EFFECTIVENESS OF INNOVATIVE POLICIES TO ENHANCE UNIVERSITY-INDUSTRY COLLABORATION IN DEVELOPING COUNTRIES. TOWARDS TECHNICAL UNIVERSITY-INDUSTRY LINKS IN GHANA

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ABSTRACT: *In today's global world, generating new knowledge and turning it into new products and services is a complex process that involves a broad range of actors. Transforming the results of scientific research into new commercial products is a shared challenge between researchers and industry to maximize the social and economic benefits of new ideas. Such partnerships contribute positively to address innovation market failures and help to realize the full social returns of research and development(R & D) investments. In recent times, the rise in global knowledge and technology has intensified the need for universities and industry to forge strategic partnership that goes beyond the traditional funding of research projects. World-class research universities are at the forefront of championing such partnerships to hone the competitiveness and competence of their institutions and the partnering companies to help address social challenges and drive economic growth. This study explores the priorities and scope of university–industry collaboration indeveloped and developing economies, motivation to form such collaborations and barriers to such cooperation. Finally, the study examines the effectiveness of these innovative policies to promote university-industry collaboration in developing countries.*

KEYWORDS: University, Industry, Collaboration, Labour, Employable

INTRODUCTION

In recent times, factors such as the rapid pace of technological change, the development of knowledge-based economy and high labour mobility are influencing the universities the world over, to forge strategic partnerships with industry. Integration into the technological change and global knowledge economy also compels most industries to undertake continuous refinement of their production processes, internal systems, workplace practices and marketing strategies, which unfortunately, do not often align with institutional curricula, course organisations and pedagogy in the universities (Boahin, 2015). Under such circumstance, dependence on specialized knowledge or narrowly prescribed skills for specific jobs and roles rather limit transfer of skills and labour mobility (Harvey et al, 2002). One of the surest ways to enhance labour mobility and employability is to link academia with industry for skill development, efficient innovation systems and technology transfer, promotion of entrepreneurship and economic growth (Yusuf, 2007).As argued by Mgonja (2017), the capacity of a nation to produce wealth depends increasingly on the investment it undertakes in strengthening the so-called" triangle of knowledge" which consists of research, education and innovation.

The term 'University-Industry collaboration' (UIC) comes with several variants such as University-Industry Linkages (UIL), University-Industry Partnership (UIP), University-Industry Alliance (UIA) and University-Industry Relationship (UIR). However, University-

Industry Collaboration (UIC) will be used in this paper as the main term to describe the ties between university and industry although other terms may be used interchangeably as and when it becomes necessary.

In the current competitive environment, companies must achieve a high level of performance, develop innovative products, reward customer needs and rapidly respond to market demands. Under this technology and economic environment, it is even more important for firms, businesses and public sector organizations to continuously innovate products, processes and services. However, most of companies do not have all the needed skills and research capacity to develop such products on their own. Firms are increasingly finding it mutually beneficial to collaborate with university as the surest way of meeting these requirements. By working with university, businesses gain access to cutting–edge expertise and new techniques and approaches that they do not have in-house. Similarly, working with industry affords universities the opportunity to test the practical applications of their research in the real-world situations. While universities have important role in the innovation system, as 'producer of scientific knowledge', firms use this knowledge to enhance their production processes (Sellenthin, 2011).University-industry collaborations is believed to provide high labour mobility, innovation and economic growth and development (Guan &Zaho, 2013, Iqbal et al 2015 cited in Draghici et al, 2016).

Essentially, collaboration between universities and industries encourages skills development through education and training, innovation and technology transfer, acquisition and adoption of knowledge and the promotion of entrepreneurship in a form of start-ups and spin-offs (Dooley & Kirk, 2007, Mgonja, 2017). Further, the entities collaborating are able to exploit synergies and complementarities of scientific and technological capabilities to commercialize their R&D outcomes, increase the mobility of labour between public and private sectors and increase the propensity of firms to introduce new products and to patent (Guimo'n, 2013).In addition, technology advances in the industry and labour market requires current and future employees to be flexible, adapt to current and future operations and the capacity to learn at all times.

There is a variety of complementary processes by which university researchers can interact with industry and society in general. These include publications, collaborative research, educating students or spin-offs producing trained researchers with the latest research techniques who can be integrated in international research network (Czarnitzki et al, 2000 in Sellinthin, 2011).

Problem Statement

A number of studies haveshown that universities are catalyst for industrial innovation (Mansfield 1998, Jaffe 1989, cited in Sellenthin, 2011).This is because, firms do not innovate in isolation, but instead use collective forms of knowledge production in their innovation processes (Edquist, 2005).On the other hand, industries acknowledge the role of university research in their innovation processes(Rosenberg & Nelson, 1994, cited in Sellenthin, 2011). As a result, universities in Ghana and the world over are being inevitably drawn into the modern national policy agenda through research and development programmes and initiatives. The main aim is to foster university–industry collaboration to address graduate employable skills, relevant programmes to the economic growth and development, industrial input into curriculum development to meet labour market needs. Increasingly, the universities are under constant pressure to deliver research that would more directly benefit the innovation system of

their national economies through skill development, innovation and technology transfer and the promotion of entrepreneurship (Stellenthin, 2011).

Over the last decade, there has been an increasing interest in the literature on the topic on UIC in relation to innovation and innovation policy.Policymakers and debates at regional and national levels are increasingly seeking the best practices to maximize the effectiveness of the interactions between firms and the public research institutions. Empirical studies on UIC have mainly been focused on technologically advanced countries such as USA, Japan, UK, China, France and Germany, among others which commit a substantial proportion of their GDP on R&D expenditures. However, little is known in the literature about relationships between universities and industries in developing countries particularly in Africa. Although it has been widely reported in the literature that several policy initiatives have been suggested to promote UIC the world over, few studies have attempted to investigate the effectiveness of these policies. While linkages in the developed countries usually involve sophisticated research and innovation, universities in the developing countries lack the capacity to engage more actively and with greater intensity with firms to achieve the desired results from the linkages.

In 2016, Ghana converted eight out of the ten polytechnics into technical universities with a cardinal aim of developing strong linkages and collaboration with relevant industries, businesses, professional bodies and technical experts in the design and delivery of programmes (Technical Universities Act 922 of 2016).This study is designed to investigate the effectiveness of the policies issues to promote university–industry collaboration in developing countries like Ghana.

The central research question for the study is: To what extent are the innovative policies to support university- industry collaboration effective in developing countries?

Purpose of the study

The purpose ofthe study is to explore the scope and priorities of university–industry collaboration indeveloped and developing economies in order to assist emerging institutions like Ghanaian Technical Universities to develop a more strategic partnership with industry to drive economic growth. Most universities in developed economies with cutting–edge research do not find it easy in partnering with industry (Filippetti and Savona, 2017). According to May 2010 study of the European University Business Cooperation reported by Edmonson et al (2012), most European universities that form partnerships with industry too often do not achieve the potential for synergy due to failures of communication.It is believed that developing economies like Ghana will face even greater barriers to such cooperationdue to limited budgets and multiple competing priorities. For this reason, the study further assesses the extent to which innovative policiesdesigned to promote university-industry collaboration provide useful input to address the funding gaps and foster growth and development in developing countries. Finally the study suggests implications of the policy initiatives towards a more strategic partnership aimed at addressing the cultural and communications divide that tends to impair university-industrycollaborations developing countries.

The evolving role of university

A number of authors emphasise the changing role of universities for innovation and economic development (Martin, 2003, Mowery &Sampat, 2005 in Dooley & Kirk, 2007, Mgonja, 2017). In this regard, two types of university models can be identified. The first type of university

involves the traditional model, also referred to as Mode 1 while the entrepreneurial university or Mode 2 is the second type. The term Mode 1 and Mode 2 are adapted from the work of Etzkowitz&Leydesdorff (2000) cited in Stellenthin, (2011). Mode 1 is viewed as the university under public funding model while Mode 2 is an integrated university–industry-government model as clearly described in Figures 1 and 2 respectively. Mode 1 University possesses a dual mission of education/teaching and research discovery where the output is considered a public good (Rapport et al 1999 in Dooley & Kirk, 2007).

The main characteristic Mode 1 is to carve out an independent space for scientist, beyond the control of economic interest (Etzkowitz&Leydesdorff (2000) inStellenthin, (2011), and has the followingfeatures as described vividly in Figure 1.

- community of teachers and students producing knowledge (teaching and creative research) within individual scientific disciplines with little or no direct application to societal needs

- ability to attract government funding depends on quality of the research proposal

- autonomy of researchers (scientists) to pursue their individual research trajectories

- Research output is disseminated as 'free good' to the public(society/ industry) in the form of publication in conferences and peer-reviewed journals (Dooley& Kirk, 2007)

- At certain times, university Technology Transfer Office (TTO) may identify Intellectual Property(IP) of the research for license or sale to industry for financial reward

- Research is produced to recognize novelty and expertiseas well as professional development(Stellinthin, 2011).

Mode 1

Publication

Contracting Research

Licensing of IP

University   →   Industry
                 ←-------------

Discovery   Verification &

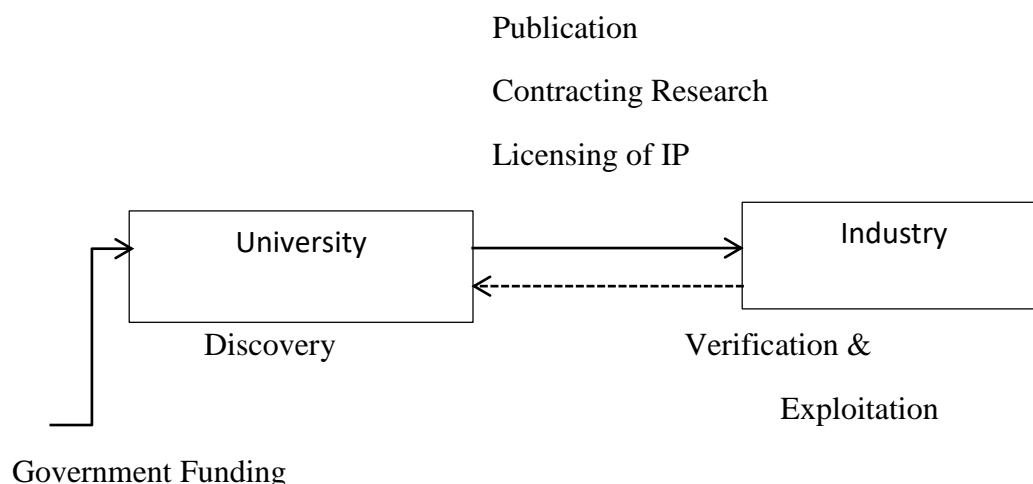   Exploitation

Government Funding

Figure 1.University research under Mode 1. (*Adapted from Dooley and Kirk, 2007)*

However, the increased importance of universities in economic development has given rise to Mode 2 , which is a closer interaction and alignment between academic and industrial institutions, namely; teaching, research, entrepreneurial and scholastic (Etzkowittz, 2000, in

Dooley & Kirk, 2007). The channel of university- industry interaction can be broadly defined into four categories, namely:

(i) Research support (ii) knowledge transfer (iii) technology transfer and (iv) cooperative research (Santoro, 2000, in Dooley & Kirk, 2007). It's a shift from sponsorship to partnership, depending on the relationships and offers greater scope and mutual benefits on long -term focus

According to Dooley & Kirk (2007), entrepreneurialuniversity (Mode 2) is an informal links between privately or publicly funded research centres and the market, entrepreneurs and firms.The characteristics of Mode 2 as shown in the Figure 2include;

- an open attitude towards interaction with innovation and academic growth, society and commercial context.

- a shift from sponsorship to partnership

- deepening of relations on long term focus and greater scope for mutual benefits

- afocus on direct organisation funding and research output to the benefits and values of the surrounding societies.

- plays crucialrole in the innovation system as 'producer' of scientific knowledge relevant not only in the academic circles but also in a commercial context

- research or knowledge creation is produced 'in the context of application' (Stellenthin, 2011).
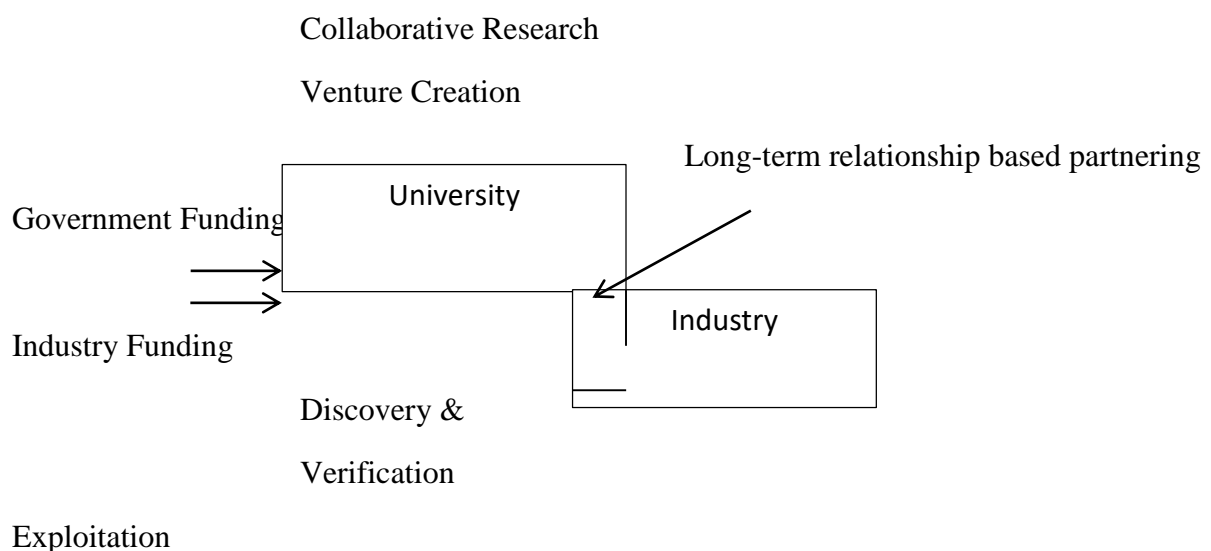
Mode 2

Figure 2.University research under Mode 2 (*Adapted from Dooley and Kirk, 2007)*

As shown in Figure 2, Mode 2 emphasises the role of the university, Industry and Government collaboration in what is also called the 'tripple helix' structure proposed by Etzkowitzand

Leydesdorff(2000). The entrepreneurial university does not only create academic knowledge but also shares it with industry through application and commercial contexts. As firms raise the technological level, they move closer to an academic mode, engaging in higher level of training and knowledge sharing. Government acts as public entrepreneur and venture capitalist in addition to its traditional funding and regulatory role.

Types of University–Industry collaboration

There are many types of university-industry collaboration depending on the objectives, scope and institutional arrangement. Collaboration may be more or less intense and may focus on training or research activities. It could be formal such as equity partnerships, contracts, research projects; patent licensing or informal as interaction in conferences and expert groups (Hagedoorm, Link &Vonortas, 2000,inGuimo'n, 2013). It can also take the form ofa short-term and long- termcollaboration. The short term collaboration refers to on-demand problem solving with pre-defined results, and tend to be carried out through contract research, consulting and licensing(Guimo'n, 2013). Long-term collaborations are usually associated with joint projects and public-private partnerships, including privately –funded university institutes or chairs, joint university research centres and research consortia; often allowing firms to contract for a core set of services / specific deliverables in a flexible manner (Koschatzky&Stahlecker, 2010 in Guimo'n, 2013). The various types and their relationships are shown in Table 1.

Table 1: Topology of University–Industry links, from higher to lower intensity

High (Relationship)	Research partnerships	Inter-organizational arrangements for pursuing collaborative R&D, including research consortia and joint projects
	Research services	Research-related activities commissioned to universities by industrial clients, including contract research, consulting , quality control, testing, certification and prototype development
	Shared infrastructure	Use of university labs and equipment by firms, business incubators and technology parks located within universities
Medium Mobility	Academic entrepreneurship	Development and commercial exploitation of technologies pursued by academic inventors through a company they (partly) own(spin-off companies)
	Human resource training and transfer	Training of industry employees , internship programs, postgraduate trainingin industry, secondments to industry of university faculty and research staff, adjunct faculty of industry participants
Low (Transfer)	Commercialization of intellectual property	Transfer of university of university-generated IP to firms (via licensing)
	Scientific publications	Use of codified scientific knowledge within industry
	Informal interaction	Formation of social relationships(conferences, meetings, social networks)

Source: adapted from Perkmann and Walsh, 2007

Industry-University collaboration between Developed and developing economy.

The priorities and scope of the university-industry collaboration differ significantly between developed and developing economies as detailed in Table 2. In developing economies, university–industry collaboration tends to be more informal, focuses on firm's recruitment of university graduates, for staffing, internship and consulting, insufficient capacity or experience to collaborate with industry in innovation-related projects and limited managerial capacity in research.

In the developed economies, however, university –industry acts as an important driver of economic development as shown in Table 2.

Table 2: Priorities for university-industry partnership between developed and developing countries

	Developed countries	**Developing countries**
Teaching University	▪ Private participation in graduate programs ▪ Joint supervision of PhD students	▪ Curricula development to improve undergraduate and graduate studies ▪ Student internship
Research University	▪ Research consortia and long term research partnerships to conduct frontier research	▪ Buildingabsorptive capacity to adopt and diffuse already existing technologies ▪ Focus on appropriate technologies to respond to local needs
Entrepreneurial University	▪ Spin-offs companies, patent licensing ▪ Entrepreneurship education	▪ Business incubation services ▪ Entrepreneurship education

Since 1990s, the strategic mission of universities has moved beyond the tradition of teaching and research to a 'third mission' with the focus on addressing the needs of industry and contributing to economic growth and development. These three university missions have given rise to the distinct concepts of teaching university, research university and entrepreneurial university. It must be emphasizedthat university- industry links can take place in any of the three regimes with distinct focus on training and complementary roles. For example, collaboration in research (Research University) may give rise to opportunities for training doctoral students (teaching university) or creation of spin-offs companies or licensing of patents (entrepreneurial university).

Significance of the study

Knowledge and technology transfer from university to industry is crucial in the sense that it is assumed to have impact on innovation processes in firms. Innovation is often seen as systemic

processes influenced by interactions of firms, universities, regulatory agencies and other actors in the innovation system(Nelson 1993, Edquist 1997 cited in Draghici et al, 2016).Therefore, the study is significant because the involvement of businesses and other relevant stakeholders in the governance of research institutions can help to orient research and education activities towards the needs of society, bringing expertise to support knowledge transfer activities and the willingness to introduce innovation-oriented approaches towards entrepreneurship. This will facilitate inter-sectoral mobility through temporary staff exchanges as well as the hiring of graduates by industry.

The outcome of the study with its implication for policy and practice will address the challenges that hinder collaboration between researchers and industry particularly in low-income countries. It is likely to provide operational guidelines to research institutions regarding the management and exploitation of the intellectual properties in the context of UIC. Finally, the study aims to highlight the need to create science parks, business incubators, start-ups and spin-offs in the universities to advancing research, innovation and technological development.

METHODOLOGY

The study aims at finding out the extent towhich policies for promoting university-industry collaboration are effective in developing countries. The review of this study was based on relevant literature and policy papers form several database including Academic Search Elite, Educational Resources Information Centre(ERIC), Science Direct and Web of Science in order to explore university – industry collaborations and lessons from successful collaborations in other countries. A second set of searches was performed on the innovation support measures contained in the combined ERAWATCH-Trench Chart database. The measures described in this database contain information on policy briefs on innovation, evaluation reports on university-university partnerships, models of partnerships, science-industry linkages and commercialization of research results across Europe.

Series of Google searches were also performed using combination of specific keywords and descriptors such as 'university-industry collaborations', 'investment in R & D programme', 'Research and Innovation', knowledge transfer between research institutions and industry, 'Business Incubators and Spin-offs' 'innovation networks' etc which revealed more recent evaluation materials on the topic. A more rigorous further search using Scopus database revealed over 50 articles. After eliminating those articles which were not related to the topic, about 20 articles were selected for analysis. Among therelevant articlesand Working Papers werethe Journal of Technology Transfer, European Journals of Innovation Management, Nesta Working Papers, European Commission, The Innovation Policy Platform, Science /Business Innovation Board among others. The outcome of the analysis was used to provide operational guidelines and policy issues for promoting university-industry collaboration in developing countries, particularly in the Technical University in Ghana.

Motivations for university- industry collaboration

The success of university-industry collaboration hinges on the missions and motivations of each partner. In most universities, key motivation for partnership include improvement of teaching and research, access to funding due to the inadequate government subvention to universities, reputation enhancement and access to industrial capabilities, empirical data and

resources to commercialise research ideas. Other reasons include securing additional resources to finance programmes of study (adequate equipment and training materials), improving the quality of training programmes and contents, developing potential career pathways for students, facilitating the transition from school to work and promoting continuing access to workers (Cunningham and Go'k, 2012).

Firms, on other hand, are motivated to collaborate with universities to gain access to complementary technological knowledge (patents and tacit knowledge), tapping into a pool of skilled workers, providing training to existing or future employees, gaining access to public funding and incentives, reduce risks by sharing the costs of R& D and to influence the overall teaching and research agenda of universities (Guimờn, 2013). Other motivations of the firmsare using networks to increase synergy, efficiency and power, accessing complementary resources to exploit own resources to create new capabilities and enhance competitiveness, creating high risks high opportunity situations, decreasing R&D costs by pooling risks and co-opting competition, attaining economies of scale and scope. Firms also collaborate with universities to access leading edge research knowledge, research infrastructure or research services to develop in-house capabilities or to identify potential future employees (Cunningham &Go'k, 2012).

Partnership models

Models of collaboration between industry and university may range from short, medium to long term partnerships with associated risks and impacts on both parties. Three main models are identified.

> Transaction-based model – this model involves the establishment of technology Transfer Offices (TTO) that provides specialized core facilities and specific technology that are shared by multiple departments across disciplines.TTOs aims at improving transfer of technology through support services such as patent application process, licensing agreements, contract research, search for funding sources training and support in the creation of university-based spin-offs.

> The benefit of this model is 'transaction-based research–for–hire' leading to mutual trust and long- term partnership between both parties.

▪ Establishment of business incubator programs to deal with medium to long-term partnerships. It is an effective springboard for start-ups and spin-offs companies that result directly from in-house research. Providing constant access and management services to businesses within the academic campuses does not only allow the newly-established business to maintain regular links with research settings in the university as it matures, but also encourages industry professionals to gain direct access to laboratory and equipment as researchers and students gain access to industry professional, thereby building a mutually beneficial network of knowledge and collaboration.

▪ A long –term strategic collaboration involves a large scale research network such as universitypartnering with private industry at variety of scales, including large corporations, small-businessesand non-profit organizations, and government agencies under a consortium of parties that share a common set of goals. It is an open source research network aimed at creating a platform for innovation and discovery by linking together academia, industry, government agencies, philanthropic organizations,

NGOs,private investors and individuals across the globe.In India, Open Source Drug Discovery (OSDD) has brought together over 7000 participants to research and develop drugs for tropical diseases including tuberculosis and malaria. This partnership model has an advantage of promoting efficiencies, transparency between entities, open exchange of information, pooling resources, breaking down barriers to intellectual property rights and ensuring that research results address the needs of the local community or labour market (Corzo, 2015).

Benefits/ impacts of university- industry cooperation

In order to sustain university- industry collaboration, the two entities must gain mutual benefits from their interactions. Benefits accrue to university in collaboration with industrial partners include the following:

- Access to sources of research funding in addition to the traditional sources. This allows researchers to deepen their competencies and capacities, leading to increased stability for retaining research staff.

- Increased access to proprietary technology developed by the industry that promotes discovery process. This includes process equipment and materials such as chemicals and compound libraries

- Enhanced status when competing for publicly funded research/project due to the ability to demonstrate channels for disseminating research output and its direct contribution to the economic development to the country.

- Faster feedback loops in relation to output of universities discovery and transfer of research findings between the entities. Research findings from the universities can easily be verified or validated by industry and industry data fed back to the university, leading to better alignment of research output with industrial partners

From the perspectives of the industry, the benefits gained in partnership with university include;

- Access to world-class scientific base within the university as in the biotech sector, where the complexity of the innovation process makes it increasingly difficult for the industrial partner to possess all the necessary competences

- Access to knowledge (both codified and tacit)that has been developed within the centre through decades of publicly-funded research

- Access to world-class academics who are both scientifically and industrially aware of the state of the art

- Acquire competitive advantage through access to better leads and faster channels than their competitors, enhancing the product development process

- Access to rich sources like highly-skilled researchers and infrastructure, making a collaborative research project with the university more cost-effective (Dooley & Kirk, 2007, Guimo'n, 2013).

Policies to stimulate university-industry collaboration

This section examines policy options to promote university –industry collaboration particularly in developing countries facing very limited budgets and multiple competing priorities

R& D incentives and grants

A typical approach to enhancing university–industry collaboration is to design R&D research grants, matching grants and tax incentives with suitable consortium of firms and university.Successfully tested in Netherlands, Ireland, and UK is the 'innovation voucher' usually in a form of small credit lines provided by governments to small to medium enterprises to purchase services from universities and public research centers, with a view to introducing innovations in firms and business operations(OECD, 2010)

However, firms in developing countries show little interest in requesting grants because they do not either see the need to collaborate with universities, match the funds with internal operations or find the grant application process too complex.Universities on the other hand, often do not align their research agenda to market demands and therefore are not very attractive and relevant to the needs of local enterprises. Guimȯn (2013) reports that a grant scheme to promote university-industry collaboration was launched in Uganda in 2007 with funding from the World Bank, but firms had little interest in participating in the program leading to the failure of the otherwise innovative facility.

Reforming the reward systems for researchers in universities

The current assessment and rewardsystem in the universities places more emphasis on teaching experience, publication in scientific journals and external funding as the dominant criteria in tenure track systems and salary scalesto the neglect of commercial issues such as patents (Sellenthin, 2011). Government can reform the existing academic reward system for university professors and researchers by introducing new incentives to enhance collaboration with industry. Since 2010, emerging countries like Turkey have introduced new incentives in addition to the traditional criteria to promote andreward university researchers for developing industry linkages in a form of R&D funds moblised from private sources, number of consulting or R&D contracts with industry, earnings from consulting, income from patent licensing, participation in spin-offs or start–ups, encouraging sabbaticals into research-related enterprises (Guimo'n, 2013).Governments' funding for research for universities in UK, India, Canada, and Singapore are based on achieving certain level of contracts with industry (Yusuf, 2007).

In many developing countries,careers for cooperating with industry are not rewarded in tenure track or sometimes considered as unethical. Institutional constraints such as employment rules for civil and public servants and bans on creating private organisations at public universities (joint ventures with firms) limit academic entrepreneurship and possibility of exploiting patents and other forms of IP (Brimble, cited in Guimȯn, 2007). Furthermore, in some countries, public-sector researchers are not allowed to work for industry on a part-time, consultancy or other basis.

Conflicts over Patenting &Commercialization of research results(transaction related barriers)

One major barrier to effective collaboration relates to disagreements among collaborators on ownership of IP and division of revenue amongst parties. While industry claim that IP from

universities is often highly priced, exposing the industry into high risk in commercialization, universities fear that industry may steal their discoveries and generate revenue that rightly belong to them.Since 2000,legislative reforms and regulatory frameworks for IP management and codes of conduct in collaborative projects have been introduced in developed and middle-income countries like Brazil, Mexico, South Africa, Malaysia, China and Philippines, making it possible for universities to file for patents on research products and to grant licenses for these patents to private firms. In addition, the creation of technology transfer offices in universities is an institutional mechanism to assist researchers in patenting their results and obtain license fees and royalties(Correa and Zuniga, 2013).

However, IP reforms and creation of TTOs are not substitute for countries with weak national innovation system. In developing countries like Ghana, results of IP reforms have not been encouraging due to low technological capacities of universities (both human capital & infrastructure), limited awareness of the benefits of IP among researchers and firms, lack of interest among firms in technological development and overall institutional weaknesses.

Development of Science and technology parks, spin offs, and business incubators.

Developing science parks in the campuses of universities has the potential of creating university research spin-offs and start-ups through public venture capital and grants to entrepreneurs. Science parks are intended to create research clusters and promote collaboration between firms and research institutions, and often include business incubators to support spin-offs and start-up companies

Despite its potential advantages, there are many failed attempts of science parks initiatives in both low and middle income countries due to financial constraints and lack of necessary endowments to achieve success (Yusuf, 2007). The situation is even worse in low-income countries because of low number of universities managing science parks and technology transfer due to lack of adequate financial and human resources and capabilities. Most of the offices in many African countries offices lack the material resources and expertise to handle industry partnerships and technology transfers effectively (Mgonja, 2017). Only a small number according to Mgonja was involved in managing science parks, business incubators and technology transfer. Poor quality of education in developing countries and inadequate funds rather lead to low percentage of academic staff with PhD training and qualifications while the few qualified scientists seek better job opportunities in developed economies. As a result, most African countries find it extremely difficult to engage industry in innovative projects that can be converted   into economic returns through patents, spin offs, consulting and contracting.

In the same way, industry operating at a low technological capability and low interest in technological innovation tend to have lower demand for external knowledge that universities could provide.

Education and training

Education and training and for that matter, recruitment of skilled graduatesis the most important link between university and industry. In order to enhance stronger university-industry collaboration requires a consultative process with relevant industry players, professional bodies and business managers to make input in the curriculum development so that university programmes better respond to labour market needs.

In addition, the need for Government's policy that provides support for student internship schemes for undergraduates, participation of firms in graduate programmes and joint supervision of PhD students who may undertake part of their research within firms. The result is to promote transfer of knowledge from public R& D institutes and universities to private sector (SMEs), improving employment possibilities (offering long-term employment), career paths of young researchers and private sector's R&D capacity.

In lower income countries like Ghana, lack of skilled workers remains one major factor hindering competitiveness and innovative capacity of firms. This situation arises from poor quality of education and inadequate funds for equipment and infrastructure making it difficult to enter into any meaningful partnerships with industry for innovation related projects.

Globalization and university –industry collaboration

The globalization of knowledge, technology and innovation networks brings opportunities to low income countries like Ghana. These networks can take the form of multinational companies(MNCs) collaborating with local or foreign universities, leading universities from developed countries opening up satellite campuses and R&D centres in developing countries or collaborating with local firms in technology generation and diffusion. All these networks are the main drivers of the internationalization of their R&Dcentres, technology transfer,allows universities to leverage their reputation, knowledge base and management practices, international technology transfer and diffusion(Guimȯn, 2013).

These initiatives, however, are driven by generous funding from local governments and international donors. For example, Carnegie Mellon University, a high-ranking university in America set up a full-fledged campus in Rwanda in 2011 with funding from Rwandan government and African Development Bank(Guimȯn, 2013).However, poor economic and GDP growth facing most governments in developing countries have significantly reduced state funding to higher education which has affected their research capacity and infrastructure. Other obstacles against successful collaboration are lack of information, difficulties in finding contact persons, transaction costs and finding the right partner among others. There is also the danger of crowding out of local industries without innovative networks and universities and research institutes in the home country which may receive less public funding or face greater difficulties in attracting talented researchers and students.

Differences in the research orientations between university and industry(orientation-related barriers)

The differing cultures of the parties can impede success in developing economies most of which still operate within the traditional teaching and research mission.. The two actors operate on different timescales, objectives and value systems (Elmuti et al, 2005, in Dooley & Kirk, 2007). While universities research mission is on medium to long term effects, the focus of firms is to seek short- term results and clear contributions to current business lines. Given these two different systems of knowledge production, firms often conflict with university researchers over the topic of research, timing and form of disclosure of research results. While researchers may be keen on disclosing results priority, firms wish to keep secret or appropriate information. Finding appropriate balance that harmonize their operations is a big challenge

A corollary from the earlier point is the conflict between private and public knowledge production. The desire of academia to publish in reputable journals for promotion and tenure

does not go withindustry's focus of maintaining secrecy to secure intellectual property rights and gain competitive advantage and temporary monopolies (Stellenthin, 2011).

Implications for emerging technical universities in Ghana

From the review, the following issues appear as key lessons and recommendations for emerging technical universities in their quest to foster effective collaboration between university and industry.

(a) Pooling resources and R& D results by research institutions

Universities with inadequate material resources and expertise, especiallythose that do not have sufficient volume of exploitable research results need to pool their knowledge, competencies and resources or R&D results and associated IP rights together from several research institutions. Pooling resources together will ensure significant benefits as resources are made more widely available throughout the research institutions while industry players become aware of the research centres that generate IPs. For instance, pooling patents together will not only create critical mass of intellectual property necessary to attract industry or private sector but also trigger stronger relationships between knowledge transfer offices for further inter-institutional engagements.

(b) Promoting Entrepreneurship Mindset

Promoting entrepreneurial mindset and relevant skills among researchers can greatly reduce the cultural divide between research institutions and industry. To achieve this, research institutions need to be equipped with entrepreneurship education to provide training on basic knowledge transfer, business skills, managing intellectual property, interact with industry, start and spin-offs from inventions.

Furthermore, university programmes need to be strongly oriented towards helping solve the scientific and technological challenges in the world of work. This is imperative because most of the academics in partnerships are without industrial experience neither do they have the tendency to network outside their area of expertise.

(c) Creation of reward systems

In many countries, research institutions have reward systems whereby the inventor receives a share of any profits made when licensing or spinning of inventions. In thispractice, profits are evenly shared among the researcher, the research institutions and the business partner. For such reward to work effectively requires an appraisal of the existing criteria to take into account for career progression in the universities' activities such as patenting, licensing, mobility and collaboration with industry.

Government policy on funding incentives should reward universities and companies that do not only form strong partnerships but also long-term strategic relationships that allows parties to share risk, vision and mutual trust especially with well-defined, transparent and clear agreement in the sharing of resultant intellectual property. Incentive packages to both university and industry may trigger stronger partnership that pushes the frontiers of knowledge and become engine for innovation and economic growth.

(d) University autonomy is vital

The need to offer autonomy to universities to form partnerships with industry free from governmental and ministerial interference is very crucial. This requires the university Council, Deans and Faculty heads to come out with appropriate strategy for university partnership relevant to the growth of the university. Without freedom to operate with checks and balances, effective collaboration with industry will be an illusion.

(e) Puttingin charge leaders with shared vision

Collaboration works perfectly when it is managed by people who cross boundaries between business and academia and have deep understanding of the two cultures they need to bridge (Edmondson, 2012, Corzo, 2015). It requires the creation of a joint steering group including senior academics and company executives to make high level input, exchange information and brainstorming on common areas of interest particularly in transaction and orientation related issues. After all successful partnership thrives on a win-win situation for all parties

(f) Encouraging cross-fertilization of ideas

To encourage seamless relationship between university and industry, there is the need to create opportunities for academics and company researchers and executives with shared interest to come together to dialogue and exchange ideas over lectures or seminars. Building two-way exchangescan also be achieved when university professors are encouraged to work or take their sabbatical leave to work in the industry and invite industry staff for lectureship appointment in the university. Bringing both sides together can spark conversations and strategic issues to strengthen relationships

(g) Redefine the role of universities in developing economies

For university-industry partnership to accelerate innovation and address the pressing social challenges, the mission of universities in the developing countries needs to be redefined to include collaboration with industry. With this new role, universities in the developing economies will go beyond teaching and research to solving key social challenges and introduce innovations that will drive economic growth. In this direction, these universities will not only generate new ideas but also churn out competent and highly skilled workforce for globally competitive economy.

CONCLUSION

The review of the existing policy initiatives for promoting university-industry linkages clearly shows that to a large extent, those initiatives do not support effective partnership between university and industry in developing countries. Major barriers to these policy initiatives include mismatch of research agenda to market or local enterprise demands, transaction and orientation challenges, institutional constraints on civil and public service employment, low technological capacity of industries, unskilled workforce, and funding challenges among others. This study has attempted to add new perspectives to the existing policy initiatives to address the specific challenges confronting developing economies in their quest to foster university–industry collaboration. Among the policy directionsfor low income countries like Ghana, and for that matter, the technical universities to benefit from these networks require

pooling of resources, results and expertise together with clusters of innovative local firms, promoting entrepreneurship mindset, availability of appropriate human capital, innovation-friendly regulatory regimes and a shared vision that clearly identifies the purpose, goals and transparent agreement for the use the resultant IPs.

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