EFFECT OF UNIVERSITY-INDUSTRY LINKAGES ON COMMERCIALIZATION OF INNOVATIONS OF HIGHER EDUCATION: EVIDENCE FROM ENUGU STATE, SOUTH-EAST NIGERIA

IBEME, Nwamaka Patricia
Department of Public Administration
National Open University of Nigeria
Emails: **makspals@yahoo.com   nibeme@noun.edu.ng**

Abstract

The study examined the effect of linkages between university and industries on commercialization of innovations of higher education in Nigeria with evidence from Enugu State, South-East Nigeria. Some of the objectives of this study were to: examine the effect of government policies on the number of Intellectual Rights sold or bought; find out the effect of funding mechanisms on the number of research contracts awarded to academic staff. The methodology adopted by this study was descriptive survey research. Questionnaire that comprised 19 close-ended items that were set on the 5-point Likert-type scale was used to collect primary data from the five sample units. Results of the reliability test carried out on the said research instrument showed that it had a Cronbach's Alpha Index of 0.84. The sample units included the University of Nigeria Nsukka, Enugu State University of Science and Technology, Enugu, National Open University of Nigeria, Enugu State Government and the Ama Plant of Nigerian Breweries Plc. The population for the study was 4,281 out of which a sample of 353 respondents was drawn using Cochran's finite population correction technique. Target respondents for the survey were selected using purposive sampling technique, which used only the staff of the units sampled who possessed good knowledge of issues involved in university - industry linkages. Descriptive statistics comprising frequency counts, tables, and percentages was used to analyze the data that resulted from coding of the responses from respondents, while Multiple Regression Analysis was used to test the four hypotheses of the study. The study found that government policies had significant effect on the number of Intellectual Property Rights sold or bought; that human resource development had significant effect on the number of scientific conferences or training sponsored by the government or firms. The study recommended that: government should strive to provide the enabling environment that paves the way for effective university-industry partnerships; sustainable funding mechanism that will target multiple levels including government, private sector and productive sector to be put in place; and, stakeholders in the university-industry linkages should embark on regular capacity-building on relevant skills.

Key Words: Linkages, Partnerships, Commercialization, Invention, University, Industry

Introduction

Synergies between higher educational institutions and industries (and other players in the productive sector) can play a critical role in securing and leveraging additional resources for higher education, promoting innovation and technology transfer, and ensuring that graduates have the skills and knowledge required to effectively contribute to the workforce (Mouton, 2015). As a matter of fact, there has to be a very strong collaborative partnership between Higher Educational Institutions, Government and the Industry, the "Triple Helix", the confluence which is a powerful one that drives the economies of nations (Bogoro, 2015:2).

In the developed or industrialized countries, partnership between University and Research Institutes, on one hand, and industry and governments, on the other, is one of the most effective strategies for technology development and a useful tool for ensuring the effective and efficient application of science and technology to the resolution of social problems. Such partnerships take many forms including the joint execution of research projects, the award of research contracts, the development of curricula and the provision of continuing engineering education for practicing engineers and scientists. Because of the awareness of the direct and indirect benefits associated with the partnerships, they occur readily with less external prodding. Furthermore, each of the partners has in place the policies and institutional arrangements to engage in such collaborative work and researchers with scientific ideas of economic value are assisted in forging links with industries/entrepreneurs and financial institutions (Bamiro, 2015).

However, in most African countries, partnership between local industries and universities is not very common. Hence, the transformation of research results to products/technologies is usually left to the individual who, without the necessary institutional framework and experience, only allows the idea to collect dust in a little known journal. There are several reasons why the enabling institutional arrangements for such partnerships have not developed over the years.

In fact, many countries in Africa lack an enabling environment for reorienting and aligning universities and other higher education institutions (Universities) towards a more entrepreneurial role. Apart from perhaps the Maghreb region and South Africa, most of sub-Saharan Africa lack high-tech industries and a true technology culture that arises from the constant pressure to update and deepen technology in order to survive in a competitive marketplace (Sawyerr and Barry, 2018). Many of Africa's industries are often small to medium-scale firms producing for local markets, while the relatively larger ones are subsidiaries of transnational companies which draw upon the in-house Research and Development capabilities of the parent company. Others note lack of awareness of the existing research results and new technologies by industry; the absence of strong involvement of the users in defining the research agenda; and, the irrelevance of some university research (Dhesi and Chadha, 2016). Other factors identified include lack of sufficiently qualified researchers, weak research infrastructure, inadequate funding for research, and donor-influenced research priorities (Barry, 2016; Mouton, 2017). Under such conditions, the link between the supply of skills and new knowledge from higher education institutions in Africa and the demand for these from industries and other parts of the productive sectors are not clearly established. Low investment in science and technology and lack of national strategies further compound the difficulties (Mouton, 2018).

In Nigeria, the university system was initiated with the establishment of the first university in 1948. The colonial government was essentially concerned with creating a pool of manpower required for the civil service. The immediate post-independence years witnessed the establishment of three new universities one in each of the three regions that then existed. Since then till date, the number of educational and knowledge infrastructure has grown astronomically with 153, over 100 polytechnics, over 98 colleges and over 300 research institutes and innovation agencies (Ogunwusi & Ibrahim, 2014; Jegede, 2016a, 2016b, 2016c, 2017). It was generally recognized that the relatively few educated Nigerians lacked any knowledge of managerial and technical skills required for industrial production and development. The establishment of these institutions was thus part of the efforts to improve the local supply of skilled manpower (Adeoti, 2016).

On one hand, universities in Nigeria increased in number (and some also increased in size) and, on the other hand, industrialization was promoted under import substitution strategy. Both university development and industrialization progressed in the decades of 1960s and 1970s. Educational development and industrialization were both supported by the oil economy until the decline in the price of crude oil in the late 1970s. The de-industrialization that was glaring by mid 1980s and the crisis of decline in government support for the universities that began in late 1970s brought out the first set of indications that both the university system and the Import Substitution Industrialization (ISI) strategy were very weak and unable to sustain economic growth of the 1960s and early 1970s.

The increasing role of knowledge in development suggests that universities, government and industry have to interact not only to create, but also to employ knowledge for development. While there are ample evidence of interaction between universities and industry in developed and newly industrializing countries, developing countries are replete with universities that function, for the most part, independent of industry; and industry that depends on foreign sources of knowledge to sustain production and possibly meet competitive challenges.

In this paper, we examined the effect of tripartite linkages involving Universities, industry, and government on commercialization of research findings towards increased economic growth and development in Nigeria. We obtained empirical evidence from selected Universities, firms and government. These were represented by the Enugu State Government, University of Nigeria Nsukka (UNN), Enugu State University of Science and Technology (ESUT), and National Open University of Nigeria (NOUN) Enugu Study Centre and on the side of industry, the Ama Plant of the Nigerian Breweries Plc, 9th Mile Corner Ngwo, and Innoson Industrial and Technical Company Limited, Enugu.

Statement of the Problem

In Nigeria, while the national Science, Technology and Innovation (STI) system is expansive and massive, it has not resulted in significant expansion in industrial activities and national economic prosperity. This is because of little or no interaction among the actors, weak infrastructure and insignificant fund appropriation, thereby limiting national economic, technological and industrial growth and development. In view of the low level of industrialization in Nigeria, the country has institutionalized a Vision 20-2020 to position it as one of the top 20 global economies by the year 2020, Thus, Nigeria aims at significantly

increasing the manufacturing local content and linkages with other sectors of the economy with the specific objective of enhancing global competitiveness of locally produced goods and services. In achieving this role, there is need to intensify effort in developing science and technology infrastructure, and thereby expand the potential of innovation in the industrialization process. From assessment by experts, Nigeria's journey towards achievement of its Vision 20/2020 initiative will be constrained by a number of factors. Among these are the country's low technological capabilities, low level of infrastructure to modulate innovation capacity or ability to create or apply new knowledge to solve practical problems. According to experts, Nigeria currently stands at 66th position out of 73 countries in an assessment that ranked nations according to innovation capacity.

In 1986, the first National Policy on Science and Technology (S&T) was launched. The policy identified that S&T-related activities in the country had been carried out without well- defined national direction. The public universities, research institutes and research outfits in private sector companies are expected to be drivers of research and development and home-grown technologies. Also, R&D are expected to lead to home-grown industries and multinational companies within the country, However, since 1964 till now, despite the endowment of the nation with a large population and abundant natural resources, Nigeria is yet to advance economically. Up till now, the nation does not have any globally branded product, multinational company, technical and managerial expertise or worldwide range of Intellectual Property Rights exploited globally that emanated from its indigenous knowledge and industrial efforts. While educational and knowledge infrastructure abound in the country with about 153 universities, over 125 poly-techniques, over 98 colleges of education, over 300 institutions composed of research institutes, innovation agencies and policy implementation departments, multinational companies and large pool of skilled labour force including a sizeable number of diaspora, the economy is still technologically weak with a very high national poverty incidence that implies that over 100 million Nigerians are living below the poverty line. In fact, many countries in Africa lack an enabling environment for reorienting and aligning universities and other higher education institutions (universities) towards a more entrepreneurial role.

Apart from perhaps the Maghreb region and South Africa, most of sub-Saharan Africa lack high-tech industries and a true technology culture that arises from the constant pressure to update and deepen technology in order to survive in a competitive marketplace (Sawyerr and Barry, 2018). Many of Africa's industries are often small to medium-scale firms producing for local markets, while the relatively larger ones are subsidiaries of transnational companies which draw upon the in-house R&D capabilities of the parent company. Others note lack of awareness of the existing research results and new technologies by industry; the absence of strong involvement of the users in defining the research agenda; and, the irrelevance of some university research (Dhesi and Chadha, 2016). Other factors identified include lack of sufficiently qualified researchers, weak research infrastructure, inadequate funding for research and donor-influenced research priorities (Barry, 2016; Mouton, 2017). Under such conditions, the link between the supply of skills and new knowledge from higher education institutions in Africa and the demand for these from industries and other parts of the productive sectors are not clearly established. Low investment in science and technology and lack of national strategies further compound the difficulties (Mouton, 2018).

The following are the research questions for this study.

1.   What is the effect of government policies on university industry linkages on the number of licensed inventions being sold or bought in the system of innovation in Enugu State,   Nigeria?

2.   What is the effect of funding mechanisms on the number of research contracts awarded to academic staff in Enugu State, Nigeria?

3.   What is the effect of human resource development on the number of scientific conference or training sponsored by government or industries in Enugu State, Nigeria?

4.   What is the effect of communications strategies on the number of licensed inventions being marketed or sold by Universities in Enugu State, Nigeria?

This study pursued the following specific objectives:

1.   To find out the effect of government policies on university industry linkages on the number of licensed inventions being sold or bought in the system of innovation in Enugu State, Nigeria.

2.   To investigate the effect of funding mechanisms on the number of research contracts awarded to academic staff in Enugu State, Nigeria.

3.   To assess the effect of human resource development on the number of scientific conferences or training programmes sponsored by government or industries in Enugu State, Nigeria.

4.   To examine the effect of communications strategies on the number of licensed inventions being marketed or sold by universities in Enugu State, Nigeria.

Research Hypotheses

i: Government policies on university industry linkages have no significant effect on the number of licensed inventions being sold or bought in the system of innovation in Enugu State, Nigeria.

ii: Funding mechanisms for university industry linkages have no significant effect on the number of research contracts awarded to academic staff in Enugu State, Nigeria.

iii: Human resource development in key areas of university industry linkages has no significant effect on the number of scientific conferences or training sponsored by government or industries in Enugu State, Nigeria.

iv: Communications strategies with the outside world by universities have no significant effect on the number of licensed inventions being marketed or sold by Universities in Enugu State, Nigeria.

Theoretical Framework
Diffusion of Information (DOI) Theory
According to Rogers (2003), this theory seeks to explain how, why, and at what rate new ideas and technology spread through cultures. This theory was developed and popularized by F.M. Rogers (1962) in his book, *Diffusion of Innovations*. He opines that diffusion is the

process by which an innovation is communicated through certain channels over time among the members of a social system or specific population.

Rogers (2003) explained the process of innovation diffusion as one which is dictated by uncertainty reduction behaviour amongst potential adopters during the introduction of technological innovations. Innovation Diffusion Theory (IDT) consists of six major components: innovation, characteristics, individual user characteristics, adopter distribution over time, diffusion networks, innovativeness and adopter categories, and the individual adoption process. Arguably, the most popular of the six components of IDT centers on the characteristics of the innovation itself. After analyzing a variety of previous innovation diffusion studies, Rogers singled out the five characteristics of innovations that consistently influence the adoption of new technologies.

The New Growth Theory (NGT)

The *New Growth Theory* is championed by Romer (1994). The theory is, of course, an offshoot of the classical theory known as *Human Capital Theory,* which defined human capital as the stock of individual knowledge, ideas, skills, capabilities, and core competencies that is acquired through education and training and also include talents, intelligent quotient (IQ), practical experiences etc (Dosi, 1993; Grossman and Helpman, 1994; Marshal, 1920).

The New Growth Theory holds that unlike physical objects, knowledge and skills or technology are characterized by increasing returns, and these increasing returns drive the process of growth. The Theory emphasizes that economic growth results from the increasing returns associated with new knowledge. Knowledge has different properties than other economic goods (being non-rival, and partly excludable). The ability to grow the economy by increasing knowledge rather than labour or capital creates opportunities for nearly boundless growth. Markets fail to produce enough knowledge because innovators cannot capture all the gains associated with creating new knowledge. Obviously because knowledge can be infinitely reused at zero marginal cost, firms which use knowledge in production can earn quasi-monopoly profits. All forms of knowledge, from big science to better ways to sew a shirt exhibit these properties and contribute to growth.

This new theory addresses the fundamental questions about what makes economies grow: why is the world measurably richer today than a century ago? Why have some nations grown more than others? Because ideas can be infinitely shared and reused, we can accumulate them without limit. They are not subject to what economists call "diminishing returns". Instead, the increasing returns to knowledge propel economic growth.

New Growth Theory helps us make sense of the ongoing shift from a resource-based economy to knowledge-based economy. It underscores the point that the economic processes which create and diffuse new knowledge are critical to shaping the growth of nations, communities and individual firms. Ultimately, all increases in standards of living can be traced to discoveries of more valuable arrangements for the things in the earth's crust and atmosphere. No amount of savings and investment, no policy of macroeconomic fine-tuning, no set of tax and spending incentives can generate sustained economic growth unless it is accompanied by the countless large and small discoveries (rooted in ideas or knowledge) required to create more value from a fixed set of natural resources (Romer, 1993b: 345).

Today, we tend to focus on the computer and the Internet as the icons of economic progress, but it is the process that generates new ideas and innovations, not the technologies themselves, that is the force that sustains economic growth.

Romer (2003) is credited with stimulating New Growth Theory, but as Romer himself notes (Romer, 1994b), there is really nothing new about the theory itself. The central notion behind New Growth Theory is increasing returns associated with new knowledge.

The physical world is characterized by diminishing returns. Diminishing returns are the result of the scarcity of physical objects. One of the most important differences between objects and ideas is that ideas are not scarce and the process of discovery in the realm of ideas does not suffer from diminishing returns (Romer quoted in Kurtzman, 1997).

The centerpiece of New Growth Theory is the role knowledge plays in making growth possible. Knowledge includes everything we know about the world, from the basic laws of physics, to the blueprint for a microprocessor, to how to sew a shirt or paint a portrait. Our definition should be very broad including not just the high tech, but also the seemingly routine.

Conceptual Framework
Research Findings, Inventions and Innovations

Research findings simply refers to the outcome in the form of special knowledge that results from research efforts, be it, basic research, applied research or development researcher carried out by higher institutions of learning, research institutes, or industrial firms (Bentley, 2018). In the linear model of innovation, public research especially in the universities generates basic knowledge, which leads to inventions and inventions when commercialized, become innovations (Adeoti, 2016b). Innovation, on the other hand, is defined as the application of basic knowledge acquired through science and technology research and investment to achieve physical production of goods and services (Roggers, 2007). It must be noted that this knowledge might be acquired through learning, research or experience. But until this knowledge is applied in physical production of goods and services and translated to development, it cannot be considered to be 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 real technological change required for economic progress are located outside the ivory towers. However, several studies that illustrated the NSI framework have proven that economies that are innovation-driven (i.e. knowledge economies) are characterized by evident strong university-industry collaborations, especially in strategic sectors of the economy.

Research and Development (R & D)

Research is a means of demonstrating one's ability and capability in solving an identified problem and it is an important pointer to the national technological capability (Oguwusi & Ibrahim, 2016). One of the major roles of research is in breeding industrialization which brings about jobs and wealth creation, arrests social menace, assists in curbing rural-urban migration and poverty reduction.

Research as an endavour comes in three forms: basic (theoretic or experimental) research, applied research, and development research. Basic research as identified by Frascat-Manual (2018) and Yusuf (2016) refers to experimental or theoretic work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts without any particular application in use. The main aim of this research is to gain deeper knowledge or understanding of the subject without specific application in mind. Basic research does not have specific immediate commercial objectives, although it may be performed in fields of present or potential commercial interest. The outcomes or results are not generally sold but are usually published in scientific journals or circulated to interested groups. Applied research, on the other hand, are undertaken as original investigation to acquire the knowledge. According to Siyanbola (2018), it is primarily directed towards a specific practical aim or objective to gain knowledge in meeting a specific and recognized need. In industry, applied research are undertaken to discover new scientific knowledge that has commercial objectives with respect to products, processes or services. This type of research gives operational forms to ideas and the knowledge or information obtained from it is often patented, but may also be kept from the public. The third type of research, the development research is the systematic use of the knowledge derived from research directed towards production of useful materials, devices, systems or methods including the design and development of prototypes and processes. This type of research is systematic in nature, inferring from knowledge gained through research and practical experience which is directed to producing new products, devices as well as installing new ones and improving the existing ones. The outcomes are intended primarily to produce particular products that will be able to meet customers' expectations in the market or a product that will enhance productivity. In the US for instance, the universities and colleges performed approximately 53.8% basic research and the federal government estimated to have provided 58.90% basic research funding most of the time. Industry, on its own part, accounts for 65.7% of all applied research, while federal laboratories and universities accounted for the rest.

The Concept of National System of Innovation (NSI)
Freeman (1987) defines NSI as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies. He further elaborates in Freeman (1992) that NSI may be used in a broad or narrow sense. In a broad sense, NSI encompasses all institutions which affect the introduction and diffusion of new products, processes and systems in a national economy; while in a narrow sense it only involves the institutions that are directly concerned with scientific and technical activities. For the purpose of our discourse, NSI in the broad sense would provide a more comprehensive overview needed to understand the local focus and global reach of the knowledge accumulation and application processes that are required to tackle underdevelopment and put the economy on the path of sustainable growth.

According to Lundvall (2012) and Adeoti (2016a), the elements of NSI include: internal organization of firms, inter-firm relationships; role of the public sector, institutional set-up of the financial sector, R&D intensity and R&D organization, and the educational and training system. NSI may be viewed as an integrated system of economic and institutional agents directly promoting the generation and use of innovation in a national economy.

Schumpeter (1949) expressed innovation as outcome of different combinations of resources. The making of new combinations to generate new products or processes is knowledge dependent and saddled with uncertainties that make continuous investment in knowledge an imperative. Klime and Rosenberg (2016) also emphasized the importance of knowledge in the innovation process. They defined knowledge as the 'stock part' of science and expressed research as the 'flow part' that creates new knowledge or knowledge that adds to the accumulated knowledge of the NSI. As presented in a taxonomy by Johnson *et al.* (2002), knowledge can also be viewed in terms of what, who, why and how we know thing. In context of NSI, knowledge that produces innovation is synonymous with what Kuznet (2017: 91), termed "useful knowledge" as proxy for technological knowledge that drives modem economic growth.

From the foregoing, the NSI framework suggests that there is a local focus in knowledge for development while at the same time the challenge of international competitiveness demands a global reach for knowledge or technology at the frontier. The local focus is essentially a necessity arising from the fact that local technological capability should attain some level at which it can assimilate foreign technology and adapt it to address local development problems. This local focus would comprise the generation and use of knowledge at the local level to build competence that transcends traditional barriers to knowledge in both formal and informal sectors of the economy. Central to the NSI framework is the dynamics of learning in a national economy. Learning could be by doing, using and interaction (DUI), and can even be more important than the stock of knowledge (Lundvall and Johnson, 2013). Viewed from this perspective, technological capability may be regarded as comprising the indigenous accumulated knowledge acquired through the accustomed learning processes and the ability to absorb, adapt and advance a foreign technology through endogenous process-of learning. The endogenous learning process through which a foreign technology may be assimilated depends largely on the depth and scope of the existing indigenous knowledge. Lunvall and Johnson present the notion of the 'learning economy' as an economy where the ability to learn is crucial for the economic success of individuals, firms, reasons and nation economies, and the learning economy is not necessarily a high technology economy. Learning can take place in all parts of the economy, including the so-called low technology sectors. Thus, the local focus of NSI promotes the generation of learning mechanisms, which enable the thriving of local innovation networks that are aimed at improving the local technological capability.

The global reach dimension of knowledge within the NSI framework involves the interactions among agents in a network that has evolved or that is actually designed to generate and use technology at the frontier. The challenge of international competitiveness suggests that it is difficult for a country to be competitive in all sectors. Hence, specialization has been a strategy that has worked for countries that have succeeded in catching up in the technological and economic advancement. To effectively specialize and match on to catching up, appreciable degree of mastery of technology at or close to the frontier may be necessary. However, most developing countries lack this capability within their NSI, and hence the need to reach out globally to attract global knowledge into its NSl. There are at least two ways of achieving this: one is policy-induced and the other is market-driven. It can be policy-induced by deliberate interventions that provide incentives for attracting nationals in diaspora to

collaborate with national agents and institutions in technological activities that are aimed at solving local development problems. Examples in this respect may include the search processes to develop vaccines for HIV/AIDS, malaria; and the development of drought-resistant crops. Such policy intervention can also be extended to provide opportunities for foreign experts interested in collaborating with nationals in addressing local problems. The market-driven approach may entail a specialization strategy that' makes investment in a select sector or sectors attractive to foreign companies. Foreign direct investment drives is such sector(s), and locational advantages might eventually, encourage the establishment of research laboratories by the foreign company.

Review of Related Literature

Commercialization of Education, Knowledge and Research Findings

Commercialization of research results has become the· new catch-cry in most advanced economies as they embrace innovation as a key driver of economic policy. The transfer, exploitation and commercialization of public research results have become a critical area of science, technology and innovation. The knowledge and research generated by public research system is diffused through a variety of channels among which are the mobility of academic staff, scientific publications, conferences, contract research with industry and the licensing of university inventions. Effective commercialization of research results in any nation depends on rapid technological innovation, effective strategic management of knowledge and a clear focus on value-added goods, services and industries. According to Bently (2013), the world faces major issues such as climate change, limited natural resources and changing age demographics. Thus the need for transition to a more sustainable economy is creating global market opportunities for entirely new solutions. Advancement in technology development has radically altered the economic system in the world. Nations and businesses that can achieve higher levels of performance in innovation will be well placed to be leaders of tomorrow. Thus, wealth is no longer being measured in terms of physical winch alone. It must be measured by the degree of access to, and timely use of, knowledge and technology that leads to intensive value-added capabilities. Thus, commercialization of research findings is becoming an important aspect of economic development. However, while commercialization has led to substantial investments in public research in America, the perception in Europe is that the continent has failed to benefit from its substantial investments in public research. European governments have responded by introducing policies to promote commercialization such as introduction of University courses on entrepreneurship for future academics and a range of other programmes to encourage technology transfer by promoting formal contractual relationships between the business sector and public science (Appiah *et al.,* 2017). In India, the development and commercialization of new technologies have become very important in the research agenda. Even though India started the development of its scientific infrastructure in a planned way immediately after independence, commercialization of technology attracted the attention of policy makers only in 1980s. According to Kumar and Jain (2013), venture capital funds were established in the 1980s and a technology policy statement was also introduced in 1983 to provide risk-sharing funds as well as managerial expertise for technology development and commercialization.

What does University Industry Linkages Mean?

University Industry-government linkages can take various forms and levels of partnerships from contract or sponsored research, to joint research, professional courses, consultancies to creating opportunities for student placements, staff exchange, and joint curriculum development. University Industry- government linkages are often conceived as a three-way interaction between universities, government, and firms as described in the *Triple Helix Theory* (Etzkowitz, 2008). Today universities are considered not only as centres of knowledge and learning, but as key institutions in national innovation systems (Nelson, 2006). In order to plan their role within the innovation system, universities need to be well-linked to enterprises, other research institutes, and supported by government policies. The USA, for example, has enacted key legislations such as the 1980 Bayh-Dole Act to incentivize patenting, licensing, and technology transfer of University research. Through state intervention, Brazil has helped centre universities as technology incubators (Etzkowitz, 2008). At the University level, technology transfer departments, technology incubators, and science parks have been set up to encourage and manage entrepreneurial activities (Schiller, 2007).

What is the Importance of University-Industry Linkages to Nigeria

Nigerian universities have often been criticized as ivory towers that churn out graduates and research that are irrelevant to the needs of employers and the social, economic, and technical challenges facing Nigerian economies. There is a growing perception that the knowledge and skills taught to students at Nigerian universities do not meet the requirements of industry and the wider economy. This mismatch, coupled with under-training in the critical skills of problem-solving, analytical thinking and communication is blamed, at least in part, for the emerging high graduate unemployment and under-employment in many parts of Africa (Pauw, 2008). There is need to bring together universities with productive sector representatives to update and upgrade curriculum to ensure that students graduate with relevant skills for the workforce. In addition to the understanding that universities need to produce work-ready graduates with the requisite skills for the job market, it is also increasingly recognized that universities should play a pivotal role in applying research and innovation to address socio-economic problems and promote innovation for economic growth by forging strategic partnerships with the productive sectors of the economy and national innovation systems.

In the broader literature, perceived benefits from University Industry-government collaboration include: providing new channels of alternative funding in an era of constrained funding; access to or acquisition of state-of-the art equipment; improved curriculum and training in technology-oriented programmes; enhanced employment prospects for students; supplemental income for academic staff; and clearer contribution of universities to the economy, among others (World Economic Forum, 2011: Martin, 2000). In the context of fiscal constraints, graduate unemployment, and the need for universities to demonstrate greater accountability to society and respond to national development imperatives, the topic of university industry-government linkages is becoming increasingly prominent in the discourse on higher education in Africa in general and Nigeria in particular.

In terms of promoting entrepreneurialism and practical skills among staff and students, the majority of institutions report employing industry professionals as adjunct

faculty staff, engaging guest speakers to provide business and entrepreneurial advice, and offer student attachments/co-op placements. Enhanced graduate employability as a result of improved curricula, skill development and internships, as well as increased job satisfaction among academic staff were noted as positive externalities of promoting linkages with the productive sector. Many institutions, however, reportedly have no resources specifically dedicated to supporting entrepreneurial activities by staff. While industry professionals can bring value-added knowledge and hands-on experience to the classroom, it is also important to ensure that such professionals are suitably qualified to teach at the university level.

UNESCO in February 1994 launched the University Industry-Government Science Partnership (UNISPAR) Programme in Nigeria with a view to promoting cooperation between universities and industries in the region. The main objective of the programme is to facilitate indigenous technology development through transfer of research results from university industry-government. This emphasis was intended to assist the continent in indigenous technology development specifically targeted at small scale manufacturing enterprises and other local problems.

Over the last four decades, governments around the world have stimulated linkages between academia and industry. In recent years, this trend has gained ground (Dill & van Vught, 2010). Stimulating technical advance in industry is viewed as a necessity to promote economic growth. Policy makers across countries seek to stimulate universities to become more entrepreneurial, engaging more actively with the productive sector in order to generate employment and grow the economy.

As universities become more involved in promoting economic development, there is a push from various governments for more relevant research and training. One way to address this call for relevance is by encouraging stronger and sustainable linkages between universities and the industry. Such linkages are particularly relevant in Nigeria as universities were established with a specific mission to contribute to nation building. In Nigeria, the Federal Universities of Technology Act CAP F23 LFN 2004 and the Federal Universities of Agriculture Act CAP F22 LFN 2004 are examples of such envisioned University Industry linkages where the universities are mandated to "identify technological and agricultural problems and needs of Nigeria and to find solutions to them within the context of overall national development". This can only be achieved through an effective partnership between the industry and the universities. Unfortunately, the focus of universities for now is chiefly on training the workforce with less emphasis on directly impacting on national economic development.

Universities can contribute to technological innovation in several ways. These include conducting research in technological fields relevant to industry, providing technical assistance to local firms, educating well-trained professionals, and supporting faculty to engage in consulting and commercialization activities (Geiger & Sa, 2015). In the corporate sector, there is a trend in high technology industries towards better and closer linkages with university research. Firms' readiness to seek out multiple sources of knowledge is viewed as critical for their success in fiercely competitive markets (Chesbrough, 2013). This drives large companies to establish more partnerships with research institutes, where knowledge is generated and advanced.

Universities' research productivity is crucial in determining the level of linkages with industry. In terms of factors that facilitate university industry-government partnerships, the organizational structure of universities has been identified as an important dimension in their technology transfer performance (Bercovitz *et al.,* 2014). Also, the role played by geographical proximity in the development of partnerships between university and industry is very important. Although geographical proximity can have a motivating factor, the quality of higher education institutions is the most important determinant factor for industries to engage with universities in their region (Vedovello, 2017; Laursen & Salter, 2011).

In the African context, Nigeria inclusive, University research capacity appears to be very limited, taking into account regional and country variations. Research capacity, defined by Volmink and Dare (2015), as *"comprising the institutional and regulatory frameworks, infrastructure, investment and sufficiently skilled people to conduct and publish research"*, varies greatly across the continent. Indeed, a study by the RAND Corporation revealed that, with the exception of South Africa, Egypt, Mauritius, and Benin, African countries were part of a group of scientific laggards (RAND Corporation, 2011). Furthermore, a 2013 report recognized that African higher education lacks capacity not only at the system and institutional levels, but also at the level of individual academics (Jones et al., 2013).

The limited research capacity of universities in developing countries, including in the African continent (Altbach, 2012, 2016) has been described as a major hindrance in forging partnership with the industry. At the institutional level, universities in Africa have long been facing funding difficulties due to limited state resources. Universities face constraints in building research programmes in relevant fields of science and technology that would be of interest to industry. Generally, weak research capacity and insufficient R&D funding inhibit a more sustained research role (Atuahene, 2017). These structural issues prevent universities from training a larger number of scientists and retain productive researchers. With limited funding and support to their research mission, universities are usually hard-pressed to initiate and sustain programmes of research (Mohamedbhai, 2018; Mouton et al., 2018).

New Strategies for Effective University- Industry-Government Linkages in Nigeria
Like in most countries in sub-Saharan Africa, the reality in Nigeria is that the NSI is relatively weak (Muchie *et al.,* 2016), and the developmental role of universities is highly constrained. As the foregoing discourse suggests, the challenge of creating developmental universities in Nigeria is closely linked with the state of the NSI. The firm is at the centre of the NSI framework as the loci of innovative activities and the critical unit that determines the innovative outcomes of the interactions among agents in the NSL. For universities to attain significant developmental roles, it, therefore, follows that their interactions with firms would be crucial. Firms in this respect should be viewed from its generic meaning of firm as a productive unit which can be a farm, manufacturing or commercial enterprise. Innovation is important for competitiveness in all types of enterprises. In dynamic economies, growth is powered by the NSI that functions to generate and employ innovation. The University system, as a sub-system of the NSI, plays fundamental roles especially as the principal agent for specialization. The University system interacts with the industrial system in strategic sectors that present opportunity for competitive advantage.

If Nigerian universities are to contribute more actively to innovation, there is a need to support *closer interactions* among *governments, universities,* the *industry,* and other relevant actors. The various national policy frameworks are not in themselves sufficient, but provide a start as well as incentives and help clarify the role of each stakeholder in advancing innovation.

In Nigeria, how can university industry-government collaboration serve as impetus for the creation of developmental universities? Institutional reform is a major component of current economic reform. Reforming the University system has been in focus and a subject of intense debate (NUC, 2016). First, it is important to point out that Nigeria's education and industrial policies are isolated from each other. The NSI approach that links various policy measures that are aimed at making innovations drive the economy is still relatively alien to Nigeria's policy process. For example, the Nigerian Industrial Policy addressed critical issues of competitiveness, policy, finance, technology advancement, incentives to industries, research and development without any significant relationship with the role of the educational system in providing the ingredients required for these elements to achieve the objectives of economic growth and development. The education policy concentrates on development of formal education to achieve the objectives of Education for All (EFA) without thorough analysis of what is required to make the educational and training system fulfill the role of generating knowledge for development in an innovation system framework. The starting point for creating developmental universities in Nigeria, therefore, requires a close integration of the education and industrial policies. To achieve this, either the education or the industrial policy could be the entry point. For the purpose of our discourse in this paper, we have chosen the industrial policy because it has more clearly defined specific objectives.

The aim of the Nigerian industrial policy is to place Nigeria among the ranks of industrially developed countries, while the specific objectives include:

- to encourage the private sector to play a pivotal role in the industrial development of the country;
- to increase industrial output and linkages for both domestic and export market;
- to increase value addition by creating a few niches of competitive advantage;
- to increase capacities for entrepreneurship and technical skills in order to create more direct and indirect employment opportunities;
- to increase competitiveness of made-in-Nigeria products;
- to facilitate inflow of foreign capital and technologies; and
- to encourage geographical dispersal of industries (FMI, 2013).

Placing Nigeria among the largest economies as conceived in Vision 20-2020 will require a speeding up of the pace of Nigeria's industrialization. A close relationship between the universities and industrial firms is a necessary strategic input. If Nigeria would be among the most industrialized, then she has to learn to innovate and have some sectors of the economy employing technology at the frontier. The basic requirement of the universities would be to train scientists, engineers and other related skills with active involvement of firms that would later employ them. Involving firms in university training activities could be directly by the participation of factory scientists and engineers as resource persons for teaching specialized course modules, and by industrial training of students in firms operating in the field of the

prospective career of the student. Indirect engagement could involve joint development of the relevant course contents or curricula by Universities and firms, and periodic review of the course contents to suit industry or practitioners' demands.

University industry-government collaboration could also stimulate the integration of financing mechanisms for research and development within the education and industrial system. R&D for most companies in Nigeria are known to be done by multinationals whose R&D centres are located outside Nigeria (Adeoti, 2016b). Local R&D is generally limited to adaptation and imitative types. Though this may not immediately lead to attaining international competitiveness, if encouraged with the right mix of incentives, it has the potential of improving the chance of Nigerian firms becoming real innovators. University research themes or projects should be identified in collaboration with industry and there should be active participation of government as major financier of such collaboration, while industry is committed to employing the useful outcomes of the R&D. This model would be particularly relevant to small and medium-sized enterprises, which have limited capacity for engaging in R&D.

Another enticing option for University-Industry collaboration is the location of specialized universities in an industrial park or near an industrial cluster where businesses related to the specialization are thriving. This would be akin to establishing a University of computer and information technology in Ikeja, where there is an important ICT cluster or the citing of the Mechanical and Automobile Engineering Department of a Federal University of Technology in Nnewi, which is known for a thriving industrial cluster, specialized in the manufacture of automobile spare parts.

Furthermore, linking Nigerians in the diaspora through university industry-government network would be very useful. Juma (2017) presents some examples from which Nigeria could learn. He reported that significant experiments are under way around the world to make effective use of the diaspora. The Swiss government recently converted part of its consulate in Cambridge (Massachusetts, USA) into a focal point for interactions between Swiss experts in the USA and their counterparts at home. The Swiss House was created in recognition of the importance of the area as the world's leading knowledge centre, especially in the life sciences. In addition to Harvard University and Massachusetts Institute of Technology (MIT), the Boston area is home to more than 50 other colleges and universities and a cluster of biotechnology activities.

There is no shortcut to promoting strong university industry-government linkages without strengthening the academic and managerial capacity of universities. Nigerian universities need a larger base of continuing, long-range academic research programmes in areas that interface with national, regional, and local economic and social contexts. University research cannot be expected to deliver prompt solutions to immediate problems. Rather, it is through sustained research and education efforts that expertise is built in disciplinary and interdisciplinary fields. Such expertise, if aligned with the knowledge needs and demands of national and local industry, can have a meaningful impact in economic activity.

To harness the potential of University research and education to industry, universities also need to be supported and funded in such a way as to allow them to build the administrative capacity for industry and community engagements. Therefore, well-trained,

knowledgeable staff in areas ranging from *industry liaison, community outreach,* and *technology transfer* is important enablers and facilitators of industry connections. Academic staff cannot be expected to fulfill these roles in an effective way, without distracting them from core academic functions.

For partnerships to take a firm root, careful implementation of policy instruments aimed at stimulating university industry-government linkages is essential. The multiple actors involved have specialized and disparate needs. Higher education institutions need to build and strengthen their research and education infrastructure. Firms need greater R&D capacity and incentives to invest in partnerships with universities (Bogoro, 2015). Greater awareness across the sectors of their needs and capabilities is also needed. Fundamentally, governments need to establish predictable and stable funding mechanisms for university industry-government research, business R&D, and specifically for partnerships involving the two sectors. Uncertainty as to the availability of resources in relatively short time horizons mitigate against productive university industry-government engagements.

For universities, there are many actions that could be taken to improve the development of partnerships with industry. Fundamentally, universities have to better define and frame their potential contribution to national economic development for internal and external audiences; each other should be promoting innovation and supporting regional economies.

Once universities can identify their place and potential contribution to national development, senior officials might engage with local industry from a clearer position on how to advance the university mission. The quality of university outputs (e.g. graduates, research findings, teaching) is a strong determinant in the success of university industry-government linkages. Furthermore, better communication among universities and firms would be helpful. Universities have to be able to provide more evidence on the expertise and projects, which might increase industry awareness and interest to invest in partnerships.

Strong leadership is critical in higher education development. Senior administrators need to make industry- university partnerships a priority within their institutions. The goals and benefits of university industry-government links need to be clearly communicated to researchers, as well as the principles guiding them for mutual benefit. Moreover, larger and longer-term partnerships need senior leadership encouragement and support. Academics need a favourable incentive and reward structure for engaging with industry in a constructive way.

If it is to have an impact in industry, some university research programmes in relevant disciplines (e.g. agriculture, engineering, materials science, computer science) need to be oriented towards issues that impact local economies and industries. For that to happen, greater interaction with external stakeholders might be facilitated through events, associations, and networking initiatives.

Within universities, stimulating interactions across teams of researchers with complementary expertise should be encouraged, regardless of their disciplinary or departmental affiliations. Innovation in industry does not happen within disciplinary silos. Multidisciplinary teams of experts are better positioned to address complex problem by bringing together theories, knowledge, skills and methods from various fields and applying them to generate solutions. Interdisciplinary research programmes that include industry

partners should be encouraged in universities. Those programmes might be housed in dedicated research centers, including business representatives in their Advisory Boards.

Universities should take advantage of their position as public institutions to exercise the role of public spaces for stimulated debates on local economic, social, and technological challenges. Universities may organize and host events bringing together academics and industrial representatives, along with other relevant stakeholders.

Informal social interactions can also be helpful in sparking dialogue and working relationships. Purposefully using university facility for events and social engagements can facilitate such interactions.

Industry should also work with higher education institutions counterparts to improve their research and training capacity. This can be done in multiple ways. For example, businesses may provide internship positions for students, and make their staff available for guest lectures, bringing their expertise to universities. More sustained forms of engagement can also be pursued. Individual firms, or even business associations, may work together with higher education to establish educational standards to inform the curriculum and educational experience of students in relevant fields. Such initiatives might contribute to addressing the perceived irrelevance of University education to the business sector. Finally, industry can also be a supportive partner in the creation, support, and staffing of research laboratories through gifts, donations, and research funding. Through these kinds of practices, industry can be a stronger partner in the process of strengthening the academic quality and relevance of Nigerian universities.

Deciding to innovate locally is also a choice that industry needs to make. It might make better sense in the short term to resort to imported technologies or business solutions. In the long run, however, this preference has the cumulative effect of not creating endogenous capacity to innovate. Taking steps to create the competencies within firms and in partner institutions such as universities might seem costly, but the benefits of such investments need to be assessed within a long-term horizon that includes capacity building for sustained problem-solving and innovation.

Methodology

This study adopted descriptive survey research in which pre-tested and well validated questionnaire was used to collect data from respondents who were selected from some staff of the selected five sample units. The said sample units included the University of Nigeria Nsukka (UNN), Enugu State University of Science and Technology (ESUT), Enugu, NOUN Enugu study centre, Enugu State Government (ENSG), and the Ama Plant of Nigerian Breweries Plc, Ameke Ngwo.

The choice of the multiple actors involved in this study have specialized and disparate needs. The universities need to build and strengthen their research and education infrastructure. The industries need greater Research and Development capacity and incentives to invest in partnerships with universities. Greater awareness across the sectors of their needs and capabilities is also needed. Fundamentally, governments need to establish predictable and stable funding mechanisms for university industry-government research, business Research and Development, and specifically for partnerships involving the two sectors. And for

partnerships to take a firm root, careful implementation of policy instruments by government aimed at stimulating university industry-government linkages is essential.

Secondary data were collected from published and unpublished official documents obtained from these institutions and manufacturing industries. The population of the sample units was 4,361. From this population, a sample of 353 was drawn using Cochran's finite population correction technique.

This special formula is given by:

$$n = \frac{n_o}{1+\frac{n_o-1}{N}}$$

Where,

n = adjusted sample size

n_0 = correction factor $n_0 = \left[\frac{Z^2pq}{e^2}\right]$

N = Population size for the study

To determine the sample size for this study, we assume the following:

z = 1.96 (i.e 95% confidence level)

p = Estimated proportion of an attribute that is present in the population (estimated at 50% or 0.5)

q = I-p (the proportion of an attribute that is not present in the population (100% - 50% or 0.5)

e = desired level of precision (estimated at 5% or 0.05).

To obtain n_o (finite population correction factor), we substitute in $\left[\frac{Z^2pq}{e^2}\right]$ as follows:

$$n_o = \frac{1.96 \text{ x } 1.96 \text{ x } 0.5 \text{ x } 0.5}{0.05 \text{ } x \text{ } 0.05}$$

$$= \frac{0.9604}{0.0025}$$

$$= 384.16 = 384$$

Therefore, n_o (finite population correction factor) is 384.

N is already given as 4,281 above.

Substituting in the formula $n = \frac{n_o}{1+\frac{n_o-1}{N}}$

above, we obtain:

$$= \frac{384}{1+\frac{384-1}{4,281}} = \frac{384}{1.089465}$$

$$= 352.4666 = 353 \text{ (rounded up)}.$$

Therefore, the sample size for the study was 353.

Purposive sampling technique which favoured only target respondents in the sample units who were adjudged to possess good knowledge of the business education, management and entrepreneurship was used in selecting the 353 respondents that participated in the study. Results of the Cronbach's Alpha test showed a reliability index of 0.82. Descriptive statistics comprising frequency units, tables and percentages was used in analyzing the data, while the

four hypotheses of the study were tested using Multiple Regression Analysis, all with the aid of SPSS software.

The questionnaire comprised 19 close-ended items set on the 5-point Likert-type scale. Results of the reliability test of the questionnaire showed it had Cronbach's Alpa index of 0.84. The respondents were selected using purposive sampling method, which allowed selection of only the senior management staff of the sample units who had good knowledge of issues concerning university-industry-government linkages.

Descriptive statistics that consisted of frequency counts, tables and percentages was used to analyze the data collected. Inferential statistics known as Multiple Regression Analysis was used in testing the hypotheses of the study. Both the analysis and tests were done with the aid of SPSS software.

Results

Results of the analysis showed that out of the 353 questionnaire distributed, 333 (94:4%) were returned well completed, 13 (3.9%) were not returned at all, while 7 (2.0%) were returned but rejected owing to inappropriate completion. It was the responses borne by the 333 well completed questionnaires that were extracted and coded into data that were used for both the subsequent analysis and test. In this section, the results of the Multiple Regression Analysis based on the model earlier specified above by the study are presented below.

As earlier stated, the hypotheses of the study are tested using Multiple Regression Analysis. The test was carried out using the primary data generated from the field survey. As part of the test procedure, the said data were fed into the SPSS software according to each of the four hypotheses. The results of the test are displayed in tables 1, 2 and 3 below.

Table 1: Model Summary

Model 1	R	R Square	Adjusted R Squared	Std Error of Estimate	Durbin Watsun stat.
1	0.547	0.229	0.601	0.91487	2.614732

(a) **Dependent variable:** number of licensed inventions bought or sold, number of research contracts awarded, number of scientific conferences or trainings sponsored, and number of licensed inventions marketed or sold.

(b) **Predictors (constants):** government policies, funding mechanisms, human resource development, communication strategies

Source: Field Survey at UNN, ESUT, NOUN and NBL, Enugu, 2019; published and unpublished documents by UNN, NOUN, ESUT, ENSG, and NBL.

Table 2: ANOVA Model

Source of difference	Sum of squares	Df	Mean square	f,	Sig
Between Groups	8.111	3	2.7923	10	.000
Within Groups	37.306	347	0.270		
Total	45.415	350			

(a) **Dependent variable:** number of licensed inventions bought or sold, number of research contracts awarded, number of scientific conferences or trainings sponsored, and number of licensed inventions marketed or sold.

(b) **Predictors (constants):** government policies, funding mechanisms, human resource development, communication strategies

Source: Field Survey at UNN, ESUT, NOUN and NBL, Enugu, 2019; published and unpublished   documents by UNN, NOUN, ESUT, ENSG, and NBL.

Table 3: Co-efficient

	Unstandardized Coefficients		Standardized coefficients	T	Sig
	B	STD Error	Beta		
Constant	1.659	0.242		6.85	0.000
government polices	0.83	0.07	0.097	1.189	0.002
funding mechanisms	0.22	0.065	0.279		0.001
human resource development	-0128	0.05	0.203		0.002
communication strategies	0.314	0.071	0.307	1.51	0.019

(a) **Dependent variables:** number of licensed inventions bought or sold, number of research contracts awarded, number of scientific conferences or trainings sponsored, and number of licensed inventions marketed or sold.

(b) **Predictors (constants):** government policies, funding mechanisms, human resource development, communication strategies

Source: Field Survey at UNN, ESUT, NOUN and NBL, Enugu, 2019; published and unpublished a documents by UNN, NOUN, ESUT, ENSG, and NBL.

The results of the Multiple Regression Analysis as displayed in tables 1 and 2 are interpreted below. Table 1 shows that the Adjusted R Squared has the value of $r^2 = 0.602$ which indicates that when all the variables are combined, the multiple linear regression model could explain for approximately 60% of the variation in commercialization of research findings in Enugu State. In table 2, it is shown that the calculated F-value is 10.0, which shows that the regression model is very significant and well specified at the probability of 0.000. Table 3 shows that the four independent (predictors) variables have the following beta and probability values: government policies (B = 0.097; p = 0.002); funding mechanisms (B = 0.279; p = 0.001); human resource development (B = 0.203; p = 0.012); communication strategies (B = 0.314; p = 0.019). From table 3, we can easily construct the prediction equation of the relationship or model as follows:

Commercialization of research findings = 1.659 + 0.097 (government policies) + 0.279 (funding mechanisms) + 0.203 (human resource development + 0.307 (communication strategies).

When interpreted, the equation tells us that when government policies go up by 0.097 or 10%, commercialization of research findings goes up by 1 and when funding mechanisms go up by 0.279 or 28%, commercialization of research findings goes up by 1. The table also shows that when human resource development goes up 0.203 or 20%, commercialization of research findings goes up by 1; and when communication strategies go up by 0.307 or 31%, commercialization research findings goes up by 1.

Test of Hypotheses
The four hypotheses were tested by using the primary data generated from the field survey. The test of the hypotheses was based on the results of the Multiple Regression Analysis as contained in Table 3 above.

Hypotheses No.1:
i: Government policies on university- industry-government linkages have no significant effect on the number of licensed inventions being sold or bought in the system of innovation in Enugu State, Nigeria

Table 3 shows that the beta value is 0.097, while the probability is 0.002, which is less than the critical probability of 0.05. This means that there is very low probability that the statement overall model was insignificant was true.

Decision
The probability of the model (0.002) is less than the critical probability of 0.05 and the model found to be significant with a calculated F-value of 10.0. Based on the decision rule for Regression Analysis, the null hypothesis is hereby rejected and the alternate hypothesis accepted. We therefore, conclude that government policies have significant effect on the number of licensed inventions being sold or bought in the system of innovation in Enugu State, Nigeria.

Hypothesis No.2

ii: Funding mechanisms for university- industry-government linkages have no significant effect on the number of research contracts awarded to academic staff in Enugu State, Nigeria.

Table 3 also shows that the beta value of the model is 0.279 as it pertains to funding mechanisms has probability of 0.001, which is less than the critical probability of 0.05.

Decision

Since the probability of the regression model as it pertains to funding mechanisms is 0.001 which is less the 0.05 critical probability threshold and the model significant at a calculated F-Value of 10.0, we should reject the null hypothesis and accept its alternate one going by the decision rule of the study. We, therefore, conclude that funding mechanisms have significant effect on the number of research contracts awarded to academic staff in Enugu State, Nigeria.

Hypothesis No.3

iii: Human resource development in key areas of university- industry-government linkages has no significant effect on the number of scientific conferences or training sponsored by government or industries in Enugu State, Nigeria.

Table 3 shows that the beta value of the model with regard to human resource development is 0.203, while its probability is 0.012 which is less than the critical probability of 0.05.

Decision

Given the fact that the probability of the model as it pertains to human resource development is 0.012, which is less than the critical probability of 0.05, we should reject the null hypothesis and accept the alternate one. We have no other option, therefore, than to conclude that human recourse development has significant effect on the number of scientific conferences or training sponsored by government or industries in Enugu State, Nigeria.

Hypothesis No.4

iv: Communications strategies with the outside world by universities have no significant effect on the number of licensed inventions being marketed or sold by Universities in Enugu State, Nigeria.

Table 3 also shows that the beta value of the model with regard to communication strategies is 0.307, while its probability is 0.019, which is less than the critical probability of 0.05.

Decision

Since the probability of communication strategies is 0.019, which is less than 0.05, we should reject the null hypothesis and accept its alternate one. We, therefore, conclude that communication strategies have significant effect on the number of licensed inventions being marketed or sold by Universities in Enugu State, Nigeria.

Implications of the Results of this Study to Development

This study holds far-reaching great implications for the development of science and technology, the national system of innovation (NSI), the industrial sector, the higher education sector and, above all, economic development in Nigeria. By and large, this study has somewhat opened the eyes of members of the Triple Helix (government, industry and academia) to the challenge of envisioning a new horizon of development that would focus on the role of knowledge as the basis for economic transformation of Nigeria. In the days gone by, it was economic resources that drive the economy; today, we have indeed reached a new horizon, whereby it has become clear that it is knowledge that drives the economy.

The aforementioned new vision for economic transformation implies that government is now saddled with the challenge of formulating a new policy that will place great emphasis on renewing research and public science infrastructure, building technical capacity, increased finding, stimulating business development and increased participation in the global economy. The logical implication of the foregoing is that for the aforementioned policy foci to achieve the desired results there is need to strengthen Nigeria's national system of innovation (NSI) by architecturing it with the appropriate frameworks and polities to govern and incentivize university-industry interactions, partnership and collaborations.

The results of this study also first and foremost imply that the academia have to come out from their present lethargic concern and properly and clearly define their place and potential contribution to national development so that their senior officials can engage with the local industry from a clear position. Again, emphasis should be on quality assurance in all their processes, namely, curricula of academic programmes, instructional delivery and learning transactions, instructional materials, and assessment and evaluation so as to guarantee quality of output (graduates, research findings, teaching, and community service) the foregoing is very important as it is this that can convince the industry towards forging mere and greater partnership with the academia. How to effectively communicate such evidence of such quality output to the industry is another aspect of the challenge. Finally, another implication of this study is that the academia, more than ever before, need strong leadership capable of prioritizing university-industry linkages, orienting research efforts to local need, and forgoing grater inter-disciplinary research collaboration among researchers from diverse academic fields or disciplines in solving current national or local problems.

Conclusion

The literature demonstrates that strengthening Universities linkages with the productive sector in Africa, including Nigeria, is constrained by inter alia: low numbers of qualified faculty, including doctorate degree holders, brain drain, ageing faculty, and other issues associated with retention; low enrolment in mathematics engineering, and other science-related disciplines against large enrolments in social sciences and humanities; inadequate research infrastructure in many universities and lack of access to up-to-date publications; funding constraints; and teaching rather than research-focused mandates. These constraints, however, should not be considered as a deterrent to strengthening working relationship with the productive sector, but should be taken into account in devising the best way forward.

There is no gainsaying the fact that University - Industry partnership is a very crucial logical strategy for building technological capacity and promoting economic development of

Nigeria. The partnership will bring together generators and developers of knowledge (universities and research institutions) and those, who utilize that knowledge for economic development (industry). Therefore, it is a useful mechanism for utilizing national scientific and technological capacity for development. Additionally, the partnership offers opportunities to all stakeholders. For the Higher Education Institutions and the scientist, it is an opportunity to generate income and strengthen their capacities. It also capacitates them to serve their communities and enhance their profile in society. Industry also benefits in many ways including access to scientific resources available in the universities and the improvements in their technologies and operating performance, which may rise from the partnership.

Recommendations

For this to ensue, however, certain factors are pertinent.

➢ The scientist needs to take measured steps to address the concerns and misgivings of industry and also take cognizance of the peculiarities of local industries.

➢ Scientists should also take note of the character, in particular, the size and nature of ownership (foreign owned or multi-nationals) of the industries. In order to achieve quick results on partnership, locally owned industries should be approached for partnership.

➢ Measures need to be taken by all stakeholders to address the constraints on all sides that inhibit the partnership. Government has to create the enabling environment and policies for this.

➢ Industry and institutions also have several hurdles to overcome in order to forge an effective partnership. These constraints are in general derived from the scarcity of financial resources, the absence of relevant human resources in local industries, negative attitude towards local ideas and the nature (size and ownership) of the industries.

➢ There is also need for sustained capacity-building in relevant skills and policy development. This could be through support training, entrepreneur-in-residence programmes, exchanges, and other means to develop entrepreneurial skills among academic staff should be prioritized by Universities. There is need to build institutional expertise in intellectual property management; to support institutions to develop or strengthen existing strategic plans and develop realistic, implementable action plans for meeting stated goals; and to support opportunities to learn from African and international institutions with a strong history of engagement with the productive sector.

➢ Creating a conducive, enabling environment for supporting linkages with the productive sector requires a multidimensional approach that supports interventions beyond those listed here. Strengthening linkages with the productive sector should ideally go hand in hand with parallel efforts which include, inter alia, strengthening research governance and management, science and mathematics education, and graduate training at doctoral degree level. On the private sector side, industries also need to be brought on board as more active partners, while governments need to take responsibility for architecting National Innovation System

with appropriate frameworks and policies to govern and incentivize University - Industry interactions.

References

Association of African Universities & Association of Universities and Colleges of Canada. (2012) , *Strengthening University-industry linkages in Africa: A study on institutional capacities and gaps*. Ghana: AUU Publishers

AAU (2012), Report on Technology Generation and Uptake in African Universities.

Adeoji, J. (2015), *HEI-firm interaction in Nigeria: An "analysis of the constraints and emerging opportunities*. Unpublished report, Nigerian Institute for Social and Economic Research". Ibadan

Adeoti, J. O. (2014), *Technology and the environment in Sub-Saharan Africa: Emerging trends in the Nigerian manufacturing industry,* Aldershot, United Kingdom: Ashgate Publishing Limited.

Adeoti, J. O. (2016a), University-Industry linkage and the challenge of creating a developmental University in Nigeria, *Towards Quality in African Higher Education,* 16 (1): 375-387.

Adeoti, J. O. (2016b), Building technological capability in the less developed countries: The role of a National System of Innovation, *Science and Public Policy,* 29 (2): 98- 104.

Appiah, N., Agyapong, A. & A. Asamoah (2012), Effects of commercialization policy on the performance of CSIR-Forestry Research Institute of Ghana. *Ghana Journal of Forestry* 28(1): 51-63

Atuahene, F. (2017), Re-thinking the missing mission of higher education: An anatomy of the research challenge of African universities, *Journal of Asian and African Studies,* Vol. 46 (4), 321-341.

Bamiro, O. A. (2014), The Nigerian REI System and the challenge of building a world-class science and technology institution. Convocation Lecture delivered at the Modibbo Adama HEI of Technology, Yola. August 14.

Bamiro, O. A. (2015), REI-Industry partnership in the innovation process: Cases from Nigeria and Ghana. *Proceedings of the Regional Conference on Innovation Systems and Innovation Clusters in Africa,* Dares- Salaam/Bagamowo, Tanzania Feb 18-20, 2004 (pages 341-366)

Bently, N. (2013), Executive Summary: Innovation- the successful exploitation of ideas- is key driver of economic growth for developed countries. Concept to Commercialization. 2011-2015. Technology Strategy Board.

Bercovitz, J., Feldman, M., Feller, I. & Burton, R. (2014), Organizational structure as a determinant of academic patent and licensing behavior: An exploratory study of Duke, Johns Hopkins, and Pennsylvania State universities. *The Journal of Technology Transfer,* 26, 21-35.

Bogoro, S. E. (2015), Enhancing the relevance of research and industry partnership in Nigeria: A case for new strategies. Convocation Lecture at the 2015 Convocation Ceremony of the Federal HEI of Technology, Owerri at Owerri, December 3.

Chesbrough, H. (2013), *Open innovation: The new imperative for creating and profiting from technology.* Boston: Harvard Business School Press.

Creso, M. Sa (2014), Perspective of industry's engagement with African universities. *The Journal of Technology Transfer,* 27: 21-35.

Dhesi, A.S. and V. Chadha (2011), Factors influencing technology transfer from R&D institutions to manufacturing: Empirical evidence from India in *Science Technology & Development,* 2: 225-237.

Dill, D. and & Vught, F. (2010), *National innovation and the academic research enterprise.* Baltimore, MD: John Hopkins HEI Press.

FMI (2013), *Industrial policy of Nigeria: Policies, incentives, guidelines and institutional framework,* Federal Ministry of industry Abuja, Nigeria.

Frascati-Manual, A. (2012), Proposed standard practice for surveys and experimental development. 6th Edition OECD. 30pp.

Freeman, C. (1987), *Technology policy and economic performance: Lessons from Japan,* London: Longman.

Freeman, C. (1992), Formal scientific and technical institutions in the national system of innovation. In B. Lundvall (ed.). *National System of Innovation - Towards a Theory of Innovation and Interactive Learning:* London: Routledge.

Geiger, R. & Sa, C. (2015), *Tapping the riches of science: Universities and the promise of economic growth.* Cambridge: Harvard University Press.

Grossman, G. and E. Helpman (1994). Endogenous innovation in the theory of growth. *Journal of Economic Perspectives* 8 (1).

Humphrey, D. B. (2014) Replacement of cash by cards in U.S consumer payments, *Journal of Economic and Business, 56,. '211-225*

Jansen, J. D. (2012), Mode 2 knowledge and institutional life: Taking Gibbons on a walk through a South African University. *Higher Education,* 43, 507 -521.

Jegede, O. J. (2016), Reflections on quality promotion and capacity development in higher education in Africa. Keynote Address at the Southern African Regional Conference on Quality Assurance.

Jegede, O. J. (2016a), A compelling need for a comprehensive review of the laws establishing regulatory agencies and tertiary institutions for open and distance learning in Nigeria, Being an Invited.

Jegede, O. J. (2016a), The role of private higher education in sustainable development. Being an Invited Keynote Address to the 14th International Conference on Private Higher Education in Africa Held at/he African Union Conference Centre, Addis Ababa, Ethiopia, 12 to 14 July.

Jegede, O. J. (2016a). Global job crises: Curriculum misfits, reform perspectives and strategic imperatives. Being a Keynote Address to the 2nd Annual Blossom Career & Entrepreneurship Summit, with the Themer Curriculum Re-Examination: Skills Opportunities & the Dilemma of Academic Ambitions, Organised by the Best of the World Ent. Ltd held at The Haven, Oba Akinjobi Way, Ikeja GRA, Lagos, Thursday, 2nd and Friday, 3rd June.

Jegede, O. J. (2016b), Intellectual output for innovation and enhancement of socio-economic transformation. Being a Keynote Address at the Zimbabwe Open University International Research Conference Held at the Rainbow Towers Hotel, Harare, Zimbabwe, Thursday, 28th to Friday, 29th July.

Jegede, O. J. (2017a), Ensuring quality and relevance of higher education, life -long learning, teacher education development through public private partnership. An Invited Keynote Address to the 15th Annual International Conference on Private Higher Education in Africa held at the Intercontinental Addis Hotel, Addis Ababa, Ethiopia, 25th to 27th July.

Jegede, O. J. (2017b), Quality of university education in Nigeria: The challenge of social relevance, Convocation Lecture at the 22nd and 23rd Combined Convocation Ceremony, University of Uyo, Nigeria, Friday 3 November.

Johnson, B., Lorenz, Ecand Bengt-Ake I. (2002), Why all the fuss about codified and tacit knowledge, *Industrial and Corporate Change,* 1 (2), 245-262.

Jones, N., Bailey, M. &. Lyytikainen, M. (2017). Research capacity strengthening in Africa: Trends, gaps and opportunities. DFID &. IFORD. Retrieved in September 2013 from http://www.odi.org.uk/sites/odi.org.uk/filesjodi-assets/pu   blications-opinion   -files/2 77 4.pdf

Juma, C. (2006), Re-inventing growth: Technological innovation and economic renewal in Africa, Paper presented at the African Development Bank, Tunis, Algeria.

Juma, C. (2017), The new culture of innovation: Africa in the age of technological opportunities. Keynote paper presented at the 8th Summit of the African Union, Addis Ababa. Ethiopia.

Kirmar, V. & Jain, .P. K. (2013), Commercialization of new technologies in India: An empirical study of perceptions of technology Institutions, *Indian Institute of Technology,* India, pp 113-120

Kline, S. J. and Rosenberg, N. (2016), An overview of innovation. In R. Landau, and N. Rosenberg (eds.), *The positive sum strategy,* National Academy Press, Washington, D.C.

Koehn, P. H. (2012), Donors and higher education partners: A critical assessment of US and Canadian support for transnational research and sustainable development. *Compare,* 42(3).485-507.

Kross, G. Lorentzen, J., Petersen, I., Adeoti, 1., Odekunle, K. Adeyinka, F., Nabudere, D., Mukasa, . L., Eabaro. E. &. Mananja, D. (2016). Knowledge for development: HEI-firm interaction in Sub-Saharan Africa. Unpublished Report. Cape Town: HSRC.

Kross, G., Adeoti, J. & Nabudere, D, (2012), Universities and knowledge-based development in Sub-Saharan Africa: Comparing REI-firm interaction in Nigeria, Uganda and South Africa, *The Journal or Development Studies,* 48(4), 516-530.

Kuznets, S. (2017). *Economic growth and structure,* W. W. Norton, New York.

Laursen, K., Reichtein, T. &. Salter, A. (2011), Exploring the effect of geographical proximity and REI quality on REI-industry collaboration in the United Kingdom. *Regional Studies,* 45(4), 507-523.

Lundvall, B. (2012), "Introduction"; in B Lundvall (ed.), *National System of Innovation - Towards a theory of innovation and interactive learning,* London: The Free Press

Lundvall, B. and B. Johnson (2013), Promoting innovation systems as a response to globalizing learning economy, in J.E. Cassiolato, H.M.M. Lastres and M. L. Maciel (eds.), *Systems of innovation and development: Evidence from Brazil,* Edward Elgar, Celtenham, UK.

Marshall, A. (1920). *Principles of Economics.* London: Macmillan.

Martin, M. (2000), *Managing HEI-industry relations: A study of institutional practices from 12 different countries.* A Working document in the series "Improving the managerial effectiveness of higher education institutions." Paris: International Institute for Educational Planning/UNESCO.

Massaquoi, J.G.M. (2012), HEI-Industry partnership for cooperative technology development in Africa: Opportunities, challenges, strategies and policy issues. Report on the Meeting of HEI-Industry Partnerships in Africa. Meeting of HEI-Industry Partnerships in Africa, Harare, Zimbabwe, May .21-24, 2001. Nairobi:

Mohamedbhai, G. (2018), *The effects of massification on higher education.* Association of African Universities. Accra, Ghana.

Mouton, J. et al., (2015), *Science & technology: A .baseline study on science and technology and higher education in the SADC Region.* Wits: Southern Africa Regional Universities Association (SARUA).

Muchie, M., Gammeltoft, & Lundvall, B. (eds.) (2016), Putting Africa first: The making of African innovation systems. Aalborg, Denmark: Aalborg University Press.

Munyoki, J., Kibera, F. & Ogutu, M. (2017), Extent to which HEI-industry linkage exists in Kenya: a study of medium and large manufacturing firms in selected industries in Kenya. *Business Administration and Management.* 1 (4): 67-79.

Nelson, R. R., David C. M., and Jan F. (2006), *The Oxford Handbook of innovation.* Oxford: Oxford Handbooks Online, Oxford University Press. 27 October 2011 <http://dx.doi.org/10.l093/oxfordhb/9780 199286805.001.000 I>

Pauw, K., Oosthuizen, M. & Van Der Westhuizen, C. (2008), Graduate unemployment in the face of skills shortages: A labour market paradox. *South African Journal of Economics,* 76: 45-57

RAND Corporation (2011), Science and technology collaboration: Building capacity in developing countries? RAND. Retrieved 10 September 2013 from <http://www.rand.org/> content! darn/randypu bs/rnonograp hJeports/200S /MR1357.0.pdf

Rogers, E.M. (2003). Diffusion of innovations (5th ed.). New York: Free Press

Romer, P. M. (1986). Increasing returns and long run growth. *Journal of Political Economy* 94: 1002-38.

Romer, P. M. (1992). Two strategies for economic development: using ideas and producing ideas. *Proceedings of the World Bank Annual Conference on Development Economics:* 63.

Romer, P. M. (1993b). Implementing a national technology strategy with self-organizing industry investment boards. *Brookings Papers on Economic Activity: Microeconomics* 2: 345.

Romer, P. M. (1994a). Beyond classical and Keynesian macroeconomic policy. *Policy Options 15* (July-August, 1994): 15-2).

Romer, P. M. (1994b). New goods, old theory and the welfare costs of trade restrictions. *Journal of Development Economics* 43: 5.

Romer, P. M. (1996). *Why indeed, in America? Theory. history and the origins of modern economic growth.* Cambridge, MA: NBER (January, 1996).

Romer, P. M. (I993a). Ideas and things: The concept of production is being retooled (The Future Surveyed: 150 Economist Years). *The Economist:* (September 11, 1993) F70(3).

Romer, P.M. (2006) Innovation: The new pump of Growth. *Blueprint: Ideas for a New Century (*Winter, 1998).

Schiller, D. & Javier, R. D. (2007), REI-industry linkages potential and realization in developing countries: Thai experiences. *Tech Monitor,* Jan-Feb.

Schumpeter, J. A (1949), *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle,* Harvard University Press, Cambridge MA.

Siyanbola, W. O. (2016), Isn't there a better way? The case for a paradigm shift in R&D in Nigeria. Proceedings of the third Conference on Science and National Development. 17pp

The World Bank (2010). *Annual World Bank Conference on Development Economics.* The . World Bank

The World Bank (2012). Africa's Pulse. The World Bank Retrieved in October 2013from http://siteresources.worldbankorgf INTAFRICAResources African-Pulse- brochure VoI. 6.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO).

Vedovello, C. (2017). Science parks and REI-industry interaction: geographical proximity between agents as a driving force. *Technovation,* 17(9),491-502.

Volmink, J. & Dare, L. (2015), Addressing inequalities in research capacity in Africa. *British Medical Journal,* 331(7519): 705-706.

Welch, A (2005). Challenge and change: The academic profession in uncertain times. *Higher Education Dynamics,* 7,1-19.

World Economic Forum, the World Bank and the African Development Bank (2011), *The African Competitiveness Report 2011.* Geneva: World Economic Forum.

Yusuf, AK. (2012), The research scene in Nigeria's non university higher institutions, *JORIND,* 10 (2):1-8.

Yusuf, S., Saint, W. & Nabeshima, K. (2018). *Accelerating catch-up: Tertiary education for growth in Sub-Saharan Africa.* New York: The World Bank.