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Abstract

This study examines the influence of the investment climate on the productivity of manufacturing industries in Nigeria. The study is conducted in two phases: in the first phase, an econometric production function for Nigerian manufacturing industries is estimated to produce a measure of total factor productivity (TFP) for each firm; in the second stage, variation in TFP is statistically related to the indicators of investment climate as well as firm characteristics. The analyses use 2009 World Bank Enterprise survey data on Nigeria. The results show systematic variations in investment climate indicators across various industries in Nigeria. The indicators of poor investment climate – power outages, unofficial payments, losses in transit due to breakage or spoilage and tax burdens – have significant negative effects on the TFP of manufacturing industries in Nigeria. Increasing power outages by one hour per month could reduce TFP by 0.06%, while a 1% rise in unofficial payments could lead to a decline in TFP of about 1.8%. Investment climate indicators, such as management time dealing with regulations, and percentage of firms owned by private domestic individuals, companies and organizations have a positive influence on the TFP of manufacturing industries.

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1.0 Introduction

Globalization and expanding international markets in many developing countries offer opportunities for their producers to compete in emerging national and international markets. In this world of competition, producers from developing nations need to gain optimal control over production, trade and distribution in order to: (i) operate in a cost-effective way; and (ii) guarantee the quality and the value added to their products (Dolan and Humphrey, 2004). While some developing countries, such as China, India and Brazil, take advantage of globalization and are doing well, manufacturing industries in African countries still lag behind.

Generally speaking, many of the differences in industrial performance between Africa and other developing countries are linked to the business investment climate in Africa, including the physical, institutional and regulatory environment for private sector initiatives. In recent times, the cost of doing business in Africa is estimated to be between 20% and 40% above other developing nations.

In Nigeria, evidence of lower productivity relative to other developing nations is well documented by Iarossi and Clarke (2011). They discovered that firms in Kenya were about 40 per cent more efficient than firms in Nigeria, firms in Russia were almost twice as productive, and firms in South Africa almost four times as productive. In various developing countries, such differences have been attributed to two main factors: first, internal factors such as technology, capital, labour, and marketing strategies. The second factor involves the investment climate, which comprises government policy and the environment in which the industries operate. Until now, very few studies have tried to find an explanation for the poor performance of manufacturing firms in Nigeria. Two major research projects that employed firm-level data to explore performance of Nigerian manufacturing industries were those by Seker and Saliola (2018) and Iarossi and Clarke (2011). The former classified Nigeria among nations with low average TFP in the food, garment and chemical industries, while the latter merely described the extent of investment climate problems in Nigerian cities. Other studies (e.g., Chete and Adenikinju, 2002 and Ajetomobi, 2011) employed time series data. Chete and Adenikinju (2002) investigated the role of trade policies in fostering productivity growth in the Nigerian manufacturing sector between 1962 and 1985. They found a positive correlation between trade liberalization and productivity growth. Ajetomobi (2011) included Nigeria in his study of the total factor productivity of selected agricultural commodities in the Economic Community of West African States (ECOWAS). The study showed better productivity for the nation's agricultural sector than when it was included in the estimates of agricultural productivity in Africa. Generally speaking, specific work on the firm level performance of manufacturing firms in developing nations is scarce. The closest so far have been those by Veeramani and Goldar (2004) on India; Escribano and Guasch (2005) on Guatemala, Hondura and Nicaragua; as well as Dollar et.al. (2005) and Bastor (2004). A major reason for this has been lack of reliable and adequate firm-level data.

Against the above background and given the availability of World Bank Enterprise data on Nigeria, which cover 26 cities and 15 manufacturing industries, the research questions of interest in this study are: (i) what are the productivity levels of manufacturing industries in Nigeria; and (ii) what is the influence of investment climate on the total factor production of manufacturing industries in Nigeria?

The research objectives are to:

i. estimate the total factor productivity across manufacturing industries in Nigeria and:

ii. analyze the effects of investment climate on the total factor productivity of manufacturing industries in Nigeria.

In view of the above-stated specific objectives, the following hypotheses were tested: There is no difference in the TFP of manufacturing industries in Nigeria; and there is no relationship between total factor productivity and the investment climate of manufacturing industries in Nigeria.

2.0 Literature Review

2.1 Theoretical Framework

This study is based on Solow's neo-classical growth theory (Solow, 1957). Growth accounting, according to Solow (1957), aims at breaking down output growth into the growth of capital and labour inputs, as well as growth in efficient use of the production factors. The efficiency is usually measured by TFP. In the baseline, Solow (1957) set up a neoclassical production function:

$$Y_t = A_t F(K_t, L_t) \tag{1}$$

where Y_t is aggregate output, K_t is the stock of physical capital, L_t is the labour force and A_t indicates the TFP, which is Hicks neutral. This equation can be transformed in terms of the growth rates of the variables. For instance, given a Cobb-Douglas production function:

$$F(K_t, L_t) = K_t^{\alpha} L_t^{1-\alpha} \text{ with } 0 < \alpha < 1. \tag{2}$$

Taking natural logarithms and differentiating both sides of Equation 1 with respect to time t, the growth rate of aggregate output can be expressed as:

$$\dot{Y}/Y = \dot{A}/A + \alpha(\dot{K}/K) + (1-\alpha)(\dot{L}/L) \tag{3}$$

The growth rates of physical capital and labour are weighted by α and $(1-\alpha)$. The weights are the respective shares of rental payments for capital and labour in total income. With available data on α and the growth rates for output, physical capital and labour, TFP growth can be computed from Equation 2 as the residual. Hence, TFP growth is often referred to as the Solow residual. Within the context of the Solow model, the primary objective of firms is profit maximization (Acemoglu, 2008). The model assumes homogeneity of firms in the economy. This implies that all firms in the economy face the same production function, hence it is possible to assume a production function. The efficiency with which factors of production are changed into output is incorporated in a component of the model which represents the factor of technology (Weil, 2013).

Measurement is crucial in estimating the Solow residual. Major issues are associated with aggregation of the output, output and input quality adjustment, and lags in the processes of innovation, learning and implementation of technologies. In spite of these measurement problems, various works have analyzed the determinants of the Solow residual with an emphasis on embodied and disembodied technological progress. The two major rationales for choice of productivity measurement methods are: (i) the purpose of productivity measurement and, in many instances, (ii) the availability of data. Table 1 shows the main productivity measures. The partial measures in columns 2 and 3 were restricted to labour and capital productivity, which are the most frequently used partial factor productivity measures. Total factor productivity is either in the form of capital-labour TFP, based on a value-added concept of output, or in the form of capital-labour-energy-materials TFP (KLEMS), based on a concept of gross output. Among those measures, value-added-based labour productivity is the single most frequently computed productivity statistic, followed by capital-labour TFP (Mayer and Ottaviano, 2007).

Table 1: Overview of main firm-level productivity measures

Types of output	Types of input measures			
	Labour	Capital	Capital labour	Capital labour and intermediate inputs
Gross output	Labour productivity	Capital productivity	Capital labour TFP	KLEMS TFP
Value added	Labour productivity	Capital productivity	Capital labour TFP	
	Partial factor Productivity		Total factor productivity	

Source: Compiled from Escribano and Guasch (2005).

In the literature, the estimation of TFP has been done using either parametric or non-parametric approaches. In the parametric approach, econometric techniques are applied to estimate parameters of a production function to obtain direct productivity measures. In the non-parametric method, properties of a production function and results from the economic theory of production are used to identify empirical measures that provide a satisfactory approximation of the unknown "true" and economically defined index number (Solow, 1957; Hall, 1990; Foster et al., 1998; Bartelsman and Doms, 2000; Hulten, 2001; Diewert and Nakamura, 2002; Jorgenson, 2003; Jorgenson et al., 1987; Olley and Pakes, 1996; Barro and Sala-i-Martin, 2004 and Enghin et al., 2014).

In this study, the parametric approach is adopted because of a general consensus on the following limitations of non-parametric methods: (i) significant data requirements; (ii) timely availability of input-output tables that are consistent with national accounts; (iii) difficulties inherent in inter-industry links and aggregation across industries, particularly in the case of value-added-based TFP measures; and (iv) necessitates including constant returns to scale and competitive input markets.

The estimation of TFP using the parametric approach often involves formulating various hypotheses regarding the technology of production. The most common ones are the Cobb-Douglas and the translogarithmic production functions. Although both present good mathematical properties, the elasticities of the production to the inputs are easy to read and interpret with the Cobb-Douglass technology. We therefore estimate a Cobb-Douglas model expressed as follows:

$$Y_{it} = A_i K_i L_i M_i \tag{4}$$

In logarithmic form:

$$\ln(Y_{it}) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + \varepsilon_i \tag{5}$$

Where A is TFP, Y is gross output, K is capital input, L is labour input, M is material input, ε is an unobserved productivity shock, and i is an index of industries. The study assumes that all firms are price takers and wages differ across various industries. Hence, the number of employees is used to define the labour variable instead of value units. The natural logarithm of the TFP index is estimated as the residual term in the econometric production function. It is important to bear in mind that the TFP analysis in this study is based on cross-sectional data at the firm level collected in one year, or over a relatively short space of time. It is therefore assumed that all firms have access to the same level of technology. Therefore, variations in TFP should be attributed principally to variations in efficiency rather than variations in technology.

In order to control for the quality of firms' management, the years of schooling (educ) of the firms' managers is included in the model. This means that Equation 5 is expressed as:

$$\ln(Y_i) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + \beta_e \ln(EDUC_i) + \varepsilon_i \tag{6}$$

Several potential measurement errors are expected when estimating the production function defined in Equations 5 and 6. Given the availability of just one source of data, it might be difficult to correct the issue. However, it is helpful to take into account several problems with variable measurements in order to arrive at a conclusion on the validity of the findings. Enghin et al. (2014) raise measurement error in the output as an important issue; a good reason for this is that companies produce several outputs. Researchers usually use deflated revenue, or value-added output, because output quantities are sometimes not reported directly. This becomes a problem if there are differences in market power between producers that affect revenues. This would show up as productivity differences when estimating production functions, even though it is not. It could also be that a company has market power in one of its product markets and not in others, but as all revenue is aggregated this is not taken into account. Enghin et al. (2014) also raise concerns about measurement error in inputs. For example, labour is often measured as the average number of employees at a certain time or the number of employees in full-time equivalents. This can be problematic because it implicitly assumes that all workers are equally productive. Conversely, capital is usually included as the book value of the tangible fixed assets, but this might not reasonably capture the benefits producers obtain from them. Furthermore, the book value does not show to what extent the capital is utilized (Fiechter and Meyer, 2010).

Equations 5 and 6 can be estimated using the Ordinary Least Squares (OLS) regression method, assuming a consistent exogeneity of inputs and the error term. If all relevant characteristics of individual firms are controlled for, there should be no relevant unobserved characteristics. A review of the literature shows that using the OLS approach to estimate a firm's productivity may be inappropriate as inputs are probably determined simultaneously with the firm's past productivity, which leads to a potential correlation between input levels and unobserved firm-specific shocks (Damijan et al., 2011). This endogeneity in OLS estimates usually shows up as a persistent serial correlation, and yields biased parameter estimates. In order to solve the problem of the endogeneity of some of the inputs, Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg and Caves (2003) assumed a structural approach. A shortcoming of the approach is that it does not fit well with annual data as it assumes a timing of input decision structure. Therefore, in this study, the production function equation is first estimated based on country averages: averages were calculated for firm capital, labour and output for each of the 26 city surveys, and a regression estimated using these 26 observations. This approach is known in econometrics as the "between estimator" approach because the variation between cities is the source of information for estimating the effects on productivity; this is compared to the "within" approach. The same procedure is followed as all investment climate variables are taken as city-sector averages of firm-level observations, as suggested by Dollar et al. (2005), before accounting for the influence on industry and firm-level TFP.

As a form of robustness check, industry dummies are included in the model. The model then becomes:

$$\ln(Y_i) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + industry_i + \varepsilon_i \quad (7)$$

$$\ln(Y_i) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + \beta_e \ln(EDUC_i) + industry_i + \varepsilon_i \quad (8)$$

In these equations, industry denotes industry dummies. In addition to capturing productivity differences across various industries, industry dummies will control for other unobservable traits such as industrial disputes, trade distortions, and influence of industry-specific policies. The validity of the assumption of common technology is tested by allowing the regression coefficients to vary by industry. The equations are as follows:

$$\ln(Y_i) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + \beta_e \ln(EDUC_i) + \beta_i industry_i * \ln(L_i) + \beta_j industry_i * \ln(K_i) + \varepsilon_i$$

$$\ln(Y_i) = \ln(A_i) + \beta_k \ln(K_i) + \beta_l \ln(L_i) + \beta_m \ln(M_i) + \beta_i industry_i * \ln(L_i) + \beta_j industry_i * \ln(K_i) + \varepsilon_i \quad (9)$$

2.2 Empirical Literature

Several studies have been carried out in order to understand large and persistent productivity differences among industrial organizations, and the relationship between firm-level productivity and investment climate. Enghin et al. (2014) discovered that in U.S. manufacturing industries at the 4-digit Standard Industrial Classification (SIC), the 90th percentile plant within the productivity distribution produces nearly double the output of the 10th percentile plant with the same inputs. Hsieh and Klenow (2009) find productivity differences at a ratio of 5 to 1 in both India and China. Some of the reasons for such differences include degree of competition, size of sunk cost, interaction of market rivalry and technological spillover, as well as interaction of firms' structure with organizational structure (Schmitz, 2005; Collard-Wexler, 2013; Nicholas et al., 2007; Maksimovic and Phillips, 2002; Schoar, 2002 and Hsieh and Klenow, 2009). Other relevant factors that explain productivity differences include human capital, incentive pay, managerial skills, trade patterns and labour market dynamics (Abowd et al., 2005 and Lazear, 2000).

With the availability of more recent enterprise data collected and collated by the World Bank, more empirical studies (Ba Trung and Kaizoji, 2017; Kinda et al., 2015; Manole and Spatareanu, 2015 and Şeker, 2017) show that investment climate plays a significant role in driving firms' production and costs. The papers generally show that manufacturing firms in developing countries are exposed to international competition. They specifically indicate that small and medium-sized domestic firms dominate developing countries' industrial sectors and exhibit a relatively high sensitivity to investment climate limitations. Şeker and Saliola (2018) recently provided the groundwork for testing various stylized facts about TFP and related factors such as exporting, innovation, access to finance, foreign ownership, and regulation across developing countries. Conceptually, some of the early and later studies differ in their approaches to productivity measurement, choice of investment climate indicators to include in the model, and how different estimation problems are addressed.

Several methods have been developed to explain the relationship between investment climate (IC) and firm-level productivity. These include: OLS, Solow growth model, fixed-effect regression, production function, production frontier method, stochastic frontier production function and the inefficiency model classic technique (Escribano, et al., 2005; Kinda, et al., 2015; Liu and Nishijima, 2012; Olley and Pakes, 1996; and Dollar et al., 2005. Kinda et al. (2015) examined firm productivity and investment climate in developing countries using the following methods: (i) partial labour productivity (LP), defined by the ratio of the value added (Y) to the number of employees (L); (ii) capital productivity, defined as the value added to capital stock; and (iii) parametric technical efficiency, which accounts for random noise and does not consider the whole residual as a TFP measure, unlike in the Solow approach. The study revealed the dimensions of the investment climate in which industry could assist manufacturing industries in the Middle East and North Africa (MENA) to be more competitive globally. The advantage of this method, based on the Solow residuals, is that it does not require inputs to be exogenous or input elasticity to be constant. The disadvantage of this approach is that it necessitates having constant returns to scale and competitive input markets. The research study by Dollar et al. (2005) determined the investment climate and identified reforms that would lead to higher productivity, more efficient investment, and ultimately more job creation and growth, and thus control for city characteristics as there might be externality from other firms in the city.

Moreover, many studies were carried out on the key determinants of the investment climate and TFP, which include: economic and political stability, rule of law, infrastructure, approaches to regulation and taxes, functioning of labour and finance markets, and broader characteristics of governance such as corruption, and thus proposed that a good investment climate fosters productive private investment and economic growth by creating opportunities for the private sector to invest, create jobs, and lay the foundations for long-term business success (Fan et al., 2007; Augier et al., 2010 and Escribano et al., 2005). However, Escribano et al. (2005) specifically evaluated the impact of IC variables and other firm control (C) characteristics on several productivity measures and discovered that their estimates reveal a consistently high impact of investment climate on productivity. Their policy implications were clear in that investment climate was shown to be an important factor and the relative size of the effect of the different investment climate variables reveals where reforms are required. The result obtained in terms of investment climate on TFP revealed that the poor performance of Nigerian firms were due to many factors, such as electricity, telecommunication, transport, corruption, labour regulation, customs and license permits, access to finance, access to land, macroeconomic environment, tax rates and tax administration. Hence, their study focuses on constraints in the business climate and the serious costs they impose on Nigerian firms (Iarossi and Clarke, 2011 and Augier et al., 2010). However, Augier et al. (2010) based their report on small firms, and/or those that do not export and/or those with no access to foreign capital. Moreover, many studies reported that TFP is a multi-factor productivity measure which represents the efficiency of the firm in changing factor inputs into outputs, which can be influenced by many factors, including technology, managerial quality and incentives, corporate governance, government policies and, of course, various dimensions of the investment climate that eventually make a significant contribution to firm-level productivity (Escribano et al., 2005; Fan et al., 2007 and Kinda et al., 2015).

3.0 Research Methodology

3.1 Description of Dataset

Following the ISIC (revision 3.1) classification, the following industries were covered by the 2009 World Bank Investment Climate Survey in Nigeria: all manufacturing sectors, construction, retail and wholesale services, hotels and restaurants, transport, storage, and communications and computer and related activities. The manufacturing coverage included the following sub-sectors: food and beverages, garments, textiles, machinery and equipment, chemicals, electronics, non-metallic minerals, wood and wood products, metal and metal products and other manufacturing industries. The distribution is presented in Table 2.

Table 2: Types of industries

Industry type	Industry	Frequency	Percentage
Manufacturing	Food	242	7.67
	Garments	169	5.35
	Textiles	14	0.44
	Machinery and equipment	13	0.41
	Chemicals	30	0.95
	Electronics	2	0.06
	Non-metallic minerals	210	6.65
	Wood, wood products and furniture	414	13.11
	Metal and metal products	263	8.33
	Other manufacturing	233	7.38
Retail	Retail	643	20.37
Rest of the universe	Information technology	13	0.41
	Construction and transport	133	4.21
	Hotels and restaurants	635	20.11
	Other	143	4.53
	Total	3,157	100

Source: Authors' own calculations.

The importance of each industry was based on three factors: gross output, value added and employee, which is presented in Table 3. The food and beverage processing sector as a whole is the second largest manufacturing group in Nigeria in terms of gross output, value added and number of employees, coming in after metal and metal products. The sector includes processing, packaging, domestic distribution, and exports of packaged staples (e.g., rice), branded food products (e.g., pasta) beverages (e.g., juices and carbonated drinks), and other edibles. As shown in Table 3, there are large differences in the size of the different industries included in the enterprise survey. The six largest industries account for more than 75% of total gross output, value added and number of employees. These include hotels and restaurants, retail, wood and wood products, metal and metal products, food and beverages, and non-metallic minerals. Given the priority accorded to food and beverage processing, the industry is expected to be more productive than others, but Table 4 shows that it is fifth in order of importance based on gross output, value added and number of employees.

Table 3: Importance of industries

Industry	Gross output	Value added	Employee
Chemicals	1.07%	1.05%	1.01%
Electronics	0.11%	0.12%	0.14%
Food	7.24%	7.17%	7.31%
Garments	5.34%	5.38%	5.28%
Machinery and equipment	0.54%	0.54%	0.52%
Metal and metal products	9.02%	9.04%	9.02%
Non-metallic minerals	7.03%	7.13%	7.26%
Other manufacturing	7.24%	7.25%	7.105%
Textiles	0.54%	0.52%	0.53%
Wood, wood products and furniture	12.65%	12.71%	12.58%
Retail	19.56%	19.42%	19.34%
Construction and transport	4.15%	4.17%	4.23%
Hotels and restaurants	20.52%	20.50%	20.58%
Information technology	0.37%	0.40%	0.40%
Other	4.59%	4.63%	4.71%
Total	100.00	100.00	100.00

Source: Author.

Given the considerable differences in output and value added across industries, the main focus of this study is to test whether such differences can actually be traced back to investment climate challenges facing firms. Therefore, the results and discussion in the next section begin with a succinct description of the investment climate for the major industries.

3.2 Investment Climate

A general list of various quantitative measures of the investment climate collected by the survey is presented in Table 4. The list sometimes contains multiple indicators covering a similar theme. For example, access to finance is made up of information on use of overdraft facilities as well as the share of firms that have a bank loan, while electricity includes duration of power outages in number of hours per month, percentage of electricity from a generator, and losses due to power outages measured as a percentage of total sales. Within the same theme, the correlation among the indicators is very strong. Thus, insignificant variables are dropped in the empirical analysis in the next section. The overall list of indicators in the survey are: duration of power outages, losses due to power outage as a percentage of total sales, percentage of electricity generated from generators, access to land, loss in transit due to breakage and spoilage as a percentage of sales, cost of security, management time in dealing with regulation, unofficial payments, days to register a phone line, water from public sources, inspection time, taxes, overdraft facilities and shares made up of bank loans. The summary of descriptive statistics is presented in Table 4.

The table indicates that there is a high rate of power outage in Nigeria. The high level of power outages means that Nigerian industries need standby generators for effective business operations. In respect of duration of power outages in number of hours per month, chemical and other industries are the worst hit (281.4 and 293), followed by food and beverage (255.8), and garments (242.5). The figures translate to more than 10 days per month of power outages in those industries. While it is expected that large firms in any location will have their own power generators, for small and medium enterprises (SMEs), which constitute the largest proportion of various manufacturing industries in Nigeria, the cost of maintaining a power generator might be quite high and worrisome. Thus, another measure of reliable power supply is the proportion of firms operating with their own generators. Apart from the electronic industry, more than 60 per cent of total electrical utilization by Nigerian manufacturing industries does not come from the public grid, but from their own generators. For machineries, chemical and other industries, the proportion is more than three quarters. In terms of losses due to power outages as a percentage of sales, the food and beverage industries have the greatest loss, followed by the chemical industry. This shows that electricity is more important to the food and beverage industry than other industries in Nigeria.

After electricity, the next greatest concern is access to finance, and the survey provided information about the financial products used by manufacturing industries as well as their perceptions about access to and cost of finance. Table 4 shows that the three industries with the biggest overdraft facilities are textiles, food and beverages, and chemicals. The share of firms with a loan from a bank or financial institution also varies quite a bit across the manufacturing industries. The responses range from a low of 0% in electronics, to 12.3% in chemicals and 5.2% in food and beverages. A major reason for the low share might be high demand for collateral security. The collateral requirement as a percentage of the loan is as high as 282.8% for the food and beverage industries.

Another question that relates to the investment climate indicator is how many days it took to secure a phone line. The results show that this appears to be good for all manufacturing industries, apart from wood (less than 16 days). An obvious reason for this success might be the privatization of the Nigerian telecommunication industry, which attracts competition among various service providers and hence leads to an improvement in efficiencies. The survey also asked how many times per year the firms are visited by government inspectors. The key issue is the extent to which this varies across the manufacturing industries within the country. Table 4 indicates that the reported number of inspections is generally low. However, it is higher in the food and beverage industries (3.7 per year) and in China (28) than in other industries or areas. A related question is how much time management spends dealing with government regulations. Here the responses provide a rather different picture. The chemical industries have the highest reported time, 3.7% of management time, compared to 4.9% in chemical, and 4.6% in food and beverages. The survey also includes questions about corruption in terms of unofficial payments. The highest indicator of corruption is reported by the textile industries (6%) followed by other manufacturing industries (5.4%) and electronics (5%). The lowest is reported in the garment industry.

In summary, there is very significant variation in many of the investment climate measures across Nigerian manufacturing industries, so the potential is there to explain differences in the performance of the industries based on variations in the investment climate.

Table 4: Sample means of investment climate indicators

Industry	Food	Garments	Textiles	Mach.	Chem.	Elect.	Non-metal	Wood	Metal	Other
Power outage	255.8 (235)	254.4 (166)	195.5 (13)	242.5 (12)	281.4 (28)	54.0 (2)	222.8 (162)	238.4 (401)	231.5 (250)	293.1 (216)
Mgt time	4.6 (242)	3.7 (169)	1.9 (14)	4.9 (13)	7.0 (29)	3.0 (2)	2.9 (210)	3.5 (414)	3.7 (263)	5.2 (233)
Loss in power outage	6.9 (173)	3.6 (113)	4.6 (12)	3.7 (10)	6.5 (17)	1.0 (2)	4.4 (131)	3.2 (308)	4.1 (201)	4.5 (156)
Land Process	104.2 (15)	92.8 (5)	. 0	105.0 (2)	59.6 (5)	.0	97.0 (18)	110.6 (34)	111.2 (19)	125.1 (22)
Have generator	67.6 (226)	62.7 (139)	53.1 (13)	78.4 (11)	76.5 (29)	50.0 (2)	73.3 (162)	65.8 (317)	69.5 (210)	73.7 (211)
Loss in transit	2.4 (242)	0.6 (168)	1.4 (14)	1.7 (13)	3.5 (30)	1.0 (2)	3.9 (210)	1.3 (414)	0.8 (263)	1.4 (233)
Loss to thieves	4.3 (36)	5.0 (8)	. 0	2.6 (2)	8.0 (2)	.0	4.9 (15)	4.3 (31)	5.2 (14)	4.3 (21)
Security cost	3.4 (47)	4.3 (19)	0.1 (2)	4.8 (3)	2.7 (7)	.0	4.1 (20)	3.3 (27)	2.6 (19)	2.2 (35)
Unofficial payment	3.6 (196)	2.2 (145)	6.0 (13)	4.6 (10)	4.3 (22)	5.0 (2)	4.0 (181)	3.5 (354)	3.2 (223)	5.4 (195)
Days to phone	15.8 (242)	24 (169)	0 (14)	12 (13)	11.8 (30)	15 (2)	31.7 (210)	12.7 (414)	4.6 (263)	14.6 (233)
Public water	28.3 (49)	31.8 (37)	8.1 (8)	47.0 (5)	32.5 (20)	60.0 (1)	27.2 (182}	29.6 (99)	28.9 (65)	32.5 (118)
Inspection	3.7 (215)	3.5 (136)	2.1 (13)	1.7 (11)	3.5 (28)	2.0 (1)	2.7 (184)	3.3 (343)	3.4 (202)	3.5 (183)
Taxation	72.7 (242)	72.2 (169)	74.4 (14)	70.8 (13)	73.6 (30)	65.0 (2)	68.2 (210)	67.7 (414)	66.4 (263)	71.0 (233)
Overdraft facility	26.6 (241)	4.1 (169)	57.1 (14)	7.7 (13)	46.7 (30)	0 (2)	11.9 (210)	9.9 (413)	13.7 (263)	16.7 (233)
Bank loan	5.2 (242)	0.6 (169)	8.2 (14)	2.3 (13)	12.3 (30)	0.0 (2)	1.2 (210)	1.8 (414)	3.3 (263)	2.9 (233)

Source: Author.

Note: Power outage is measured in number of hours/month; mgt time is management time in dealing with regulation; loss in power outage is the share of such loss in total sales; land process is the number of days to process landed property; have generator is the proportion of firms using a generator; loss in transit and loss to thieves is the percentage of a shipment lost due to spoilage and thieves, respectively; security costs and unofficial payments and taxation are shares of each variable in total sales; days to phone are number of days to obtain a phone line; public water is the proportion of firms with access to public water; inspection means number of times visited by government officials; overdraft facility means using an overdraft facility or not; and bank loan refers to the proportion of total financing from a bank loan.

3.3 Output, Labour, Capital, Materials and Firm Characteristics

The measure of output for the production function estimation in this study is sales measured in Nigerian Naira ₦for all manufacturing industries. It can be seen from Table 5 that total sales vary between ₦10 million and ₦511 million. On average, the chemical industries recorded the highest sales, followed by food and textiles. A measure of labour taken into consideration in the empirical analysis is the number of employees. This measure is preferred to value unit because wages are expected to differ across industries. The average number of employees ranged from 10 to about 72. Apart from the chemical, and food and beverage industries, all industries are dominated by small-scale firms, which employ between 5 and 19 workers (Table 5, column 6). In the food and beverage industry, medium and large-scale firms (20 and above employees) are more prevalent than small firms. This underscores the relevance of agro-industrialization in the Nigerian economy. The costs of production (materials and capital) vary across Nigerian manufacturing industries. On average, the book value of fixed assets varies between ₦200 million and ₦300 million. Table 5 further indicates that the chemical industry is the most capital intensive, followed by food and beverage. However, in the food and beverage industry more is spent on materials and intermediate inputs than in other industries. Most manufacturing industries, more than 90%, are non-exporters. The proportions are 99.4%, 99%, and 96.3% in the garment, metal, and food and beverage industries, respectively. The highest proportion of exporters is reported in the textile industry (22.4%). The low proportion of exporters might not be unrelated to the prevailing investment climate in the country, particularly the long duration of power outages and poor credit rating. These factors may create serious bottlenecks when firms are required to meet foreign demand for their products. The survey includes a question on what percentage of the firm is owned by private, domestic, individual companies and organizations. Table 5 shows that more than 90% of firms in each manufacturing industry are owned by private, domestic individual companies and organizations. The proportions are 99.5%, 99.0%, 98.8% and 96.3% for non-metal, wood, metal, and the food and beverage industries, respectively. To control for the quality of labour, the survey contained a question on the highest educational qualification of the firms' managers. Apart from the chemical industry, more than 50% of managers in Nigerian manufacturing industries possess a qualification lower than a first degree.

Table 5: Descriptive statistics: Production data and firm characteristics

Industry	Sales (₦ millions)	Labour	Capital (₦millions)	Materials (₦millions)	Small scale %	Ownership (domestic)	Non-exporter	At least first degree
Food	511	70.4	96.9	296	38	96.3	96.3	44.0
	242	242.0	242	242	242.0	242.0	242.0	25.0
Garments	10	12.7	2.1	4.1	72.2	99.0	99.4	25
	169	169.0	161	169	161.0	169.0	169.0	12.0
Textiles	178	45.4	107	95.2	50	92.8	78.6	33.3
	14	14.0	14	14	14.0	14.0	14.0	6.0
Machinery	105	28.6	13.2	44.9	61.5	92.3	84.6	0.0
	13	13.0	13	13	13.0	13.0	13.0	2.0
Chemicals	808	72.3	300	457	30	86.7	83.3	100.0
	30	30.0	30	30	30.0	30.0	30.0	11.0
Electronic	13.9	16.0	1.3	5.5	50	88.0	99.0	0
	2	2.0	2	2	2.0	2.0	2.0	0.0
Non-metal	49.2	17.9	12.4	2.2	76.7	99.5	99.0	19.1
	210	210.0	208	210	209.0	210.0	210.0	68.0
Wood	58.6	15.0	8	32.2	77.1	99.0	99.0	27.4
	414	414.0	396	414	404.0	414.0	414.0	62.0
Metal	65.3	16.2	35.6	32.4	76.8	98.8	97.3	33.3
	263	263.0	253	263	255.0	263.0	263.0	33.0
Other	105	22.0	348	55.4	67.8	98.7	96.6	44.4
	233	233.0	228	233	229	233.0	233.0	54.0

Source: Author.

3.4 Empirical Model Specification and Estimation Technique

Following common practice in the empirical literature, the analysis begins with an estimation of Equations 2–4 in order to assess the effects of investment climate variables on the productivity of firms in the business environment. The World Bank Investment Climate (ICA) surveys made available information on a large number of IC variables, as well as general information on firms' status, productivity, sales and supplies. In the questionnaire, the IC variables are classified into 6 broad categories: (a) infrastructure and services; (b) finance; (c) business-government relations; (d) conflict resolution/legal environment; (e) crime; and (f) capacity, innovation and learning. Based on a description of the investment climate in Table 4, the following variables are used to provide an overall representation of the business environment: duration of power outages, losses due to power outages as a percentage of total sales, percentage of electricity generated from generators, access to land, loss in transit due to breakage and spoilage as a percentage of sales, cost of security, management time in dealing with regulation, unofficial payments, days to register a phone line, water from public sources, inspection time, taxes, overdraft facilities and shares made up of bank loan. The firm characteristics include a size ranking: Small = 1, Medium = 2 and Large = 3; export: percentage of establishment's sales scheduled for direct exports; and ownership: percentage of firm owned by private, domestic individuals, companies and organizations. The empirical model is shown in Equation 10.

$$TFP_i = cons + a(F) + b(X) + cindustry_i + v_i \tag{10}$$

Where

TFP : Total factor productivity (estimated from a production model with the highest Wald chi-squared value)

F : vector of firms' characteristics

X : vector of investment climate variables

$industry$: industry dummy variables

a, b, c : regression coefficients

v_i : disturbance term

Iarossi and Clarke (2011) report that most investment climate constraints are potentially endogenous. It is often difficult in practice to find instruments for all investment climate variables that could be included in firm performance regressions. The common solution to the endogeneity problem is therefore to instrument or replace the firms' own constraints with the average constraints by firms in the same city, sector and region. Aterido et al. (2011) show that controlling for endogeneity can have a large impact on results. They find that access to finance, corruption, and power have a far more modest impact on firm growth after controlling for endogeneity. In this study, therefore, city-sector averages of investment climate indicators and firm characteristics are computed to control for endogeneity. The estimation of the TFP model begins with only investment climate indicators. The basic model is augmented by the inclusion of firms' characteristics described in Table 5. As a robustness check, industry dummies are also included.

4.0 Results and Discussion

4.1 Production Function for Nigerian Manufacturing Industries

The basic estimation results for the Cobb-Douglas (CD) production function at industry level are reported in Table 6. Column 1 reports the results of the model that only controls for labour, capital and material. The regression result, when the educational qualification of the firms' managers is included in the model, is reported in column 2. The last two columns show the validity tests of common technology across manufacturing industries. In the model estimation, a random effects specification is used to capture possible unobserved heterogeneity across firms. The firms are pooled across cities. The results in column 1, Table 6 indicate that the coefficients of labour, capital and materials are all positive as expected a priori and statistically significant at the 1% level of significance. The elasticities of output with respect to labour and capital are 0.24 and 0.03, respectively. This indicates that a 1% rise in number of employees and capital stock will generate 0.24% and 0.03% increase in output, respectively. In column 2, the coefficient of a manager's education is significant, but labour elasticity is reduced to 0.22, while the coefficient of capital becomes insignificant. In both cases, the production output of manufacturing industries in Nigeria is seen to experience increasing returns to scale. The positive output elasticities with respect to labour and capital show that the use of inputs in Nigerian manufacturing industries will enhance production. This indicates that the relationship between output and the inputs are complementary in nature.

Table 6: Production function estimates

Variable	model1	model2	model3	model4
Log(labour)	0.239(9.081)***	0.221(4.433)***	0.238(9.206)***	0.218(4.526)***
Log(capital)	0.039(7.162)***	0.013(0.907)	0.0401(6.578)***	0.009(0.646)
Log(material)	0.726(43.799)***	0.768(22.037)***	0.729(44.472)***	0.768(22.076)***
Log(education)		0.022(1.915)**		0.0234(1.921)**
Industry				
Garments			0.0583(1.161)	-0.02(-0.151)
Textiles			0.116(1.863)*	0.193(1.554)
Machinery			0.042(0.434)	0.241(1.425)
Chemicals			0.014(0.291)	-0.08 (-1.553)
Electronic			0.142(0.918)	
Non-metal			0.002(0.069)	-0.102(1.812)*
Wood			0.029(1.151)	-0.061(1.011)
Metal			0.032(1.095)	-0.021(0.402)
Other			0.018(0.636)	-0.053(0.903)
Constant	3.9892(18.925)***	3.646(9.338)***	3.885(17.787)***	3.749(8.992)***
R2	0.88	0.91	0.96	0.98
Wald chi square	8120***	8133***	8434	8501***

Source: Author.
*, **, *** indicate 5%, 5% and 1% levels of significance, respectively.

The assumption of common technology across industries is validated in Table 7, when the regression coefficients are allowed to vary by industries. As expected theoretically, the coefficients of labour, capital and material are positive and statistically significant at the 1% probability level. Given the results of the Wald chi-square test, the regression result presented in Table 6 column 1 is more robust than others. Hence, the residuals are used to generate a measure of TFP.

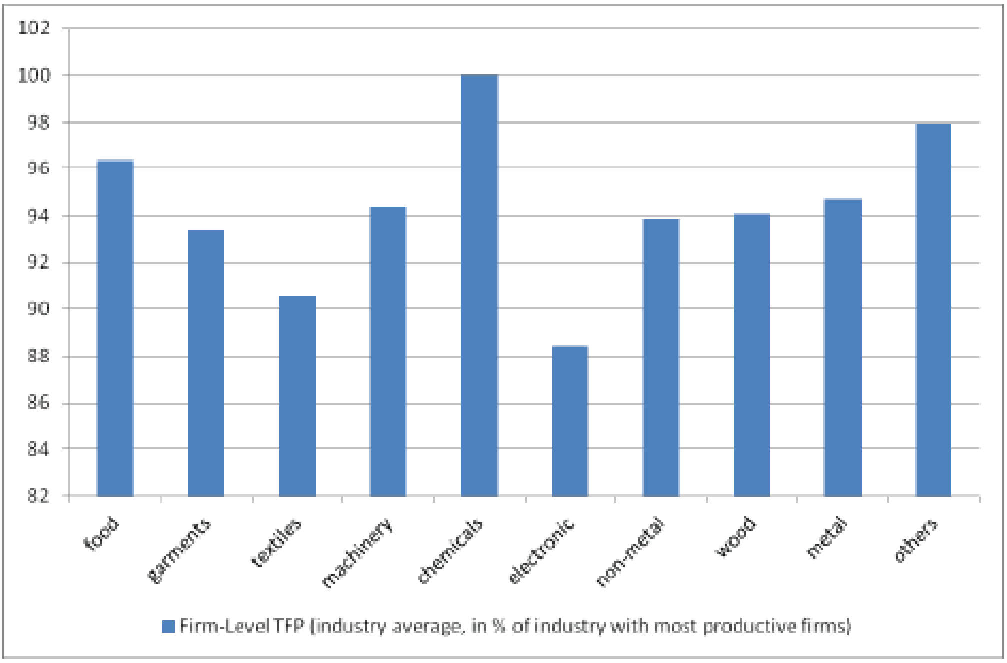
Table 7: Production function with interaction terms

Variable	model 5	model 6
Log(Labour)	0.236(5.570)***	0.128(2.171)**
Log(Capital)	0.040(5.325)***	0.022(1.604)*
Log(Material)	0.727(43.888)***	0.776(22.663)***
Food X Log(labour)	0.051(1.384)	0.144(3.052)***
Garment X Log(Labour)	-0.034(-0.76)	0.187(1.173)
Textile X Log(Labour)	-0.0306(-0.422)	-0.1891(-0.613)
Machinery X Log(Labour)	-0.0255(-0.254)	0.8258(3.6927)***
Chemical X Log(Labour)	0.0184(0.249)	0.259(3.7593)***
Electronics X Log(Labour)	-0.2971(7.787)***	(omitted)
Non-metal X Log(Labour)	-0.0118(-0.284)	0.0581(1.121)
Wood X Log(Labour)	-0.0375(0.779)	0.0212(0.424)
Metal*Log(Labour)	0.0213(0.445)	0.1196(1.708)
Food X Log(Capital)	-0.0106(-1.596)	-0.0257(-2.349)**
Garment X Log(Capital)	0.008(0.994)	-0.0348(-0.996)
Textile X Log(Capital)	0.0119(0.839)	0.0426(0.809)
Machinery X Log(Capital)	0.007(0.323)	-0.1195(-3.294)
Chemical X Log(Capital)	-0.0028(-0.177)	-0.0573(-4.045)
Electronics X Log(capital)	0.0652(10.134)***	(omitted)
Non-metal X Log(Capital)	0.0007(0.098)	-0.0154(-1.443)
Wood X Log(Capital)	0.0066(0.921)	-0.0058(-0.549)
Metal X Log(Capital)	-0.0028(-0.379)	-0.0223(-1.732)
Education		0.03(2.539)**
Constant	3.9437(18.304)***	3.5879(8.992)***
R^2	0.97	0.98
Wald chi square	8464***	8552***

Source: Author.
*, **, *** indicate 5%, 5% and 1% levels of significance, respectively.

Figure 1 presents the average firm-level TFP by industry. Splitting the sample into 10 sectors was justified by the fact that firms in each industry use more or less similar technology. The TFPs are presented in per cent of the average TFP of the best-performing industry. The results reveal that the chemical industry outranks their peers in productivity, followed by other manufacturing industries, and food and beverages.

Figure 1: Firm-level total production function



4.2 What Types of Industry Perform Better than Others?

Table 8 shows the results of estimating the relationship between TFP and investment climate variables. All variables are statistically significant with expected signs when ownership is included in the model. The variables size and export are excluded because their effects were not robust. The lack of significance of size may be explained by the argument that manufacturing firms are predominantly small scale. The insignificance of export may be due to the fact that the domestic market is so large that the share of an individual exporter does not much affect its performance. The results show that unofficial payment is critical to the performance of manufacturing industries in Nigeria. The variable is positive and significant in the model. This might be due to widespread poverty among government officials working in ministries and parastatals responsible for the registration and control of firms' operations. Their salaries are poor and payment is irregular. It might also be linked to the low degree of integrity of the task force, compelling industry players to comply with regular demands of the National Agency for Food and Drug Administration and Control (NAFDAC) and the Standards Organisation of Nigeria (SON) for the sustainability of their operations. Another interesting aspect of the results is that the duration of power outages negatively and strongly influences the productivity of Nigerian manufacturing industries. This confirms the desire of Nigerians to improve the power sector in the country. The result also shows that management time in dealing with regulation is positive and statistically significant. This indicates that the more attention is paid to legislation and regulations, especially those relating to product conformance, the better the productivity of manufacturing industries in Nigeria. This gives credence to the efficacy of government organs for enforcing compliance with industrial regulatory policies such as the SON, NAFDAC and the Federal Produce Inspection Services (FPIS).

Table 8: Investment climate and total factor production

Variable	TFP model 1	TFP model 2
Power outage time	-0.00069(-3.102)***	-0.0006(-4.20)***
Management time dealing with regulation	0.032(4.286)***	0.0235(3.666)***
Electricity from generator (%)	0.0052(3.506)***	0.0063(5.1850***
Transit loss to breakage/spoilage	-0.0226(-2.309)**	-0.0263(-3.383)***
Unofficial payment (% sales)	-0.0179(-3.218)***	-0.0087(-1.698)*
Day to phone line	0.0007(1.118)	0.0016(2.692)**
Inspections per year	0.0141(1.628)*	0.0121(1.761)*
Tax per year	-0.0023(-1.627)*	-0.0035(-2.971)**
Ownership		1.936(3.371)***
_cons	0.8368(9.923)***	0.8439(12.691)***
N	26	26
R2	0.6454	0.7797

Source: Author.

*, **, *** indicate 5%, 5% and 1% levels of significance, respectively.

5.0 Conclusion and Recommendations

This study examined the influence of investment climate on the total factor productivity (TFP) of manufacturing industries in Nigeria. The study was conducted in two phases, namely: (i) an estimation of industry and firm-level productivity measures was carried out; and (ii) differences in TFP across firms was statistically related to indicators of investment climate, taking into consideration firm characteristics. The analyses used 2009 World Bank Enterprise survey data on Nigeria. In terms of firm level productivity, it was found that the chemical industry was more productive than others. The results show that the empirical relationship between investment climate indicators and firm performance is robust when including industry dummies, which reveals that there is significant variation in the investment climate across manufacturing industries in the country. Therefore, it can be concluded that industrial policy planning is important.

The empirical results further indicated that the following investment climate factors are the most important bottlenecks affecting the productive performance of manufacturing industries in Nigeria: duration of power outages, time spent by management in dealing with state and federal government regulations, unofficial payments, inspections per year, percentage of electricity from generators, loss in transit due to breakage and spoilage, tax paid per year, and ownership of firm. As expected a priori, power outages, unofficial payments, tax and loss in transit due to breakage or spoilage negatively and significantly affect the TFP of manufacturing industries in Nigeria, while the influence of the other variables is positive and significant.

The results show that there is scope for initiating policy measures to improve the dimensions of the relevant investment climate indicators. Hence, the following policies are suggested to enhance the competitiveness of Nigerian manufacturing industries:

i. Ensure a stable and sufficient supply of power for industrial use. A roadmap for the currently passed power reform should be initiated. For example, the frequency and length of power outages could be reduced by improving the public grid through an increase in generation capacity and promotion of pricing and distributional efficiencies currently in use. In addition, clean energy generation through solar systems and inverters by private firms should be given maximum support through funding, at a single-digit interest rate.
ii. Road infrastructure should be given adequate attention. One major issue

with roads in Nigeria is that they are not strong enough for trucks moving raw materials and firms' products to various markets. This might be responsible for the significant loss in transit due to breakage and spoilage. While it is expedient for government to intensify its efforts in the construction of a modern railway system, road construction and repair should take into account the high number of trucks to enable the smooth running of the nation's industrial operations.

iii. Appropriate measures should be put in place to reduce the rate of unofficial payments and tax disincentives in the country. For example, the Independent Corrupt Practices and Other Related Offences Commission (ICPC) and the Economic and Financial Crime Commission (EFCC) should pay attention to the activities of the Corporate Affair Commission, ministries and the departments regulating the registration, operation and tax return activities of industries in Nigeria. The Manufacturing Association of Nigeria (MAN) should establish whistleblowing channels and legal procedures to stop facilitating unofficial payments to speed up performance.

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