INNOVATION BEHAVIOUR OF MANUFACTURING FIRMS IN NIGERIA

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Abstract

The increasing emphasis on innovation as driver of manufacturing competitiveness has brought to the fore the question of what factors influence its outcome in national industries? For Nigeria especially, where the objective of promoting manufacturing has recently been reinvigorated, the relevance of this question can hardly be more timeous. Using data from a Survey of innovation activities in the country's manufacturing firms we estimated a probit model of innovation behavior in the sector. Our findings reveal a positive impact of training, education level and incidence of collaboration with other innovation actors on a firm's propensity to innovate. On the other hand, poor physical infrastructure and large size are discovered to be two forms of hindrances to developing technological capability in the sampled firms. Strategic interventions to promote SMEs and upgrade their technical capability as well as improve the quality of infrastructure are some of the key policy messages that emerge.

Keywords: innovation; manufacturing, competitiveness, economic development, Nigeria

SECTION 1: INTRODUCTION

A major plank of the economic policy of current Nigerian administration is to reduce the age-long dependence on oil by diversifying the economy through promotion of manufacturing and other non-oil sectors. From a policy perspective this obsession with manufacturing is not without

some level of support as there exists, vast literature that links economic development to creation of a strong manufacturing base (Hausmann, et al., 2005)[1].

However, the task of building a virile and competitive manufacturing sector requires focusing on the right strategy. There appears to be a near consensus in current literature that the development of innovative capability is the way to unleashing this potential. In a recent Report of the Global Manufacturing Competitiveness Index (2016) published by Deloitte, innovation is presented as the most critical driver of a nation's competitiveness (Deloitte, 2016). Besides, a good number of studies have also established positive association between innovation and firm level productivity[2].

That being the case, the question then becomes how do we explain the phenomenon of innovation behavior of manufacturing firms in Nigeria? The hope is that if we can understand and isolate the critical factors that increase their propensity to innovate we will be able to design and implement appropriate intervention strategies needed to increase their competitiveness and engender a strong manufacturing sector.

To this end, our paper investigates the determinants of innovation behavior of manufacturing firms in Nigeria. Some of the current studies in this area include Oyeyinka et al. (1996) and Egbetokun and Siyanbola (2010). Both efforts took a sub-sectoral perspective with the latter

[1] The Asian growth experience that was largely driven by manufacturing is also very instructive here.

[2] See Fagerberg, et al. (2010) for a review of country level studies and Gebreeyesus (2009) as well as Goedhuys et al. (2008), (2014) for strands of recent firm level studies.

focusing on Cable and Wire Manufacturing sub-Sector and the former drawing samples from Engineering and Agro-allied sub-sector. As a departure, we cover the entire Manufacturing Sector using Probit technique to estimate an econometric model of determinants of innovation behavior.

Our findings reveal a positive impact of training, education level and incidence of collaboration with other innovation actors on a firm's propensity to innovate. On the other hand, poor physical infrastructural quality such as inadequate power supply as well as large size are discovered to be two forms of hindrances to developing technological capability in sampled firms.

The rest of the paper is organized as follows. Section 2 reviews the state of our knowledge on the issue. Thereafter, discussion on data and development of variables is taken up in Section 3. Section 4 presents our estimation technique and results before Section 5 concludes the report.

SECTION 2: LITERATURE REVIEW

We take as stating point the definition of innovation as explicitly described in the Oslo Manual as "….the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005: 46).

Central to a firm's innovative prowess is acquisition of good technological capability. The literature on technological learning (Malerba, 1992; Lall, 1992; UNCTAD, 1996; Hitt et al., 2000) conceptualizes this as conscious and deliberate efforts directed at producing and/or diffusing new knowledge in the workplace. How this capability is acquired and what factors aid or hinder such effort has remained a subject of research attention for years that we now have a fairly good body of knowledge to draw on.

One fairly recent attempt at understanding this phenomenon categorizes the determinants of firm level innovation into two basic groups of factors (Romijn and Albaladejo, 2002): internal and external.

Internal factors are of varied sources. The first of course is the stock of knowledge entrepreneurs and employees bring to the organization through their earlier education and/or work experience. Such knowledge enables them to obtain, decode and adapt or transform information to innovation in workplace. Training is another internal source that is often used to enhance workers' capability to diffuse innovation. This method presents an especially very special attribute as it allows the firm to target capability development to the specific area of needs to the firm.

Much of external factors derives from the enterprise's formal and informal interactions with varieties of outside agents that often include but not limited to customers, suppliers, government, research institutes and competitors. It is sometimes the case that when these interactions take

place crucial information that have important implications for ability to develop, imitate, adapt and generally diffuse innovation are obtained.

Another strand of literature that has significant message for innovation capability is the system perspective. As an analytical tool it argues that understanding innovation in some clearly defined settings requires a focus on network of actors and interactions among them. These actors are varied and include those proximately connected with innovation activities such as firm, customers, suppliers, finance and research institutions as well as those distantly or indirectly connected such as government, trade associations and non-economic institutions. The system perspective has been used to explain the phenomenon of innovation in various circumstances that includes the national level (National System of Innovation: Freeman, 1987; Lundvall, 1992; Nelson, 1993), regional level (Regional System of Innovation: Cooke et al., 1997) sector level (Sectoral System of Innovation: Malerba, 2002, 2005) and even technological system (Carlsson and Stankiewitz, 1995).[3]

Of particular interest to the present exercise is the role of government in shaping innovation outcome. According to the argument, government provides many types of services ranging from direct support for innovation such as public financial support or investment in research, laboratories and related infrastructures as well as indirect ones. Indirect contribution can take the form of investment in physical infrastructures such as power supplies, road networks,

[3] See Na-Allah, A. and Muchie, M. 2012. Social absorption capability, systems of innovation and manufactured export response to preferential trade incentives Research Policy 41 (2012) 93–101

communication and other facilities with the implication that an inadequacy of this may serve to inhibit the development of technological capabilities by firms.

For example, poor power supplies may force firms to seek alternative and more expensive sources with profound negative implication for efficiency. Furthermore, an inadequate supplies of power alongside poor communication facilities such as limited broadband may limit access to information especially the codified knowledge that are often transmitted through internet and other communication networks. Poor road network also makes movement of man, machine and goods very difficult and at best expensive. All these will potentially translate to high barriers to innovation activities of firms.

There has been no shortage of evidence on many of the propositions highlighted above. Using a representative survey of over 2800 firms in Sri Lanka De Mel et al. (2009) find that firm size plays a great role in process and organizational innovation. There is also strong evidence from the study that more educated individuals are more likely to innovate. This conclusion is similarly confirmed in Ayyagari et al. (2011) who find in a study of firms across 47 developing economies that presence of highly educated managers is associated with greater firm innovation.

Interactions with clients and customers have further been found to be drivers of innovations in Ghanaian firms (Zanello et al., 2014). Focusing on Nigeria Cable and Wire Manufacturing sub-sector Egbetokun and Siyanbola (2010) present evidence that linkage and collaboration are more important than firm-related variables in promoting innovation capability. The positive impact of training on productivity is demonstrated in Mano et al. (2012).

The impact of a good number of public related facilities has equally not been left out in analysis of innovation phenomenon. Romijn and Albaladejo (2000) find evidence that public financial support for R&D is positively related to firm innovation. Sivak et al. (2011) find that regional infrastructure that includes transport, IT and finance had significant impact in determining outcome in a study of the impact of governance and infrastructure on firm innovativeness. A related finding is contained in Oyeyinka et al. (1996) that poor physical and engineering infrastructure constitutes an important constraint to the rate of innovation in Engineering and Agro-allied sub-sector of the Nigerian manufacturing industry.

We contribute to this fledging literature by considering the determinants of innovation in the entire manufacturing sector of the Nigerian economy.

SECTION 3: DATA AND VARIABLE CONSTRUCTION

Data

Data utilized for this study came from report of the Survey of innovation in Nigerian firms. It was carried out by National Centre for Technology Management (NACETEM, 2012) and conducted for only the Manufacturing and Services Sector. The Survey period covers 2008-2010. It was inspired by the NEPAD African Science Technology and Innovation Initiative (ASTII). Its framework follows that of the OECD Countries.

Information on various aspects of innovation activities undertaken by about 1360 Manufacturing and Services oriented firms were collected. Out of these only 700 firms that belong in the Manufacturing activities were included in this analysis. Guided by the literature and based on information available from the Survey we were able to extract the following variables for the study.

Variable Definition

Dependent Variable (Innovation): This reflects the event of observing product or process innovation outcome for a firm. It takes the value of 1 if a positive outcome is observed and 0 otherwise.

Independent Variables: As captured in model estimated the explanatory variables comprise various measures for age and size of the firm, quality of infrastructure, skills of workforce, workers' training, imported Machinery & Equipment, firm's collaboration with external agencies and indicator of government support.

Size is captured by the total number of employees in a firm's payroll in 2008 and takes on discrete values of 1 (micro), 2 (small), 3(medium) and 4(large). A micro firm has less than 10 employees while a firm is classified as small if it has between 10 and 50 staff. For staff strength that is more than 50 but less than 100 a medium size classification is assigned. Large firms are those with up to 100 or more employees. Expected sign of this variable is unclear

Age of the establishment reflects how long the firm has been around. It is captured by the difference between the year of establishment and 2008. For our econometric estimate, a firm with less than 10 years of experience is considered relatively young and assigned a discrete value of 1. Older establishments with a value of 2 are those with up to 10 but short of 20 years of operating experience in the country. If by 2008 a firm has spent more than 20 years since it was founded it is classified as Very Old and assigned a value of 3. Like age we do not have a priori knowledge of the direction of impact of this variable.

Quality of physical infrastructure is our proxy variable for measuring how embeddedness in an environment with poor physical infrastructure impacts on firm's innovativeness. The questionnaire administered had specifically sought to know from respondents the degree to which presence of inadequate infrastructures like electricity hampered innovation activities during the study period. Responses were calibrated on a continuum of 0 (No Impact) to 3 (High Impact). In between these extremes were 1 and 2 for Low and Medium Impact experiences respectively. All other things being equal poor infrastructural quality should associate negatively with innovation outcome.

A second measure of the impact of local embeddeness in poor infrastructural environment captures how well an inadequacy of innovation related facilities like laboratories hinders innovation. Like the case with physical infrastructures responses vary among those who claimed such inadequacy had no impact at all on their operation and those who believed it had a profound impact: 0(No Impact); 1(Low Impact); 2(Medium Impact); 3(High Impact). Absence or insufficiency of facilities would naturally penalize innovation.

External collaboration of firms reflects the incidence of cooperation for innovation or in other words active participation with other enterprises or non-commercial institutions on innovation activities. It takes on the value of 1 if a firm did cooperate for such purpose during the study period and 0 otherwise. We expect a positive association of this variable with the dependent variable.

Skills of workforce are measured by the level of educational attainment of an average staff. We define this as the approximate percentage of total employees that had at least University degree during the reference period. Organisations with less than 10 percent of staff having at least a University degree are considered low skilled and given 0 values while those with 10 percent and more are treated as high-skilled and assigned the value of 1. Skill factor should impact positively on innovation.

Related to workers' skills is training that is often employed to increase the knowledge capability of workforce. A positive value of 1 is assigned if an enterprise engaged in internal or external training for personnel specifically for the development and/or introduction of new or significantly improved products and processes during reference period. A value of 0 means the firm in question did not implement such activity. Like skills this variable should associate positively with innovation activity.

Aside from training importation of Machinery & Equipment can also confer knowledge advantage as it embodies codified form of knowledge. Thus any firm that imported the item during the period is considered to have gained competitive advantage over a firm that did not.

This is captured in the econometric specification as 1 for firms that imported and 0 for firms that did not.

Government support for innovation is intended to isolate the role that assistance from government played in predicting innovation outcome. Responses take a binary dimension with an affirmative answer to the question 'Did your enterprise make use of government support in its innovation activity?' assuming a positive value of 1 and 0 otherwise. Other things being equal government assistance will have beneficial effect on innovation.

Summary statistics for these variables in presented in Table 1.

Table 1: Summary Statistics

Variable	No of Obs	Mean	Standard Dev.	Min	Max
Innovation	692	0.63150	0.48275	0	1
Govt Support	692	0.23555	0.42465	0	1
Poor Ph Infrastructure	692	2.44798	1.00586	0	3
Poor Inn. Infrastructure	645	1.77674	1.20161	0	3
Training	700	0.48857	0.50023	0	1
Size	692	1.06503	1.10392	1	4
Age	522	1.96169	0.87538	1	3
Machinery & Equipment	692	0.31503	0.46486	0	1
Collaboration	692	0.15143	0.35872	0	1
Workers' Skill	692	0.31069	0.46311	0	1

SECTION 4: ESTIMATION TECHNIQUE AND RESULT

Estimation

To econometrically explore the determinants of innovation behaviour of firms in Nigeria a Probit model is estimated.

The latent variable is given by the following relationship:

$$y_i^* = \beta_0 + \beta_i X_i + \varepsilon_i$$

The probability to innovate y^*_i is assumed to be a function of a set of observable firm characteristics $x\iota$ and a good number of unobserved ones β_i associated with the vectors $x\iota$ *et* εi. The error term is assumed to be normally distributed.

Given that y_i represents the dichotomous variable, its relation to the latent variable y^*_i can be expressed as follows:

$y_i = 1$ if $y^*_i > 0$

where $y_i = 1$ if innovation outcome is observed for firm

$y_i = 0$ if $y^*_i \leq 0$

where $y_i = 0$ if firm did not innovate.

On account of this the model we estimated is expressed thus:

$$y^*_i = \beta_o + \beta_1 govt.support_i + \beta_2 poorinfra1_i + \beta_3 poorinfra2_i + \beta_4 training_i + \beta_5 sze_i + \beta_6 age_i + \beta_7 mach.equip_i + \beta_8 collab_i + \beta_9 wskills_i + \varepsilon i$$

Table 2 defines the proxies contained in the model.

Table 2: Definition of Proxies

Proxy	**Definition**
govt.support	Government Support
poorinfra1	Poor Physical Infrastructure
poorinfra2	Poor Innovation Infrastructure
training	Training
sze	Size
age	age
mach.equip	Machinery & Equipment
collab	External Collaboration
wskills	Workers' Skills

Result

Table 3 presents result of estimation for our model.

In the Table, values for the Average Marginal Effect estimates and their corresponding p-values indicating levels of significance are given in columns 4 and 5 respectively. Overall 5 of the variables (Poor Physical infrastructure, Training, Size, External Collaboration and Workers' Skills) were found to be significant at various levels of tests.

Table 3: Probit Results for Innovation Behaviour of Firms

Variable	Coefficent	P>|z|	Av. Marginal Effect	P>|z|
Government Support	-0.105	0.652	-0.019	0.652
Poor Ph. Infrastructure	-0.213	0.028	-0.039	0.025**
Poor Inn. Infrastructure	0.047	0.516	0.009	0.515
Training	2.218	0.000	0.409	0.000***
Size	-0.193	0.026	-0.036	0.023**
Age	-0.057	0.554	-0.011	0.553
Machinery & Equipment	-0.634	0.275	-0.117	0.273
Collaboration	1.439	0.010	0.266	0.009***
Workers' Skills	0.351	0.048	0.065	0.050*
No of Observations	492			
Pseudo R2	0.219			
Correctly Classified	63.26%			

Note: (*) denotes significance at 10%, (**) denotes significance at 5%, (***) denotes significance at 1%

Aside from being significant at 5 percent level the variable 'Poor Physical Infrastructure' also turned out with the expected negative sign. This suggests that a one unit change in the variable decreases the probability of innovation by 0.025. But working in different direction we can confirm that the propensity to innovate increases with training. If training goes up by one unit the probability that a firm will innovate increases by 0.409. These findings are consistent with some previous efforts that have been documented.

We do not have a priori knowledge of the direction of sign for the 'Size' variable but as can be seen it turned up with a negative sign. This can be interpreted as saying the probability to innovate decreases with firm size: large firms are less like to innovate than their smaller

counterparts. We find this to be at variance with the positive finding reported in some previous studies (De Mel et al., 2009; Egbetokun and Siyanbola, 2010).

The positive sign reflected for both the variables of 'External Collaboration' and Workers' Skills' are in tandem with what literature leads us to expect. At the 1 percent level of significance there is a clear suggestion that external collaboration by firms significantly increases the likelihood of successive innovation efforts. This has been confirmed in several previous studies (Oyeyinka et al., 1996; Egbetokun and Siyanbola, 2010). Finally, workers' skill like in many other studies is confirmed here as well to associate with positive innovation outcome.

SECTION 5: CONCLUSION

Against the background of a reinvigorated impetus to mainstream manufacturing in Nigeria's drive towards economic self-sufficiency, this paper investigated the determinants of innovation behavior in the country's manufacturing sector. The interest on innovation is understandable given the fact that competitiveness in modern economy depends on technological capability of a firm.

Whereas there are studies that have attempted to explain innovation in the context of Nigerian manufacturing many of these tended to focus on sub-sectoral samples to draw inferences.

Against this background our paper estimated a probit model for the entire manufacturing sector. We found as predicted that embeddedness in environment with poor physical infrastructure hindered innovativeness of firms studied. In addition the incidence of external collaboration by firms and level of workers' skills had significant positive effect on propensity to innovate in the same way that training did. Size was however, revealed to be unbeneficial to innovation in the study.

The major policy lesson that follows from here is that besides making efforts to improve the quality of physical infrastructure especially power supplies promoting firm collaboration with other innovation actors within the network system should be taken seriously. In addition, the revelation that younger firms were more innovative than their older counterparts seems to suggest that the road to achieving greater competitiveness in Nigerian manufacturing may lie in supporting the Small and Medium Scale enterprises (SMEs). In this respect the attention currently being accorded the sector through such intervention as the establishment of the Development Bank of Nigeria not only to provide finance but also technical support should be sustained and improved upon. Such technical support should especially be targeted towards improving the skill levels of SMEs'entrepreneurs and workers through education and training as these were also revealed to impact positively on a firm's propensity to innovate.

REFERENCES

Ayyagari, M., Demirguc-Kunt, A. and Maksimovic, V. 2011. "Firm Innovation In Emerging Markets:The role of Finance, Governance, and Competition", *Journal of Financial and Quantitative Analysis,* 46: 1545-1580.

Carlsson, B. and Stankiewitz, R. 1995. “On the Nature, Function and Composition of Technological Systems”, in: Carlsson, B. (ed.), *Technological Systems and Economic Performance*. Kluwer: Dordrecht.

Cooke, P., Gomez U and Extebarria, M. 1997. “Regional Innovation Systems: Institutional and Organizational Dimensions”, *Research Policy* 4–5: 475–493.

Deloitte, 2016. Global Manufacturing Competitiveness Index. Available at: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Manufacturing/gx-global-mfg-competitiveness-index-2016.pdf

De Mel, S., McKenzie, D. and Woodruff, C. 2009. "Innovative Firms or Innovative Owners”? Determinants of Innovation in Micro, Small, and Medium Enterprises", The World Bank, Washington DC (US).

Egbetokun, A. A. and Siyanbola, W. O. 2010. “The Determinants of Innovation Capability in Nigeria”, Available at: https://www.researchgate.net/publication/235970138_The_Determinants_of_Innovation_Capability_in_Nigeria

Fagerberg, J., Srholec, M. and Verspagen, B. 2010.” Innovation and Economic Development”, in Bronwyn, H. H. and Rosenberg, N. (eds.) *Handbook of the Economics of Innovation*, North-Holland

Freeman, C., 1987. *Technology Policy and Economic Performance: Lessons from Japan*. Frances: Pinter, London.

Fu, X., Zanello, G., Essegbey, G. O., Hou, J. and Mohnen, P. 2014. "Innovation in Low Income Countries: A Survey Report." TMCD and DEGRP, Oxford (UK).

Gebreeyesus, M. 2009. “Innovation and Microenterprises Growth in Ethiopia”, in *Development* Szirmai, A., Naudé, W. A. and Goedhuys, M. (eds.).*Entrepreneurship, Innovation, and Economic Development,* Oxford (UK): Oxford University Press,.

Goedhuys, M., Janz, N. and Mohnen, P. 2008. “What Drives Productivity in Tanzanian Manufacturing Firms: Technology or Business Environment?” *European Journal of Development Research* 20: 199-218.

Goedhuys, M., Janz, N. and Mohnen, P. (2014). “Knowledge-based Productivity in "Low-Tech" Industries: Evidence from Firms in Developing Countries”, *Industrial and Corporate Change* 23: 1-23.

Hausmann, R., Pritchett, L. and Rodrik, D. 2005. “Growth Accelerations”, *Journal of Economic Growth,* 10(4): 303-329

Hitt, M.A., Ireland, R.D. and Lee, H., 2000. "Technological Learning, Knowledge Management, Firm Growth and Performance: An Introductory Essay", *Journal of Engineering and Technology Management* 17 (3/4): 231–246.

Lall, S., 1992. "Technological Capabilities and Industrialisation", *World Development* 20 (2): 165–186.

Lundvall, B.A., 1992. "National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning", London: Pinter,

Malerba, F., 1992. "Learning by Firms and Incremental Technical Change", *The Economic Journal*, 102: 845–859.

Malerba, F., 2002. "Sectoral Systems Of Innovation and Production", *Research Policy* 31: 247–264.

Malerba, F. 2005. "Sectoral Systems Of Innovation: A Framework for Linking Innovation to the Knowledge Base, Structure and Dynamics of Sectors", *Economics of Innovation and New Technology*, 14 (1): 63–82.

Mano, Y., Iddrisu, A., Yoshino, Y. and Sonobe, T. 2012. "How can Micro and Small Enterprises in sub-Saharan Africa become more Productive? The Impacts of Experimental Basic Managerial Training", *World Development* 40: 458-468.

Na-Allah, A. and Muchie, M. 2012. "Social Absorption Capability, Systems of Innovation and Manufactured Export Response to Preferential Trade Incentives", *Research Policy* 41: 93–101

NACETEM, 2012. "Nigeria's Innovation Survey, 2008-2010", Available at:www.nacetem.org.

Nelson, R.R., 1993. *National Innovation Systems: A Comparative Study*. Oxford: Oxford University Press,

OECD, 2005. "Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data," 3rd/Ed. OECD Publishing, Paris

Oyelaran-Oyeyinka, B., Laditan, G.O.A. and Esubiyi, A.O. 1996. Industrial Innovation In Sub-Saharan Africa: the Manufacturing Sector in Nigeria. *Research Policy*, 25(7): 1081–1096.

Romijn, H. and Albaladejo, M. 2000. "Determinants of Innovation Capability in Small UK Firms: An Empirical Analysis", QEH Working Paper Series – QEHWPS40

Romijn, H. and Albaladejo, M. 2002 "Determinants of Innovation Capability in Small Electronics and Software Firms In Southeast England", *Research Policy* 31: 1053–1067

Sivak, R., Caplanova, A. and Hudson, J. 2011. “The Impact of Governance and Infrastructure on Innovation”, *Post-Communist Economies* 23(02): 203-217

UNCTAD, 1996. “Fostering Technological Dynamism: Evolution of Thought on Technological Development Processes and Competitiveness. A Review of the Literature”, Geneva: United Nations,

Zanello, F. G., Essegbey, G. O., Hou, J. and Mohnen, P. 2014. Innovation in Low Income Countries: A Survey Report. TMCD and DEGRP, Oxford (UK).