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Features of Academia-Industry Interactions in Nigeria

from the Perspective of Manufacturing Firms[1]

Cechy interakcji akademicko-przemysłowych w Nigerii z perspektywy przedsiębiorstw produkcyjnych

I. INTRODUCTION

The role of knowledge in economic development cannot be over-emphasized in an increasingly competitive global economy. The growing importance of knowledge poses challenges to developing economies and their universities as sources of growth[2]. Theoretical and empirical analyses using the national systems of innovation (NSI) framework suggest that developing countries that have grown in knowledge generation and use are characterised by productive interactions between the academia and firms in networks[3]. The contribution of academia (consisting of universities and public research institutes) to economic and social progress thus depends on the extent to which firms are able to employ the knowledge they generate to improve firm performance. In Nigeria, fostering interaction between universities and firms has been a major challenge. There has been no evidence of significant collaborations between the academia and firms[4]. This paper draws from the report of a survey of Nigerian manufacturing firms under a broader study of the nature and state of academia-firms interactions in sub-Saharan Africa. The regional study is primarily concerned with an analysis of the changing role of universities as contributors to economic growth and development in sub-Sa-

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2 R. Arocena, J. Sutz, *Emerging neoperipheral structures and gardening policies*. Presented at the DRUID Summer Conference, Industrial Dynamics, Innovation and Development. Elsinore, Denmark 2004, 14-16 June, p. 8; D. Bloom, D. Canning, K. Chan, *Higher education and economic development in Africa. Report commissioned by World Bank*, Washington, DC, 2005, p. 37.

3 B. Lundvall, *Introduction*, in B. Lundvall (ed.), *National System of Innovation – Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London 1992, p. 19; R.R. Nelson (ed.), *National Innovation Systems – A Comparative Analysis*, Oxford University Press, New York 1993, p. 30.

4 J.O. Adeoti, *Building Technological Capability in the Less Developed Countries: The Role of a National System of Innovation*, "Science and Public Policy" 2002, p. 98.

haran Africa. The survey is aimed at ascertaining the level and scope of firms' interaction (or lack of interaction) with universities and public research institutes, and their implications for the building of local technological capability.

The paper is organized as follows: the next section presents an overview of the links between knowledge and development with a focus on academia-industry interactions; section three presents the research methodology; section four discusses the results of the study; and the final section concludes the paper with the summary of findings and implications for building local technological capability.

II. ACADEMIA-INDUSTRY INTERACTION: AN OVERVIEW

Universities are known to be centers of knowledge generation and training for community development. In the linear model of innovation, public research especially in the universities generates basic knowledge, which leads to inventions, and inventions when commercialized becomes innovation. From this simplistic view of the innovation process, the research activities in the universities and public research institutes are isolated from industry. Industrial research and development (R&D) activities that contribute to the technological change required for economic progress are often located outside the ivory towers. It has however been amply demonstrated that interactions among industrial stakeholders must be part of the innovation process[5]. Besides, several studies that illustrated the national system of innovation (NSI) framework have proven that economies that are innovation driven (i.e. knowledge economies) are characterized by evident academia-industry collaborations especially in strategic sectors of the economy. The academia-industry linkages in such contexts are important feature of interactions among the actors that are involved in the generation and use of technological knowledge[6]. The ability to undertake innovative research and apply its output is complex and embedded in a context of inter-organizational relationships. In advanced industrial economies, the interactions between firms and the academia are regarded as products of a developmental orientation of research activities as research is aimed at addressing community problems and in many instances research grants are won in competitive bids. For developing countries, the scope and dimension of community oriented research may not be as elaborate as in developed countries. However, there is a growing concern that the academia in the South should be alert to the development challenges in their communities and begin a drive to making research and training activities relevant to the immediate societal needs. In the NSI framework, the educational and training system and the industrial establishments are expected to interact and be involved in mutually beneficial knowledge exchanges that engender innovation. A developmental university in this context would be actively involved in a network of agents that create new products and services or new models of achieving economic objectives. In essence, a developmental

[5] C.H. Davis, F. Carden, *Research effectiveness and R&D evaluation in developing countries*, "Knowledge and Policy" 1998, Vol.10, No. 4, p. 20.

[6] H. Etzkowitz, L. Leydesdorff, *The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University-Industry-Government Relations*, "Research Policy" 2000, p. 115.

university would not only generate new knowledge that improves the stock of knowledge, but also produce change agents that carry knowledge into society and motivate society to employ and build on knowledge from the ivory towers. While the firm is the centre of the innovative activities in the NSI,[7] the developmental university interacts with all other elements of the NSI to create critical skills and impetus for the entrepreneurial functions required to make innovation the engine of growth.

III. METHODOLOGY

1. Scope of the study

The scope of the study covered the major manufacturing subsectors in Nigeria. These include food, beverages and tobacco; chemical and allied products; pharmaceuticals; rubber and plastics products; paper, printing and publishing; metal and aluminum products; textiles and garments products; wood products and furniture; non-metallic mineral products; and electrical and electronics products.

2. Sampling, data collection and sources

There is currently no reliable data on firms' distribution in Nigeria, hence stratified sample is difficult to obtain. Manufacturing firms in Nigeria are known to exist in three main industrial clustering axes, namely:

cluster 1: Lagos-Agbara-Otta-Ibadan-Ilorin

cluster 2: Nnewi-Aba-Port Harcourt

cluster 3: Kano-Kaduna-Jos

Cluster 1 has at least 50% of Nigerian firms in number and value addition[8]. To ensure good quality data collection within the limits of available resources for the study we selected cluster 1 for the study. Besides, the location of at least half of the firms in cluster 1 suggests that the survey would have significantly captured and gathered information on the essential features of the Nigerian manufacturing firms. The survey was carried out between September and November 2007.

The lists of establishments engaged in manufacturing activities in cluster 1 were collected from the State offices of the National Bureau of Statistics (NBS) located in cluster 1. These states included Lagos, Ogun, Oyo, Ondo, Osun, and Kwara states. Though the lists are fairly comprehensive (except for Lagos State) and all have addresses of the locations of firms, they are not precise on key information required for selecting a stratified sample. The format for the lists is not uniform and not all has the required information on type of manufacturing and firm size. Based on perceived industrial concentration in each of the states 220 firms were selected for questionnaire lodgement as follows: Lagos -100; Ogun -40; Oyo -20; Ondo -20; Osun -20; Kwara -20. For each state, the sample selection was random, but guided by the perceived firm size and sub-sectoral distribution of firms in each state.

Enumerators were recruited and trained for the firm survey. When a firm originally included in the survey sample could not be located or was non-responsive to the survey, such a firm was replaced with a firm of similar characteristics in the same sub-sector. At the end of the survey, we had 153 questionnaires retrieved out of which 14 were rejected because of in-

[7] L. Kim, *Imitation to Innovation: The Dynamics of Korea's Technological Learning*, Harvard University Press, Boston, MA, 1997, p. 25.

[8] NPC, *Report of the Nigeria Vision 2020 National Technical Working Group on Manufacturing Thematic Area*, National Planning Commission (NPC), Abuja, Nigeria 2009, p. 43.

adequate responses. Thus the final research sample comprises of 139 firms.

3. Data analysis

The data analysis is largely descriptive, using measures of central tendency. For the variables that assessed the respondents' perception on a likert scale of 1 ("not important") to 4 ("very important"), the degree of importance of each factor is analyzed using the weighted average index (WAI). For the computation of WAI, 4 is assigned to the highest level of perception on the likert scale while 1 is assigned to the lowest level. In effect, if for a particular factor all respondents claim the highest degree of importance (i.e. "very important"), then the WAI would be 4.0 while the same would be 1.0 if all respondents claim the lowest degree of importance (i.e. "not important"). The weighted average index is expressed as:

$$WAI = \frac{\sum_{i=1}^{4} F_i W_i}{N}$$

where

F_i is the frequency of response;

W_i is the weight or number assigned to the response on the likert scale; and

N is the total number of responses.

IV. RESULTS AND DISCUSSION

1. Characteristics of the research sample

Table 1 shows the sectoral distribution of the research sample. More than half of the sample belongs to the food, beverages & tobacco; metal and aluminum products; and chemical and allied products contributing 23%, 17%, and

Table 1. Sectoral distribution of the research sample

Sector	Frequency	Percent
Food, beverages & tobacco	32	23.0
Chemical & allied products	18	12.9
Pharmaceuticals	13	9.4
Rubber & plastics	13	9.4
Paper/printing/publishing	10	7.2
Metal & aluminum products	24	17.3
Textiles & garments	15	10.8
Wood products & furniture	4	2.9
Non-metallic mineral products	8	5.8
Electrical & electronics	2	1.4
Total	**139**	**100.0**

Source: Analysis of field data

Table 2. Size distribution of firms in research sample

Size (no. of persons employed)	Frequency	Percent
10-49	34	26.0
50-199	57	43.5
200 or more	40	30.5
Total	**131**	**100.0**
Missing cases	8	

Source: Analysis of field data

13% of the sample respectively. In literature, firms have been diversely classified into small, medium and large-scale enterprises, either based on sales turnover, capital outlay or persons employed. In Africa, firms employing less than 10 persons are generally regarded as microenterprises. Firms employing 10 to 49 persons are usually considered small-sized, 50 to 199 medium-sized, and firms employing 200 or more persons are regarded as large-sized[9]. Following this classification, Table 2 presents the size distribution of firms in the research sample. 26% of the firms are small-sized, 43.5% are medium-sized, while 30.5% are large-sized.

2. Innovation and R&D activities

2.1. Introduction of new products and processes

Table 3 presents the nature of the new or improved products and processes introduced by the sampled firms in the last three years prior to the survey. Except for the case of the introduction of products or processes that are new for Nigeria but not new for the world, the trend in the product and process changes is fairly similar. Product or process changes that are new to the world are rare among the sampled firms. This is a common feature of immature nationally system of innovation (NSI) as represented by the case of Nigeria. No new product has been introduced by 18% of the respondents, improvement of the existing product was carried out by 74%, about 24% introduced products that are new for the firm but not new for Nigeria, while about 16% has introduced products that are new for the country but not new for the world. No new process has been introduced by 15% of the respondents, 77% has introduced improved processes, about 24% has introduced processes that are new for the firm but not new for Nigeria, while only about 9% has introduced processes that are new for Nigeria but not new for the world. It is apparent from these results that introduction of "products that are new for Nigeria, but not new to the world" is more common than the introduction of "processes that are new for Nigeria, but not new for the world". It thus appears that firms in the research sample are able to manufacture some new products without necessarily embarking on significant process changes.

Table 3. Nature of new or improved products and processes

Nature of innovation	Percent of respondents	
	Product*	Process*
No new product or process	18.1	15.1
Improvement on existing product or process	74.1	77.0
New for firm, but not new for country	23.7	23.7
New for country, but not new for the world	15.8	8.6
New for the world	2.2	2.2

* the sum of this column is not equal to 100 because each response may have more than one option as the nature of the product or process introduced

Source: Analysis of field data

[9] S. Lall, G.B. Navaretti, S. Teitel, G. Wignaraja, *Technology and Enterprise Development: Ghana Under Structural Adjustment*, Macmillan Press Ltd., London 1994, p. 54; B. Oyeyinka, *Technological Learning in African Industry: A Study of Engineering Firms in Nigeria*, "Science and Public Policy" 1997, p. 312.

2.2. Reasons for not investing in R&D

As earlier indicated, 41.2% of firms in the research sample claimed that they have not invested in R&D in the past three years. Table 4 presents the results of these firms' perception of reasons for not investing in R&D. The reasons were rated on a four-level likert scale spanning 1 (for "not important") to 4 (for "very important"). The weighted average index of the responses demonstrate that the importance of universities and public research institutes are rated very low as locations of substitute R&D that could serve as reasons for lack of firms' in-house R&D. As indicated by the weighted average index, the three most crucial reasons (in order of perceived importance) for lack of investment in R&D by firms are insufficiency of external sources of information for innovation, lack of access to credit, and high cost of R&D. Other reasons that are considered more than "slightly important" by firms are "R&D is not necessary for the firm's innovation" and "R&D investment is too risky".

3. Sources of information and knowledge

3.1. Sources of information or knowledge benefiting innovative activities

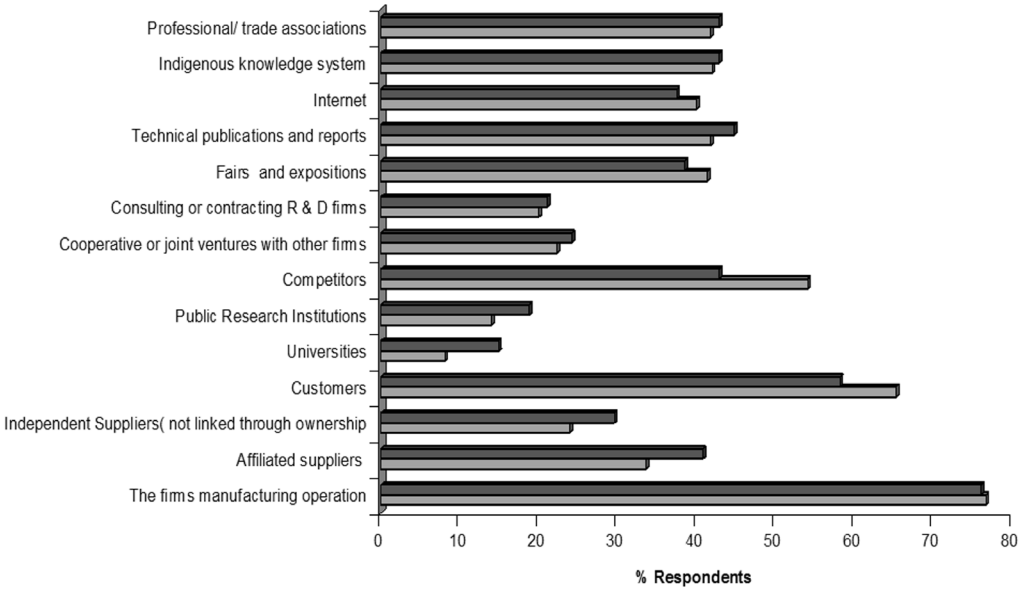
There are several sources of information and knowledge that contributes to firm's innovative activities. The decision to employ an information source largely depends on firm's ability to process, adapt and assimilate new knowledge. Firms were provided with a list of various sources of information and knowledge, and they were requested to indicate which of the sources had benefited the firm's innovative activities, in terms of suggestion of new projects or contribution to the completion of existing projects in the last three years. Figure 1 presents a comparison of the firms responses on how each of the sources of information and knowledge had either suggested new projects, or contributed to the completion of existing innovation projects.

Table 4. Firms' perception of reasons for not investing in R&D

Reason for not investing in R&D	Weighted average index
The firm does not innovate	1.8
Small market size disallow recovery of R&D invest.	1.9
R&D investment is too risky	2.1
R&D is too costly for the firm	2.3
Lack of access to credit	2.4
Difficulties to appropriate R&D results	1.8
Lack of public support	1.8
R&D is not necessary for the firm's innovation	2.2
External sources of info are sufficient for innovation	2.6
Universities substitute firm's R&D	1.4
Public research institutes substitute firm's R&D	1.6

Source: Analysis of field data

Figure 1: Sources of information and knowledge



Over 70% of the sampled firms indicated that the firms' manufacturing operations were a source of information for the suggestion of new projects as well as a source that had contributed to completion of existing projects. Customers were perceived by nearly two-thirds (65.3%) of the respondents as sources of information for the suggestion of new projects, while about 58% of the firms perceived customers as contributors to the completion of existing projects. Competitors were indicated by about 54% of the sampled firms as sources of information for new projects, while only about 43% of the respondents perceived that competitors had been sources of information that contributed to the completion of existing projects. Universities took the least position in the perception of firms as a source of information and knowledge that had resulted in the suggestion of new projects (8.1%) and contributed to the completion of existing projects (14.9%). The responses on firms' perception of the research institutes were only slightly better. Only 14% of the respondents considered public research institutes as sources of information on new projects while only about 19% of the respondents claimed that research institutes had been sources of information that contributed to the completion of existing projects. These results suggest that universities and research institutes had not been major sources of information and knowledge that contributed to the innovative activities of the sampled firms.

Figures 2 and 3 show the distribution of the respondents perception of the most important sources of information and knowledge for the suggestion of new projects and for completion of existing projects respectively. For the suggestion of new projects, 32.1% of the respondents claimed customers as the most important source of information, 21.7% claimed firms' manufacturing operations, while affiliated suppliers (suppliers linked through ownership such as parent, sister or subsidiary firm) was indicated

by 9.4% of the respondents. For the contribution to the completion of existing projects, 30.4% of the respondents viewed firms' manufacturing operations as the most important source of information, 17.6% indicated customers, while 11.8% mentioned affiliated suppliers (suppliers linked through ownership such as parent, sister or subsidiary firm) as the most important source of information. It thus appears that the three leading sources of information and knowledge for the suggestion of new projects are also the three leading sources of information and knowledge that contributed to the completion of existing innovative projects. It is also noteworthy that universities and research institutes are least considered as most important sources of information and knowledge by the respondents. In fact, none of the firms considered universities as most important source for information for completing existing innovation projects.

Figure 2: Distribution of most important source of information for the suggestion of new projects

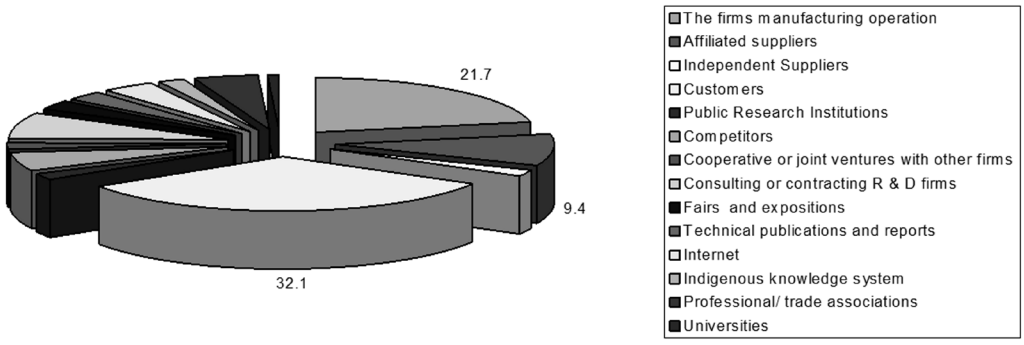
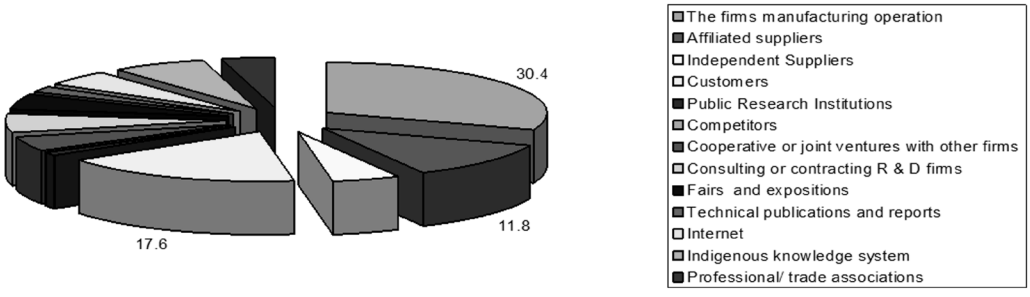


Figure 3: Distribution of most important source of information for the completion of existing projects



3.2. Why universities and public research institutes are not important sources of information for innovation

Table 5 presents the results of the weighted average index analysis of the responses given by the sampled firms on why universities and research institutes are not important sources of information for innovation. The two reasons with the highest WAI of 2.3 suggest that universities and research institutes are not rated as important sources of information for innovation because firm's R&D are considered enough to innovate and the quality of research in universities and research institutes are considered low. Added to this, reasons that are perceived by the respondents as more than "slightly important" as indicated by the WAI of 2.2 include the lack of understanding of firms' line of business by universities and public research institutes, and universities' focus on big science. Other reasons mentioned in Table 5 have WAI less than 2.0, suggesting that they are generally perceived by the sampled firms to be less than "slightly important" as explanations for why universities and research institutes are not important sources of information for innovation.

3.3. Channels of information and modes of interactions

The results of the weighted average index (WAI) analysis for the sampled firms' rating of the importance of channels of information about R&D activities or innovations of other firms are shown in Table 6. The WAI ranged between 2.0 and 2.9. This indicates that each of the listed channels of information is considered to be at least "slightly important". The two channels of information that have highest degrees of importance are "publications and report" and "public conferences and meetings" each with WAI equal to 2.9. "Informal information" and "fairs and expositions" are also perceived with considerable degree of importance with each having a WAI of 2.7. The channels of information that have the lowest ratings are "joint or cooperative R&D projects" and "contract research with other firms" with WAI of 2.0 and 2.1 respectively. It thus appears that the most important channels of sharing information about R&D activities and innovations are not channels that enable close interactions or joint investments in R&D projects.

Table 5. Firms' perception of reasons why academia are not important sources of information

Reasons	Weighted average index
Our firm's R & D is enough to innovate	2.3
Universities have no understanding of our line of business	2.2
Public research institutes have no understanding of our line of business	2.2
Contractual agreement difficult	1.9
Lack of trust	1.8
Quality of research is low	2.3
University concerned with only big science	2.2
Geographic distance	1.6
Dialogue is very difficult	1.7
Intellectual property issues	1.9

Source: Analysis of field data

Table 6. Rating of the importance of channels of information about R&D activities or innovations of other firms

Channels of information	Weighted average index
Patents	2.3
Publications and reports	2.9
Public conferences and meetings	2.9
Informal information exchange	2.7
Recently hired technical personnel	2.4
Licensed technology	2.2
Joint or cooperative R&D projects	2.0
Contract research with other firms	2.1
Products (for example, by reverse engineering)	2.5
Trade associations	2.3
Fair and expositions	2.7

Source: Analysis of field data

Table 7 presents the results of the weighted average index analysis of the rating of the importance of channels of information and modes of interactions about the research activities or research findings of universities and research institutes. For most of the channels of information, the ratings of the importance have identical WAI for both universities and research institutes. This suggests that the sampled firms' perception of the importance of the channels

Table 7. Channels of information and modes of interactions about the research activities of universities and research institutes

Channels of information/ Modes of interactions	Weighted average index	
	Universities	Research institutes
Patents	2.0	2.0
Publications and reports	2.7	2.6
Public conferences and meetings	2.6	2.5
Informal information exchange	2.1	2.0
Recently hired graduates with advanced degree	2.1	1.9
Licensed technology	2.3	2.0
Consulting with individual researchers	2.0	1.9
Contract research with universities	1.7	n.a
Contract research with research institutes	n.a	1.7
Joint or cooperative R&D projects	1.6	1.6
Participation in networks that involve universities	1.6	n.a
Participation in networks that involve research institutes	n.a	1.6
Temporary personnel exchanges	1.6	1.5
Incubators	1.4	1.4
Science and/or technology parks	1.9	1.9
Firm is owned by an university (URE)	1.3	n.a
Firm is owned by a research institute	n.a	1.3
Firm is a spin-off of an university	1.3	n.a
Firm is a spin-off of a research institute	n.a	1.3

n.a. = not applicable

Source: Analysis of field data

of information for universities and research institutes may not be significantly different. The results also demonstrate that, as in the case of respondents' interaction with other firms, the importance of "publications and reports" and "public conferences and meetings" have the highest ratings as channels of information and modes of interactions that have contributed to the respondent firms' innovative activities. The level of importance is however slightly higher for universities with WAI of 2.7 and 2.6 compared to WAI of 2.6 and 2.5 for the responses for research institutes.

For the universities, other channels of information viewed by the respondents as important and having WAI of at least 2.0 include licensed technology, informal information exchange, recently hired graduates with advanced degree, patents, and consulting with individual researchers with WAI of 2.3, 2.1, 2.1, 2.0 and 2.0 respectively. Similarly, for research institutes, other channels of information viewed by the respondents as important and having WAI of at least 2.0 include licensed technology, informal information exchange, and patents each of which has a WAI of 2.0. For both universities and research institutes firm ownership (WAI=1.3) and spin-offs (WAI=1.3) were considered least important as channels of information by the respondents firms. Incubators were also considered to have very low importance as channels of information by the respondent firms. Thus, firms owned by universities or research institutes, spin-offs, and incubators scored relatively low in terms of the importance of their contribution to the innovative activities of the respondent firms. Overall, the results in Table 7 demonstrate that arms length relationships predominate.

3.4. Use of the research outputs and resources from universities and research institutes

Table 8 shows the results of the weighted average index (WAI) analysis of firms' perception of the degree of importance of the usefulness of research outputs and resources over the last three years preceding the survey. New techniques and instruments were rated highest with WAI equal to 2.7. Research findings and laboratories/metrology have WAI of 2.4 and 2.3 respectively while prototypes have WAI of 1.9. These results indicate that the degree of importance of the usefulness of prototypes to the innovative activities of the respondent firms is less than "slightly important", whereas other research outputs or resources are considered to be more than "slightly important".

4. Collaboration with universities and public research institutes

The results reveal a generally low response rate of less than 30% to the question asking the respondent firms to indicate the degree of importance of the objectives of collaborations with universities and public research institutes. This confirms the

Table 8. Firms' perception of the importance of the use of research outputs or resources

Research outputs or resources	Weighted average index
Research findings	2.4
Prototypes	1.9
New techniques and instruments	2.7
Laboratories/Metrology	2.3

Source: Analysis of field data

findings of previous studies,[10] which indicated that collaborations between firms and universities/public research institutes are not common in Nigeria. Table 9 shows the results of the weighted average index (WAI) analysis of the respondent firms' perception of the degree of importance of the objectives of collaboration. The objectives "to help in quality control" and "to perform tests necessary for products/processes" were rated as at least "moderately important" by most respondents with WAI equal to 2.9 and 2.7 respectively. This was followed by the objectives "to get technological/consulting advice from researchers and/or professors in solving production related problems" with WAI equal to 2.3 and "to contract research helpful to the firm's innovative activities (complementary research by universities and public research institutes)" with WAI equal to 2.3. Also regarded as more than "slightly important" by most of the respondents are the objectives "to use resources available at universities and public research institutes", "to augment the firm's limited ability to find and absorb technological information", and "to get information about engineers or scientists and/or trends in R & D in the field" with WAI equal to 2.2, 2.2, and 2.1 respectively. Next to these is the objective of technology transfer from the university which was rated as "slightly important" with WAI equal to 2.0. However, to contract research that the firm cannot perform (substitutive research by universities and public research institutes) as well as to make earlier contact with excellent university students for future recruiting were rated less than "slightly important" by most of the respondents as indicated by the WAI of 1.9 and 1.8 respectively.

From the foregoing analysis, it can be concluded that most of the respondents did not consider the objectives of collaboration mentioned above as "very important" or "moderately important". Majority of the objectives for collaboration are rated as either "slightly important" or "not important". This further shows that there is relatively weak collaboration between firms and academia (universities and public research institutes) in Nigeria.

Table 9. Objectives of collaboration with universities/public research institutes by order of importance

Objectives of Collaboration	Weighted average index
Technology transfer from the university	2.0
To get technological/consulting advice from researchers and/or professors in solving production-related problems	2.3
To get augment the firm's limited ability to find and absorb technological information	2.2
To get information about engineers or scientists and/or trends in R & D in the field	2.1
To contract research helpful to the firm's innovative activities (complementary research by universities and public research institutes)	2.3
To contract research that the firm cannot perform (substitutive research by universities and public research institutes)	1.9
To make earlier contact with excellent university students for future recruiting	1.8
To use resources available at universities and public research institutes	2.2
To perform tests necessary for your products/processes	2.7
To help in quality control	2.9

Source: Source: Analysis of field data

[10] E. Okejiri, *Foreign Technology and Development of Indigenous Technological Capabilities in Nigerian Manufacturing Industry*, "Technology in Society" 2000, p. 194; J.O. Adeoti, *Biotechnology R&D Partnership for Industrial Innovation in Nigeria*, "Technovation" 2005, p. 359.

The major reasons why collaboration with universities/research institutes has been weak or failed to meet the expected objectives are analyzed in Table 10. The findings show that lack of enough "science orientation" of the researchers at the universities/research institutes is the least important reason for the failure of collaborations between firms and universities/research institutes. It thus appears that the lack of collaboration between firms and universities is not because researchers are not interested in deepening knowledge. The three factors that ranked highest as reasons why collaborations failed provide insights into the actual rationales for failure of collaborations. As demonstrated by the weighted average index analysis, the three reasons that ranked highest (in order of importance) are: low sensitivity of universities to firm's demands; mismatch between knowledge available at the university/research institutes and that needed by the firm; and researchers at the universities/research institutes are too "science oriented" with WAI equal to 2.1, 2.0 and 2.0 respectively. Other reasons mentioned in Table 10 were claimed to be less than "slightly important" by most of the respondents. It should also be noted that most of the respondents claimed that the reasons listed for failed collaboration in Table 10 are less than "moderately important". Besides, none of the respondents indicated that any of the reasons is "very important".

V. CONCLUSIONS AND POLICY IMPLICATIONS

The results of the study show that introduction of "products that are new for Nigeria, but not new to the world" is more common than the introduction of "processes that are new for Nigeria, but not new for the world". It thus appears that firms in the research sample are able to manufacture some new products without necessarily embarking on significant process changes. As indicated by the weighted average index analysis, the three most crucial reasons (in order of perceived importance) for lack of investment in R&D by firms are insufficiency of external sources of information for innovation, lack of access to credit, and high cost of R&D. These findings suggest that while firms have some capability using existing production processes to manufacture products that are new to Nigeria, R&D capability is still very weak. To build local technological capability incen-

Table 10. Reasons for failure of collaboration with universities/public research institutes

Reasons why collaboration failed to meet expected objectives	Weighted average index
Mismatch between knowledge available at the university/ research institutes and that needed by the firm	2.0
Differences in timing	1.8
Differences in points of view and/or objectives	1.9
Researchers at the universities/research institutes are too "science oriented"	2.0
Researchers at the universities/research institutes are not enough "science oriented"	1.3
Low sensitivity of universities to firm's demands	2.1
Differences regarding the appropriability of the results of the collaborative project (intellectual property issues)	1.8
Lack of preparation of firm's personnel to deal with university	1.8

Source: Analysis of field data

tives must be provided to significantly improve firms' investment in R&D. Significant increase in R&D investments would most probably also enable process changes that will result in better product innovations.

Universities took the least position in the perception of firms as a source of information and knowledge that had resulted in new projects or completion of existing innovative projects. The responses on firms' perception of the research institutes were only slightly better. These results suggest that universities and research institutes had not been major sources of information and knowledge that contributed to the innovative activities of the sampled firms. The three leading sources of information and knowledge for innovative projects are customers, firms' manufacturing operations, and affiliated suppliers (suppliers linked through ownership such as parent, sister or subsidiary firm). Generally speaking, universities and research institutes are not rated as important sources of information for innovation because firm's R&D are considered enough to innovate and the quality of research in universities and research institutes are considered low. It thus follows that building local technological capability would require increased public (and private sector) investment aimed at raising the quality of R&D in universities and research institutes.

The two channels of information that have highest degrees of importance as means of sharing information about R&D activities or innovations of other firms are "publications and report" and "public conferences and meetings". The channels of information that have the lowest ratings are "joint or cooperative R&D projects" and "contract research with other firms". These results indicate that the most important channels of sharing information about R&D activities and innovations are not channels that enable close interactions or joint investments in R&D projects. For most of the channels of information, the ratings of the importance are identical for both universities and research institutes. This indicates that the sampled firms' perception of the importance of the channels of information for universities and research institutes may not be significantly different.

Most of the respondents did not consider the objectives of collaboration as "very important" or "moderately important". Majority of the objectives for collaboration are rated as either "slightly important" or "not important". This further shows that there is relatively weak collaboration between firms and universities/public research institutes in Nigeria. The results suggest that lack of collaboration between firms and universities is not because researchers are not interested in deepening knowledge. Rather, the three factors that ranked highest as reasons why collaborations failed are (in order of importance): low sensitivity of universities to firm's demands; mismatch between knowledge available at the university/research institutes and that needed by the firm; and researchers at the universities/research institutes are too "science oriented".

In conclusion, it is important to stress that the findings of the study demonstrated that academia-industry interaction in Nigeria is generally weak from the perception of firms. Firms' interaction with public research institutes showed a remarkably similar character as the interaction with universities. The challenge of firms' collaboration with universities and/

or public research institutes on R&D or innovation projects is thus largely an issue of how to remove the constraints on the interactions between firms and universities/public research institutes. Building local technological capability require networks and interactions that engender technological learning. The sample firms are deficient in this respect, suggesting that innovation policy in Nigeria should particularly aim at promoting collaborative R&D projects.

It is also important to mention that the conclusions drawn from the study is limited by the fact that only the perception of firms are analysed. For a deeper and more balanced understanding of the academia-industry interactions, it would be useful to also carry out a complementary analysis of the perception of researchers from universities and public research institutes.

KEYWORDS

Academia-industry interaction, R&D, manufacturing, Nigeria

SUMMARY

The contribution of academia to economic development depends on the extent to which firms are able to employ the knowledge they generate. This paper draws from the report of a survey of Nigerian manufacturing firms aimed at ascertaining the level and scope of firms' interaction with the academia comprising of universities and public research institutes, and their implications for building local technological capability. The results of the study showed that while firms have used existing production processes to manufacture products that are new to Nigeria, R&D capability is still relatively weak. The academia took the least position in the perception of firms as source of knowledge that had resulted in new projects or completion of existing innovative projects. Firms generally perceive the quality of R&D in the universities and research institutes to be low, and hence depend largely on their limited in-house R&D. It thus follows that building local technological capability would require raising the quality of R&D in universities and research institutes, and active promotion of collaborative R&D projects between firms and universities/research institutes.

STRESZCZENIE

Wkład nauki w rozwój gospodarczy zależy, od stopnia w jakim przedsiębiorstwa są w stanie zatrudniać wiedzę, którą generują. Ten artykuł sporządzono na podstawie raportu z badania nigeryjskich przedsiębiorstw produkcyjnych, którego celem było ustalenie poziomu i zakresu interakcji przedsiębiorstw ze środowiskiem akademickim zawierającym uniwersytety i publiczne instytucje badawcze i ich implikacje dla tworzenia lokalnych możliwości technologicznych. Wyniki badania pokazały, że podczas gdy firmy stosują istniejące procesy produkcyjne do wytwarzania produktów, które są nowe w Nigerii to możliwości R&D (badań i rozwoju, ang. research and development) są wciąż stosunkowo słabe. Środowisko akademickie zajęło najmniej ważną pozycję w postrzeganiu przez przedsiębiorstwa jako źródło wiedzy, które pociąga za sobą nowe projekty albo realizację istniejących innowacyjnych projektów. Firmy na ogół postrzegają jakość R&D na uniwersytetach i w instytucjach badawczych jako niską instytuty badawcze będą niskie, i od tego zależy ich ograniczony wewnętrzny R & D.

Z tego wynika, że budowanie lokalnych zdolności technologicznych wymagałoby ppodniesienia jakości badań i rozwoju na uniwersytetach i w instytucjach badawczych oraz aktywną promocję wspólnych projektów badawczo-rozwojowych między przedsiębiorstwami i uczelniami/ośrodkami badawczymi.

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