the workforce are not represented in these measures. To overcome these shortcomings, we could distinguish three professional categories, namely production workers, professional and administrative employees, and other workers; and use the number of employees in each category, weighted by their base year earnings, to construct the labor input index. But due to a lack of information on the wage bill for the different qualifications, we will use the number of employees as a proxy for the labor factor.

4) Raw materials

Given the variety of materials used in each industry, we assume that the different raw materials are homogeneous. In this work, we will use the cost of purchases of raw materials and other related materials as a rough measure of this factor.

b) Comparison between Groups (ANOVA)

The most common way to determine if there are differences between two or more groups, based on a continuous variable, is to perform an analysis of variance (ANOVA).

The purpose of an ANOVA is to check whether there are differences between the means of a variable in two or more groups. If the ANOVA test is significant; At least two groups can be said to have different means.

An ANOVA performs as a hypothesis test:
H_0: μ_1 = μ_2 = ⋯ = μ_k and H_a: At least two of the means are different from each other.
With μ_k, the mean of group k. The test statistic is calculated in three steps. The sum of squares between groups using the formula :

$$SS_{bg} = \sum_{i=1}^{k} (\hat{Y}_{i\,.} - \hat{Y}_{..})^2 \quad (1.7)$$

Where k is the total number of groups, Y ̂_ (i.) Is the mean value of the dependent variable for group i, and Y ̂_ (..) is the overall mean, also called the grand mean. This sum is a measure of the difference between the means of the different groups. The SS_bg reflects both the variability caused by the differences between groups as well as the random variation of our observations. The sum of the squares inside the groups using the formula:

$$SS_{wg} = \sum_{i=1}^{k} \sum_{j=1}^{n_k} (Y_{i,j} - \hat{Y}_{i.})^2 \quad (1.8)$$

The sum of the squares within the groups represents only the degree of random variation of the observations. The test statistic F = SS_bg / (k-1) * (N-k) / SS_wg (1.9) where N is the total sample size. This statistic essentially indicates the importance of the differences between our groups compared to the random variability of our observations. Higher values of F mean that the difference between our means is large compared to the random variability of our observations.

Under hypothesis H_0, the statistic F follows a Fisher law of degree of freedom k-1 and N-k (F (k-1; N-k).)

For a fixed risk α, the acceptance zone is ZA_ (H0, α) = [0; f_ (k-1, N-k; 1-α)] with f_ (k-1, N-k; 1-α) the quantile of order 1-α of Fisher's law of degrees of freedom k-1 and N-k.

c) Determinants of Performance (TOBIT MODEL)

After estimating the different efficiency scores, it also appears important to explain these scores by examining their determinants. The efficiency score being between 0 and 1, we will use the model. In recent years, the Tobit model has been used extensively to analyze the determinants of efficiency. It seems more suited to limited variables.

The Tobit model was first suggested in the econometric literature by Tobin (1958). These models are also known as truncated or censored regression models, where the expected errors are not zero. Therefore, estimation with ordinary least squares (OLS) regression of the efficiency scores would lead to a biased estimate of the parameters since OLS assume a normal and homoscedastic distribution of the disturbance and the dependent variable.

The Tobit model can be defined as :

$y^* = X_i'\beta + u_i(\mathbf{1.10})$; avec $i = 1,2, \dots N$

$$y = \begin{cases} y^* ; & 0 \le y^* \le 1 \\ 0 ; & y^* \le 0 \\ 1 ; & 1 \le y^* \end{cases}$$

Where $u_i \sim N(0 ; \sigma^2)$, X_i et β are vectors of explanatory variables and unknown parameters, respectively: y ^ * is a latent variable, and y is the technical efficiency score. Our explanatory variables are investment, export, labor-capital ratio, firm size, and age.

IV. ANALYSIS AND INTERPRETATION OF THE RESULTS

A. Estimates of technical efficiency

a) Choice of Functional Form

The likelihood ratio test is performed to decide which functional form would best represent the production technology. The assumptions are as follows. Let the mathematical expression of these functions be: H0: Cobb Douglas type function ($\ln(y) = \ln(\beta_0) + \sum_{n=1}^{3} \beta_n \ln(X_n)$ (5.1)).

H1: Translog type function. $\ln(y) = \ln(\beta_0) + \sum_{n=1}^{3} \beta_n \ln(X_n) + \frac{1}{2}\sum_{n=1}^{3}\sum_{m=1}^{3} \beta_{n,m} \ln(X_n)\ln(X_m)$ (5.2).

With β_n represents the elasticity of production for the input Xn and β(n, m) the elasticity of cross production of the inputs Xn and Xm.

Thus, it is a question of testing the hypothesis H_0: for any pair (n, m); we have β_ (n, m) = 0 against H1: there exists at least one pair of (n, m) such that we have β(n, m) ≠ 0.

Based on the test results, as shown in Table 10, the probability (0.000) of incorrectly rejecting the null hypothesis is less than the 1% significance level. So the evidence for the rejection of the Cobb-Douglas type function is proven. Consequently, the technology of the Ivorian manufacturing industry can be represented by a Translog-type function at the 1% threshold.

This specification of the production function is more flexible and does not a priori impose any restrictions on the structure of production. However, it can violate certain regularity conditions, unlike Cobb Douglas and CES type functions.

Table 1. Result of the likelihood ratio test

chi2(6) =236.72
Prob> chi2=0,0000

Source: author's calculations.

b) Estimate and Interpretation of the Model

The next part of the analysis will consist in presenting the result of the estimation of the parameters of the translog-type stochastic production function.

At the level of the overall significance of the model, according to the Wald test presented in Table 2, the probability of wrongly rejecting the hypothesis of the overall non-significance of the model is zero. There is, therefore, evidence for the rejection of this hypothesis at the 1% threshold. Consequently, we retain that the model is globally significant at the 1% level.

Table 2 also presents the results of the estimation of the Translog type function. The purpose of this model is to estimate the influence of each input in the production process. It makes it possible to give the various links existing between the various factors of production and the final production.

With regard to the frontier parameters, as revealed by the statistics of the Student's tests (t-test) and the probabilities, we notice that the coefficients of the factors of production are significantly non-zero at the 1% level.

The estimate of γ, which is the ratio of the variance of efficiency to the total variance of production, is 0.7873561. This value of gamma (γ) also teaches us that the deviation from the border is explained by the inefficiency of companies at 78.7%, partly due to non-random effects. Indeed, only 21.3% of the differences between observed production and potential production are observed, which is due to other random effects such as measurement errors.

On the other hand, the value of (η), is statistically equal to zero, which reflects the fact that the efficiency is invariant over time.

Table 2. Border estimation results.

Dependent variable: log (production)	Coefficient	t-test	Probability
Ln(CAPITAL)	-1,613926	-6,44	0,000
Ln (WORK)	3,216972	8,97	0,000
Ln (RAW MATERIAL)	-1,288578	-9,3	0,000
Ln (CAPITAL) * Ln (WORK)	-0,1205345	-5,74	0,000
Ln (CAPITAL) * Ln (RAW MATERIAL)	0,0378037	4,5	0,000
Ln (WORK) * Ln (RAW MATERIAL)	-0,0667655	-6,86	0,000
Ln (CAPITAL)^2	0,0430899	5,36	0,000
Ln (WORK)^2	0,1009364	6,92	0,000
Ln (RAW MATERIAL)^2	0,0268795	7,79	0,000
Constant	3,538569	14,95	0,000

/mu	-0,4357978	-0,36	0,721
/eta	-0,0381733	-1,82	0,069
σ_s^2	1,693413		
Γ	0,7873561		
σ_v^2	1,333319		
σ^2	0,3600939		
Observation number	211		
Number of groups	4		
Wald chi2 (9)=	1908,07		0000

Source: author's calculations.

c) Evolution of Technical Efficiency Over Time

Table 3 shows the evolution of efficiency scores over time. There is a slight decrease in efficiency over time. It is estimated at 56.5% in 2014 to reach 53.5% in 2017. The results of the ANOVA test suggest that the technical efficiency has not changed significantly over time. This may suggest a stagnation in technical efficiency in Côte d'Ivoire's manufacturing sector over the period. According to the results of the descriptive analysis, while the turnover of the manufacturing sector declines throughout the period 2014-2017, there has been no depreciation in technical efficiency. Thus this recession in the activity of the country's manufacturing companies may have had little impact on the efficiency of the companies.

Table 3. Distribution of efficiency by year

Year	Average of the Efficiency rate	Variance
2014	57%	0,21
2015	56%	0,21
2016	55%	0,21
2017	54%	0,22
Total	55%	0,21

Source: author's calculations.

Table 4. Efficacy comparison anova test by year

chi2(3) = 0,1931	
Prob>chi2 = 0,979	

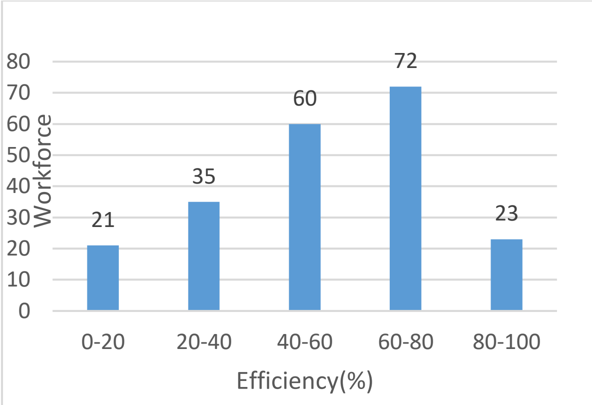
Source: author's calculations.

d) Classification of Companies According to Efficiency Rate

The efficiency of manufacturing companies in the Ivory Coast is 53.5% of its potential. This efficiency figure is significantly lower than reported in other comparable studies that examine the efficiency of companies in different countries by the SFA.

Graph 1. Presentation of the Number of Companies

according to efficiency scores**.**



Source: author's calculations.

The efficiency scores are distributed unevenly with a strong concentration of the rate between 40% and 80% of the potential. This range contains more than 60% of the companies in our sample. It reflects inefficiency in the optimal use of the various factors of production made available to them. Worse, about 10% of companies have efficiency rates below 20%.

e) Efficiency Score by Industry Sub-Group

Table 5. Distribution of efficiency by branch

Activity sub-branch	Average efficiency rate	Variance
Wood-leather and paper	47%	0,26
Metal fabrication	58%	0,2
Food production	50%	0,2
Petroleum chemicals and plastics	55%	0,18
Clothing and textiles	60%	0,23
Electronics-IT and transport	61%	0,23
Total	54%	0,22

Source: author's calculations

Table 6 shows that the efficiency scores of the different branches are concentrated around the average, with the highest score of 60.6% in the branch of "Electronics, IT and transport". It is followed by the Apparel and Textiles manufacturing branch, which has a score of 60.1%. While the wood, leather, and paper processing industry seems to be the least efficient with a score of 47.4%.

A test of equality of average efficiency scores between sub-sectors was carried out. The results of the ANOVA test confirm that there is no substantial variation in technical efficiency between the different branches.

Table 6. Anova efficiency test according to the sub-branches

chi2(5) = 6,5217
Prob>chi2 = 0,259

Source: author's calculations.

f) Breakdown of Efficiency by Zone

Table 8 presents the efficiency scores of businesses by location. As can be observed: companies located in the locality of Abidjan, on average, have a higher efficiency score compared to companies outside of Abidjan.

This difference between the average efficiencies of the two zones does not seem statistically significant. ANOVA tests show statistical equality of average technical efficiency. Thus, businesses located in Abidjan are all the more efficient than those located outside Abidjan.

Table 7. Distribution of efficiency by zone

Locality	Average efficiency rate	Variance
Abidjan	55%	0,21
Outside Abidjan	46%	0,24
Total	54%	0,22

Source: author's calculations.

Table 8. Anova test of equality of efficiency by locality

chi2(1) = 0,6272
Prob>chi2 = 0,428

Source: author's calculations.

g) Breakdown of Efficiency According to the Size of The Company

Table 9. Average efficiency by company size

Activity sub-branch	Average efficiency rate	Variance
Large business	61%	0,18
Medium-sized enterprise	56%	0,21
Small business	40%	0,23
Total	55%	0,21

Source: author's calculations

According to table 10 presenting the efficiency score according to the different sizes of companies, we observe that the large companies present themselves as the most efficient with a rate of 60.5%, followed by medium-sized companies with a score of d. the efficiency of 56.1%. Small businesses appear to be the least efficient. This result could suggest that the larger the business, the more efficient it becomes. This suggestion will be confirmed or disproved in the next section. The test for the difference in average efficiency between different company groups is shown in Table 20. According to the ANOVA test, the average technical efficiency is different depending on the size of the company.

Table 10. Anova test by company size

chi2(2) = 17,2459
Prob>chi2 = 0.000

Source: author's calculations.

h) Technical Efficiency Score and Company Age

After observing the correlation coefficients (R = 0.1755) between the efficiency score and the age of the company, we notice that there is a positive relationship between these two variables. This result implies that older firms produce, on average, closer to their production frontier than younger firms. This relationship is statistically insignificant.

B. Determinants of performance (TOBIT MODEL).

$$Y = \alpha_0 + \alpha_1 size + \alpha_2 size^2 + \alpha_3 age + \alpha_4 age^2 + \alpha_5 Ratio\_Job\_Capital + \alpha_6 investment + \alpha_7 export \quad (5.1)$$

Table 11. Result of the Tobit model estimation

Efficacité	Coefficient	t-test	Probabilité
Taille	0,000052	1,79	0,075 *
Taille^2	-1,770E-08	-2,1	0,037 **
Age	-0,000633	-0,44	0,659
Age^2	2,23E-05	0,92	0,359
Ratio travail-capital	1,41E-09	5,96	0,000 ***
Investissement	5,46E-12	2,58	0,011 **
Exportation	2,21E-12	6,92	0,000 ***
Constant	0,05894	3,47	0,001 ***
/sigma	0,072086		

Source: author's calculations.
*(***(1%) ;**(5%) ;*(10%)).*

a) Size

First, we observe that the relationship between firm size and efficiency is statistically significant and not linear. As can be seen in Table 21, which presents the results of the estimation of the Tobit model, the coefficient associated with the size of the enterprise is positive and statistically significant at the 10% level, while that associated with the square of the size is negative and statistically significant (5%). This implies that technical efficiency would initially increase with the size of the company but decrease beyond a size threshold. On the basis of the estimated parameters and after derivation of the model as a function of size and assuming all other variables unchanged, we find that the technical efficiency of manufacturing firms increases with size for firms that employ less than 1,469 employees. . Beyond this threshold, the efficiency decreases. This non-linear relationship could be justified by the fact that small companies face more competition. Therefore, they must implement certain production structures in order to be more efficient and withstand the competition they face during their lifetimes.

b) Age

Regarding the coefficients for age and squared age, we see that these two coefficients are not significant even at the 10% level. Thus it can be concluded that age (source of business experience) is not a source of efficiency in the production process in the manufacturing industry in Côte d'Ivoire. Age appears to be a non-determining factor in the efficiency of businesses. This result seems contrary to that of Lundvall and Battese (2000) and suggests that the relationship between firm age and efficiency is industry-specific in nature.

c) Work-Capital Ratio

The result presented in Table 21 illustrates that: Ivorian companies that use a greater mix of labor per capital (i.e., a higher labor-capital ratio) during the production process are more efficient. Thus increasing capital intensity increases efficiency in the production process of manufacturing firms. This result is justified by economic theory, which highlights the comparative advantage that developing countries may have in the production of labor-intensive goods.

d) Investment

We observe a positive and significant effect of the investment variable on efficiency. This result shows that there is a positive dynamic for companies that renovate their capital. It also shows that the use of new machinery (which presumably incorporates the latest technology) improves business efficiency.

This seems to be adequate in theory; the investment allows the modernization of the productive fabric and thus the improvement of efficiency in the production process. It leads to productivity gains and contributes to better use of the various production factors in the sectors in which it is involved.

Thus, the investment appears to be a determining factor in the economic activity of companies because it contributes to efficiency gains through modernization and updating of production tools.

e) Export

The coefficient associated with exporting is positive and statistically significant (1%). Thus the increase in exports improves efficiency in the use of different production factors.

The companies, through exports, benefit from the know-how and technology of foreign companies. Thus, the adoption of these different processes in its production cycle makes it possible to improve the optimal use of the various production factors made available to it throughout its operation.

As a result, the internationalization of companies, in particular exporting companies, forces companies to adopt a more aggressive strategy from the point of view of training and upgrading employees and to carry out certain structural changes allowing greater high efficiency of its production system in order to cope with the competitiveness of the foreign market.

C. Limits of the study

Apart from the weaknesses linked to the SFA approach, one of the limits of our results is that we did not take into account the possibility that certain items such as the cost of certain production factors (raw materials, energy, access industrial zones, real estate, etc.); cost of transport (furniture, etc.); the institutional environment (corruption index; state of infrastructure, etc.) or different trade barriers from one branch to another, could be a source of efficiency.

Thus, with our existing dataset, it is not possible to empirically examine the effect of differences in trade barriers and the cost of other factors on the efficiency of firms in these industries. We hope that future research can address this question using a more detailed data set.

V. CONCLUSION

This study analyzed the performance of Ivorian manufacturing companies with data from the INS business financial database over the period 2014 to 2017. Using the two-step approach, we estimated a translog-type stochastic production frontier by maximum likelihood econometric methods, which allowed us to establish the efficiency levels of individual firms; Then, in the second step, we analyzed the determinants of efficiency using the Tobit regression.

At the end of our analysis, it emerges that the average level of efficiency in the Ivorian manufacturing sector is between 53% and 54%. Based on the results of the study, it can be concluded that there is inefficiency in Ivorian manufacturing industries. It, therefore, appears urgent to improve management skills in order to strengthen the efficient use of the resources made available to them. This average efficiency of 53.5% indicates that, on average, an industry is 46.5% inefficient. Thus, there can be an increase in production of 46.5% without increasing the inputs. The minimum efficiency is 7%, and the maximum efficiency is 92%. This shows a huge difference in the use of resources. Government incentives, therefore, need to be distributed not necessarily evenly to help less efficient industries increase the efficient use of resources and increase domestic production. These figures are much lower than those reported in comparable studies in other countries. For example, Watanabe and Tanaka (2007) estimate the average efficiency of Chinese manufacturing firms at around 82%. However, this level of effectiveness is broadly consistent with similar studies conducted in other developing countries. Isaksson and GRANÉR (2009) found that the average technical efficiency of the Kenyan manufacturing sector was 55%, and Ngeh (2014) found that the average technical efficiency in Cameroon was between 10.3 and 24.1%.

The results of the analysis of the determinants of the efficiency of manufacturing companies are broadly in line with theoretical expectations. We find that the bigger the business, the more efficient it becomes. However, beyond a threshold, this size could affect its effectiveness. There is no statistical evidence to suggest that the length of a business leads to efficiency. In addition, we observed a positive link between the work-capital ratio, investment, exports, and business efficiency. These results confirm the idea that manufacturing companies in developing countries like Côte d'Ivoire must become more efficient. We hope to have paved the way for future research on the effectiveness of businesses in the Ivory Coast and in other developing countries of sub-Saharan Africa.

Given our results, several policy implications can be proposed in order to put in place better management skills and promote better use of resources in Ivorian manufacturing industries. First, policies designed to help small businesses grow can help them become more efficient in the future.

Second, government policies that attract investors and promote openness can help improve the efficiency of local businesses by giving them access to superior foreign technology, management skills, and so on.

Finally, import substitution industrialization policies may not have the desired effects on firm efficiency. These policies can result in the injection of additional physical capital into labor-intensive industries. Ivorian policymakers should therefore carefully assess their past experience with import substitution industrialization policies before embarking on similar programs in the future.

While our analysis is far from exhaustive (especially due to the limited nature of our data set), our results are an important first step in understanding the various factors that affect production efficiency in the manufacturing industry. In Ivory Coast.

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