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Electric Power Availability and Productivity of Industrial Enterprises in Cameroon

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ELECTRICPOWERAVAILABILITYANDPRODUCTIVITYOFINDUSTRIALENTERPRISESINCAMEROON

Strictly as per the compliance and regulations of:

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Djoha Seukou Yvette [α], Nourou Mohammadou [σ] & Etogo Nyaga Yves [ρ]

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I. Introduction

Electricity is seen as an indispensable component of firm performance growth, and the catalyst for the third industrial revolution (Rifking, 2012). Adequate and stable electricity availability is essential to sustain and enhance industrial production, economic growth and development (UNIDO, 2009). This dates back to the 18th century, a period when fossil fuels, particularly coal and oil, laid the foundation for industrial development in Europe and the United States (Sieferle, 2001). Since then, energy has remained a crucial input to industrial production and a key factor in improving people's lives (UNIDO, 2009).

Unfortunately, in many developing countries including Cameroon, the availability of sufficient and reliable electrical service is insufficient and constitutes a major constraint to industrial activities (Amadu and Fambon, 2020). Frequent and prolonged outages characterize service in this part of the world. For example, in Cameroon and Nigeria, power outages last at least 1,000 hours per year (MINEE, 2018; UNCTAD, 2017). Although Cameroon's electricity infrastructure index has improved from 18.20 in 2015 to 20.69 in 2020 (Doing Business Report, 2020), the duration of power outages has only decreased by 8% in Cameroon, with a high frequency of outages (Eneo Report, 2020)[1]. This means that power outages are still a major problem for the efficient operation of businesses that require continuous and reliable availability of electricity.

In addition, the World Bank's Doing Business report in 2020, ranks Cameroon 167th out of a total of 190 countries with a score of 46.1 for the ease of doing business index. On the index "getting electricity", Cameroon is even worse ranked, it occupies the 89th position. On the index of 'reliability of electricity availability and transparency of tariffs', on a scale of 0 to 8, Cameroon scores 3. In addition, 35% of the electricity produced by hydroelectric and gas-fired power plants is lost during transmission (World Bank, 2020).

As a result, about 30% of firms in developing countries including Cameroon own or share a generator, this figure rises to about 50% in South Asia and 35% in Africa (Ukoima and Ekwe, 2019). As a result, industrial firms suffer productivity losses, increases in production costs, decreases in sales and income, etc. (World Bank, 2017; Chamber of Commerce, Industry, Mines and Handicrafts of Cameroon, 2018). The work on the effects of electric deficit on the financial performance (income and costs) of industrial firms leads to a consensus on the negative effects of deficit on the financial performance of firms. On the other hand, the empirical literature on the effects of the electricity deficit on firm productivity yields mitigated results.

For example, Justice (2016) used a quasi-experimental approach and panel data for fifteen Sub-Saharan African countries. It found that a percentage increase in the intensity of power outages results in a reduction in firm-level productivity of 0.6 percent to 1.1 percent. In Cameroon, inadequate and unstable electricity availability has led to an increase in the cost of

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[1] In order to quantify and measure the extent of inequality in the availability of different services, a statistical indicator of inequality was calculated on the values of the African Infrastructure Development Index (AIDI) by country. Indeed, among the statistical indicators in this category is the GINI index, commonly referred to as the concentration index for statistical distributions (a value of 0 indicates perfect equality in the availability of infrastructure services, while a value of 1 indicates extreme inequality).

production for manufacturing firms of about 5 times the original cost of production and a decrease in their income of at least 5% (Tamo et al., 2010; Christopher, 2016).

In contrast, Hardy and McCasland (2019) find that power outages result in a 13% decrease in productivity for Ghanaian firms without workers, and find no effect on productivity for all other firms. Similarly, Firsher-Vanden et al. (2015) examine the effect of the electricity deficit on the performance of Chinese industrial firms and find that due to the electricity deficit, unit production costs increased by 8% but, firms do not experience any productivity loss due to the re-optimization of production inputs by substituting materials for energy (electric and non-electric sources).

These mixed results on the effects of the electricity deficit on productivity in the empirical literature lead us to question the case of Cameroon. Indeed, the power cuts in Cameroon have been going on for 22 years, despite the government's efforts to improve the availability of electricity[2]. Faced with this situation, the majority industrial companies use generators during power cuts. Does the use of generators by companies cancel out the negative effect of the electricity deficit on the productivity of industrial companies in Cameroon?

The aim of this article is to evaluate the effect of the electricity deficit on the productivity of industrial firms in Cameroon. Such an analysis has a double interest. First of all, this paper is in line with the microeconomic analysis of the crucial role of electrical energy on the growth and competitiveness of firms (Asiedu et al., 2021 ; Elliott et al., 2021 Cole et al., 2018). And is a continuation of the work of Thomas et al. (2010) who assessed the economic costs of generator use on the costs of industrial firms in Cameroon. Our study differs from theirs by assessing the effect of the electricity deficit on the productivity of industrial firms.It also contributes to the expansion of the work on the relationship between electricity availability and productivity of industrial enterprises in Cameroon in particular and in developing countries in general, with particular emphasis on the mitigating role of the use of generators in Cameroon.

To achieve this purpose, the rest of the paper is structured as follows: the first section presents the literature review and briefly discusses the crisis in the electricity sector in Cameroon. The second presents the methodology used, the third the results obtained and the economic policy implications.

II. Review of the Literature

The analysis of the effect of fluctuations in the availability of electrical energy on the productivity of economic activities has been the subject of an abundant theoretical and empirical literature, and gained momentum in the mid-19th century. However, interest in the relationship was later fueled by the energy crisis of the1970s that saw the increase in the study of energy costs in the production process and the subsequent effects on industry and the economy as a whole (Jiang et al., 2011). This section presents a review of previous studies that have assessed the effect of electricity availability on industrial productivity.

a) *Theoretical Background*

The link between the availability of electric power and firm productivity is supported by production and cost theory. Indeed, the output of industrial firms depends on the combination of inputs (capital, labor and other factors) available (Beckamnn, 1974 and Solow ,1974). In production theory, factors of production go beyond capital and labor to include other inputs and technology.

The productive role of the availability of electrical energy on the productivity of industrial enterprises is illustrated through the theory of the role of driving industries. At the basis of this theory is the idea that economic activity results not from the action of agents in a competitive situation, but from the specific action of economic units (firms) which, because of their position and size, can play a dominant role (Perroux, 1950). This dominant position is manifested by the induction role that characterizes the motor industries. The limits of this theory, such as the failure of the services of the driving industries (fluctuation of the availability of electrical energy), leads the theorist Kremer (1993) to formulate the O-RING theory, also called the theory of the "theoretical joint ».

The theoretical framework for analyzing the relationship between the supply of electrical energy and the productivity of industrial firms is also anchored in Michael Kremer's "O-RING" theory. Kremer (1993) emphasizes the complementarity of the factors of production. And presents an economic model in which the function of modern production (in particular in opposition to the traditional artisanal production) presents strong complementarities between the factors of production in such a way that, the failure of one of the factors of production as weak as it is it impacts negatively on the output of the production.

In addition, another channel through which the availability of electricity influences the productivity of industrial enterprises is the institutional channel, through the contribution of the institutional theory of regulation. Coase (1960), in his article entitled the social cost problem, describes the conditions for state intervention to compensate for market failure and proposes to compare the costs of private solutions (transaction costs between private agents, which depend in particular on the characteristics of property rights and

[2]The government has built new electric dams from 2015 (Lom pangar, Memve'ele)

the laws that apply to them) and public solutions (the cost of recourse to public intervention) on a basis of equal realism. Les limites de cette théorie à savoir la non couverture des coûts des entreprises publics, fondent les bases de la nouvelle économie publique de la réglementation (NEPR).

b) Effect of the availability of electrical energy on the productivity of industrial firm's

A number of previous studies show that power outages typically result in firms switching to alternative energy sources, which is usually accompanied by an additional cost to firms (Beenstock et al. 1997; Caves et al. 1992). The decision to invest in energy-related assets can be driven by many non-economic factors, as long as those factors influence the marginal benefits of those investments (Oseni and Pollitt, 2013). Firm size, industry and regional differences, and other organizational factors play an important role as economic factors in explaining firms' lighting investment decisions (Abdisa, 2020).

Abeberese et al. (2021) and Oseni and Pollitt (2013) show that the most common strategies used by companies are: using the generator; making less energy-intensive products; changing production time; choosing the business; choosing the location. To this end, about 30% of companies in developing countries own or share a generator (Amadu and Fambon, 2020), this number can reach approximately 50% in South Asian countries and 35% in Africa (Ukoima and Ekwe, 2019). The results indicate that switching to less electricity-intensive products allows companies to reduce productivity losses from outages.

In the context of the electricity blackout differential faced by firms, Abdisa (2020) studies the role of investment in self-generation by manufacturing firms in 13 Sub-Saharan African countries. The results of the study show that companies' investment in self-generation mitigates the negative effect of outages on company performance. The results of the study further reveal that investing in self-generation reduces production losses by 2 to 24% depending on a company's vulnerability to power outages.

On the other hand, Fisher-Vanden et al. (2015) instead find that, in response to electricity shortages, Chinese manufacturing firms shifted from in-house production of intermediate goods to their purchase and experienced no productivity loss. This behavior of Chinese firms is consistent with that of Ghanaian firms, which, in the face of power cuts, are shifting their mix of products to less electricity-intensive ones (Abeberese et al, 2021). This adaptation strategy may have broader implications for the variety of products available to consumers. Furthermore, the results suggest that one of the most commonly employed strategies worldwide is the use of the generator.

In Cameroon, the purchase of a large number of generators and the increase in self-generation capacities are solutions to the regular power cuts used by businesses to cope with the poor availability of electrical energy (Thomas et al., 2010). 1658 generators were purchased by industrial companies in Cameroon from 2001 to 2008, 53% in the agri-food industries, 22% in the metallurgical and chemical industries, and 25% in other sectors (Thomas et al., 2010).

In addition, four lessons emerge from the work on the availability of electrical energy on the productivity of industrial activities. The first group, consisting of the pioneering studies conducted by Kraft and Kraft (1978), supports the energy conservation thesis[3]. The second group supports a growth thesis, so the unidirectional causality goes from electricity consumption to the productivity of economic activities (Shahbaz et al., 2018 and Mawejje and Mawejje, 2016). The third group supports a feedback hypothesis, i.e., a two-way causality between electricity consumption and productivity growth (Belloumi, 2009; Morimoto and Hope, 2004); and the last group supports a neutrality hypothesis, which assumes an absence of causality between the two variables (Akarca and Long, 1980)[4].

III. Crisis of the Electricity Sector in Cameroon

Cameroon was one of the first economies in sub-Saharan Africa to liberalize its energy sector. The adoption of the 1998 Electricity Sector Law led to the privatization of the vertically integrated, state-owned Société Nationale d'Electricité (SONEL)[5]. Nevertheless, total installed generation capacity remained largely stagnant between 2000 (0.8 gigawatts) and 2012 (1.0 gigawatts)[6]. Given Cameroon's growing energy needs and population growth. As a result, Cameroon is facing a serious deficit in electricity availability, although about half of the population is not connected to the grid[7].

[3] This hypothesis argues that, in fact, the availability of electricity has a positive effect on productivity growth, ranging from energy consumption to productivity.

[4] The two variables are interdependent and are affected by energy and economic policies (feedback hypothesis). This neutrality hypothesis means that energy policies, whether expansionary or conservative in terms of electricity consumption, have no effect on the productivity of economic activities.

[5] In 2001, SONEL was acquired by the U.S. company AES Corporation, which became AES SONEL, and was granted a 20-year monopoly on production, transmission and distribution. In 2014, AES SONEL was acquired by a British group, ACTIS, and renamed ENEO Cameroon.

[6] This data is from the installed capacity of electric power from 1980 to 2012 from the Cameroon Data Portal (database), Yaoundé, Cameroon, http://Cameroon.Opendataforafrica.org/sdjsclb/cameroon-electricity-installedcapacity_1980-2012. accessed on March 18, 2022.

[7] Data on electric power availability are from 2012 and are from the (http://data.worldbank.org/indicateur), World Bank Indicators Database.

Inhabitants of major cities (Douala, Yaoundé, Bafoussam) experienced an average of nearly two hours of power cuts per day in 2015. This has probably had an effect on company behavior, since about 35% of companies in Cameroon own a generator[8].

Cameroon's privatization program has not led to a significant increase in production capacity and has not established a fully competitive market. In addition, 35% of the electricity produced by hydroelectric and gas-fired power plants is lost during transmission. The production of electricity is mainly managed by ENEO, the transmission and distribution of electrical energy is managed by SONATREL (Société National de Transport de l'Electricité). Cameroon depends entirely on national resources, with hydroelectricity accounting for 71% of electricity production, the rest being oil and gas. This heavy reliance on hydroelectricity also means that droughts have led to prolonged power outages throughout the country for several years. ENEO has established a program of rationing of electrical energy throughout the national territory, which began in 2009, and is carried out on average 5 days a week in large cities and 7 days a week in the countryside. These power cuts paralyzed the activities of the port of Douala for several days in 2015.

IV. Methodology and Database

In this paragraph we specify our basic model, and then define the variables of the model.

a) Model specification

To identify the effect of electric power availability on the productivity of industrial firms in Cameroon, we follow the path taken by Moyo (2012) and Allcott et al. (2016). We measure Total Factor Productivity (TFP) at the industry level using a Cobb-Douglas type production function as follows[9] :

$$y_i = \alpha_0 + \alpha_1 L_i + \alpha_2 M_i + \alpha_3 K_i + \varepsilon_i \qquad (1)$$

Where y denotes the logarithm of the output of firm i, K is the logarithm of the capital stock, M is the logarithm of production inputs and L is the logarithm of the number of employees in each firm. To calculate TFP, the common approach is to obtain estimates of the elasticities of output with respect to inputs α_1, α_2 et α_3 and treat the TFP as a residual of equation (2.). Thus, we obtain the following TFP:

$$LnTF\hat{P}_i = y_i - \hat{\alpha}_1 L_i - \hat{\alpha}_2 M_i - \hat{\alpha}_3 K_i = \varepsilon_i \qquad (2)$$

Using this method, the TFP estimates from equation (2.12) should be regressed using a second-stage model against a set of determinants, such as the power availability quality variables (2.12), which are clearly not random, even though they are included in the random error term ε_i.

Where $\varepsilon_i \sqcup$ n.i.d [10]. $(0,\sigma^2)$ is necessary for efficient unbiased estimation.

Newey and McFadden (1999) and Wang and Schmidt (2002) argue that, using the variable $LnTF\hat{P}_i$ obtained in equation (2.) in the second step leads to both inefficient estimates (in the form of inconsistent standard errors and, therefore, t-value determinants of TFP[11]. Thus, Wang and Schmidt (2002) argue that, as this approach results in potentially biased estimates since some factors that determine output have been omitted from equation (2.), the estimates of the estimated elasticities will suffer from an omitted variable problem and thus $LnTF\hat{P}_i$ will be incorrectly measured. On the other hand, two-step approaches are inefficient because they ignore any cross-equation restrictions. Since they do not take into account the correlation of error terms between equations (Harris and Trainor, 2005). In addition, a more serious problem associated with this technique is omitted variable bias. Thus, the regression of the first stage of equation (1) ignores other known determinants of output, and standard econometric theory indicates that the elasticities estimated from equation (1) will be biased accordingly. Thus, the estimates obtained in the second stage of the regression will also be biased, regardless of whether the factors of production and the variables that determine TFP are correlated or not[12]. Wang and Schmidt (2002) show that for two-stage estimates of productive efficiency using the stochastic frontier production approach, the boosts indicate that the bias due to the omitted variable problem is substantial.

The preferred technique is therefore to include the determinants of production and thus of TFP directly in equation (2.), as this avoids any problems of inefficiency and bias and therefore allows direct testing of whether these determinants are statistically significant. Since TFP is defined as any change in output that is not due to changes in inputs, we include these determinants directly in equation (2.) as follows[13]:

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[8] Business Survey Database (http://www.entreprisesurveys.org/), World Bank. accessed on March 18, 2022.

[9] We assume here that TFP is a function of firm age, foreign ownership, quality of electrical infrastructure… Therefore, we substitute TFP for these variables and assume that they are linearly related. This approach was used by Harris and Trainor (2005).

[10] n.i.d. $(0,\sigma^2)$ means that the error term is normal and independently distributed with a mean of 0 and a variance of σ^2. This is one of the most important assumptions of classical linear regression, and allows us to test the significance of the model and the parameters using the F-test and t-test.

[11] The t-value is the ratio of the estimated coefficient divided by the standard error and used in a particular regression model. In general, the higher the t-value, the greater the confidence we have in the coefficient as a predictor of the model.

[12] In this case, all the factors that determine production and those that determine TFP are specific to the firm and therefore correlated.

[13] Here we assume that TFP is a function of firm age, foreign ownership, quality of power availability, etc., so we substitute TFP for these variables and assume that they are linearly related. This

$$y_i = \alpha_0 + \alpha_i L_i + M_i + \alpha_3 K_i + \beta_i PINFRA_i + \beta_2 X_i + \varepsilon_{ii} \quad (3)$$

Where $PINFRA_i$ is the measure of the availability of electrical energy and X_i is the vector of variables that contains all other productivity effects, such as age, foreign ownership, size and export status. We include generator usage to verify that the use of the generator minimizes the negative effects of power outages on productivity.

b) Data source and measurement of variables

The data used for the estimation are cross-sectional data. They come mainly from the 2016 World Bank Enterprise Survey (WBES) database, which, based on a sample of 120 industrial firms, provides the inputs and outputs of firms to calculate various productivity measures such as Total Factor Productivity (TFP). The sample has the required properties of representativeness and includes specific information on the commercial and business environment in which Cameroonian industrial enterprises operate, and the internal characteristics of the enterprises.

c) Measurements of variables

Given the theoretical framework thus chosen and in view of the previous theoretical and empirical studies and the available data, three types of empirical variables are used in the estimations. The explained or dependent variable, the variables of interest and the explanatory or independent variables.

The dependent variable in our production function is Total Factor Productivity measured by gross output. Our variable of interest is availability of electrical energy, measured in our study through three alternative methods. The first measure (outage1) is the average number of outages in a month that businesses experience; the second measure (outage2) is the average duration of outages; and the third measure (outage3) is businesses' perception of electricity as a constraint to doing business. It is a binary variable that takes the value 1 if the poor availability of electricity is perceived as an obstacle by the company and 0 otherwise. This variable is constructed from a 5-modality categorical variable listed as: not a barrier; minor barrier; medium barrier; major barrier; very severe barrier. These measures are the primary measures used in the survey methodology.

We also include in the production function the other determinants of productivity that constitute the explanatory variables. We have: age of the company, which is calculated as the difference between the year the company was created and the year the survey was conducted. Company size is captured in this study by the number of permanent employees. Access to credit is also introduced into the analysis to capture the financing constraint in the evaluation of factor productivity. It is captured by a binary variable that takes the value 1 if the firm has access to credit and o in the opposite case.

The exporter status is a binary variable that takes the value 1 if the company exports and 0 otherwise. It measures the degree of participation of the company in foreign trade outside the local market. Gender is also introduced into the analysis to measure the degree of effectiveness of women in corporate management. It is a binary variable that takes the value 1 if the leader of the company is a woman and 0 if the leader is a man. Individual ownership is a binary variable that takes the value 1 if the business is individually owned and 0 other legal forms. Innovation has been recognized in the theoretical literature as a process for improving the performance of companies (Shumpeter, 1942). it is captured in this study by a binary variable that takes the value 1 if the company has introduced new or improved processes and 0 in the opposite case.

d) Estimation method

The method we use to estimate the effect of electric power availability on the productivity of industrial firms will be in two steps: The first step will be to evaluate total factor productivity through the Cobb-Douglas production function approach. And the second stage alternately uses each measure of the determinants of productivity to assess the factors that can vary the productivity of industrial firms using the instrumental variables method. In particular the method of Ordinary Double Least Squares (IV-2SLS). The 2SLS technique is preferred because it captures the potential effects of endogeneity in the relationship between electric power availability and productivity of industrial firms (Mensah, 2016; Allcott et al., 2016).

Indeed, one of the assumptions of Ordinary Least Squares is that there is no correlation between the explanatory variables and the residual in the theoretical model. We speak of endogeneity when this assumption is violated. The literature formally establishes an endogeneity bias related to the correlation between poor availability of electrical energy and productivity. For example, rapid economic growth can lead to increased demand for electricity which leads to shortages or poor institutions can lead to insufficient power supply and also reduce productivity. Performing a simple linear regression (OLS) would lead us to biased results.

e) Econometric results

The econometric results concern on the one hand the results of the first step via the use of the Cobb-Douglas production function and on the other hand the results of the estimation via the method (IV-2SLS). These results are contained in the tables below.

approach was used by Harris and Trainor (2005) and Njikam et al, (2005).

Table 1: Distribution of TFP among industrial companies

Size of the company	Distribution	Mean	Std. dev.	Min	Max
Small firm's (5-19employees)	Total Factors Productivity (TFP)	112.3105	34.34706	27.93128	179.9618
Medium (20-99 employees)	Total Factors Productivity (TFP)	130.0197	44.98602	17.08576	207.9618
Large companies (>100 employees	Total Factors Productivity (TFP)	140.8342	76.97052	5.247084	260.2875

Source: Author based on WBES data, 2016

Table 2: Result of the estimation of the effect of the availability of electrical energy on TFP

VARIABLES	TFP (1)	TFP (2)	TFP (3)
Frequency of power outage	2.384e+08		
	(0.198)		
Severity of the the power outage		6.571e+09	
		(0.197)	
Duration of the interruption			3.201e+06
			(0.202)
Age	2.597e+08	2.241e+08***	2.142e+08**
	(1.532)	(3.011)	(2.134)
Size	3.614e+07***	3.549e+07***	3.706e+07***
	(4.728)	(5.490)	(3.433)
Export	1.560e+09	1.061e+09	1.380e+09
	(0.338)	(0.384)	(0.363)
Gender	2.834e+08	7.647e+08	1.627e+09
	(0.0838)	(0.349)	(0.352)
Access to credit	4.490e+09	5.252e+09**	5.473e+09*
	(1.216)	(2.011)	(1.740)
Innovation	2.551e+09*	3.046e+09	1.856e+09
	(1.717)	(1.095)	(0.477)
Individual ownership	3.653e+09	3.175e+09	1.935e+09
	(0.891)	(1.287)	(0.347)
Constant	-1.203e+10	-1.446e+10	-9.609e+09*
	(-0.695)	(-0.487)	(-1.718)
Prob	0.000	0.000	0.000
Observations	89	89	89
R-squared	0.479	0.470	0.495
Pro> chi2	0.000	0.000	0.000
Sargan	0.314	0.553	0.421

Note: *,**,*** correspond to the significance level at 1%, 2% and 10% the values in brackets correspond to the z-statistics

Source: Author based on WBES data, 2016

V. Interpretation of the Results

Before proceeding to the interpretation of the coefficients associated with the different variables, we will discuss the econometric validity of the model, the validity tests of the instruments and the endogeneity. Thus, from an econometric point of view, our models are overall worthy of interest. The probability prob>chi2 is each time lower than 1%, which allows us to conclude that the model is globally significant. Furthermore, the Sargan over-identification test is recommended and used in several studies to test the validity of the instruments. In our case, our P-value is higher than 5%.

We performed the above estimates, using different measures of the quality of electric power availability in an attempt to test whether our estimates are robust to changes in the specification of the variables. The variable that is of central interest in this study is the poor availability of electrical energy. Our argument is the following: the industries that do not interrupt their production when there is an interruption or failure of electrical energy, because they self-generate electricity, their productivity is not affected.Moreover, the results of the estimates largely confirm our expectations. Thus, using the number of hours without electricity (duration of the outage), the quality of the electrical infrastructure has no effect on productivity. This is also true when using the severity and frequency of power outages. These results corroborate those found by Firsher-Vanden (2015), Cissokho and Seck (2013).

The most logical explanation given in the literature is that the use of the generator cancels out the negative effect of poor electrical power availability on productivity. Since, when there is an interruption of electrical energy, the industries do not interrupt their production, they continue their production by self-generating electrical energy thanks to the generating set. These results support the argument that companies that can generate their own electricity have the advantage that the continuity of their production does not depend on the availability of electrical energy. In other countries, such as China, industries replace the production of intermediate goods with their purchase (Firsher-Vanden et al., 2015). Instead, this technique increases the unit cost of production by 8%. Similarly, Allcott et al. (2016) in India show that poor availability of electric power does not affect the productivity of Indian manufacturing firms, but reduces the revenue of these firms by 5-10% and the producer surplus.

Beyond the variable of interest, our regression results reveal that other firm-related attributes have a significant effect on productivity. The results suggest that being older and probably more experienced has a positive and significant effect on firm productivity. Therefore, the older a company is, the more it improves its productivity. Our results show that the older the industry, the more it leads to an increase of 2.24% (duration of the cut) and 2.14% (severity of the cut) in TFP respectively. The effect of the age of the industrial firm on TFP is positive due to the learning-by-doing that occurs through the accumulation of experience in the production process. This result is in line with those of Bui and Nguyen (2021) and Moyo (2013).

In addition to age, which is an internal characteristic of the firm, and which has a positive effect on TFP, innovation also has a positive and significant effect of 10% on TFP of industrial firms. Indeed, a 1% increase in innovation increases productivity by 2.55%. The regression results show that innovation is a robust and significant determinant of productivity. These results are in line with those of Cissokho (2020). Similarly, industry size, a variable of the internal characteristics of firms has a positive and significant effect at the 1% level on its TFP, when approximated respectively on the three measures of electrical energy availability. The theoretical rationale for this result is that large and medium-sized companies are easy adopters of technology and easy innovators. These results are in line with those of Bui and Nguyen (2021) and Cissokho (2020).

VI. Conclusion

The objective of this paper was to evaluate the effect of the availability of electrical energy on the productivity of industrial firms in Cameroon. Using World Bank survey data from companies of the year 2016, The results of the econometric estimates from the IV-2sls model show that the poor availability of electrical energy has no significant effect on the productivity of Cameroonian industrial firm's. This insignificance of the poor availability of electricity on the productivity of industrial firms is explained by the continuity of the production process by entrepreneurs during power outages, made possible by the use of generators by Cameroonian manufacturers.

The economic implication of this result is that the poor availability of electric power in Cameroon does not affect the productivity of industrial firms. The strategies adopted by Cameroonian industries to counter the negative effect of power outages are effective in the short term. The use of the generator by Cameroonian industrialists is an effective strategy to counter the negative effect of power outages on the productivity of industrial enterprises in the short term.A future perspective of this study would be to assess the effect of the electricity deficit on the productivity of service firms.

We end by making three recommendations that governments may implement to mitigate the deficit of électricity : First, create MAGZI (Mission d'Aménagement et de Gestion des Zones Industrielles) zones around major hydroelectric infrastructure investment projects to reduce distribution and transmission losses. Secondly, intensify investments in solar, biomass and wind power generation, taking into account the specific energy needs of each region. And finally, reduce import taxes on the main materials used in the production of solar, wind and biomass energy.

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