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University-industry linkages in developing countries: perceived effect on innovation

Terje I. Vaaland
School of Business, University of Stavanger, Stavanger, Norway, and
Esther Ishengoma
Business School, University of Dar es Salaam, Dar es Salaam, Tanzania

Abstract

Purpose – The purpose of this paper is to assess the perceptions of both universities and the resource-extractive companies on the influence of university-industry linkages (UILs) on innovation in a developing country.

Design/methodology/approach – A total of 404 respondents were interviewed. Descriptive analysis and multinomial logistic regression models were applied to analyse the data.

Findings – The findings revealed significant differences between the three informant groups across the three main groups of linkage activities. The industry informants consider all three groups of UILs important for enhancing innovation, in terms of bringing student closer to the industry. The faculty members consider consultancy and research arrangements more important than collaboration, in training and educational activities. The student perceptions on all UIL activities were relatively weak on UIL activities as a vehicle to improve innovation.

Research limitations/implications – Based on the findings, it seems that the universities should take advantage of a positive attitude among industrial actors and intensify efforts to develop UILs.

Practical implications – The research can be used for sharpen international oil companies effort towards universities in petroleum rich developing countries.

Social implications – Implications for policymakers and universities in developing countries, and for the local industrial base. In a broad sense the UIL stimulated innovation has implications on poverty reduction in natural resource-rich host countries.

Originality/value – Research on UILs in developing countries is rare, particularly in a context in which international companies are faced with host country expectations and legal requirements to invest in knowledge sector and local industry.

Keywords Tanzania, Innovation, Africa, Extractive industries, SME, Petroleum industry, University-industry linkages

Paper type Research paper

1. Introduction

The need to mobilize national resources to support economic development has taken a specific form in proposals to develop university-industry linkages (UILs) (Brundenius *et al.*, 2009). These linkages can be defined as "bi-directional linkages between the university and industry entities, established to enable the diffusion of creative ideas, skills and people with the aim of creating mutual value over time" (Plewa *et al.*, 2013, p. 23). Even though UILs with multinational enterprises (including international oil companies – IOCs) exist in developing countries, the known effect of these linkages on innovation and improvement processes among indigenous firms is still limited (Mpehongwa, 2013). This paper seeks to contribute in filling this gap.

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This paper focusses on UILs between the university and foreign firms, and its perceived effect on transferring innovation into the local industrial base. The informants reflect this by assuming faculty members and students from the universities as "agents of innovation", as well as informants from foreign firms operating in Tanzania representing innovative capabilities. The question is how interaction through UILs can improve faculty and students' ability to stimulate local firm innovation. This question is in line with Brundenius *et al.* (2009), Nielsen (2007) and Barnard *et al.* (2009), emphasizing the innovation transfer effect from university graduates on enhancing innovation and competitiveness among developing country firms. This leads to the following research question:

RQ1. Which UIL activities between university and foreign firms are assumed most effective when stimulating innovation among Tanzanian indigenous firms?

Foreign companies encompass international or multinational companies (MNEs), IOCs and associated international suppliers operating in the host country. The term "university" embraces all types of higher educational institutions, including engineering and business schools organized outside traditional universities.

The context of the study is that of a developing country with rich natural resources, a weak industrial base and an active industrial participation by foreign-based firms. Discoveries of minerals and petroleum resources make the extractive industry the fastest growing sector in emerging economies, especially in Tanzania. The upstream value chain activities (i.e. exploration and exploitation) in this industry are dominated by foreign-based companies and suppliers. Whereas the mining industry has existed for hundreds of years, the petroleum industry is relatively new to Sub-Saharan nations. Petroleum nations such as Nigeria, Angola, Libya and Algeria have involved foreign companies in the production of oil for decades. Like these countries, new petroleum nations such as Ghana, Uganda, Tanzania and Mozambique are facing new challenges in applying petroleum resources as a mean to create national wealth. These countries have developed a local content policy to enhance the participation of local suppliers/companies in the extractive industry value chain. However, the industrial base in these countries has yet to provide adequate suppliers and employees with the internationally required qualifications (URT, 2014)[1]. In the early stages of development of the petroleum and mining sector in particular, the capacity to meet professional industry requirements is likely to be low, especially in countries that lack an industrial base (Tordo *et al.*, 2013). Foreign companies are therefore increasingly facing an explicit challenge in involving local suppliers in the petroleum value chain and recruiting local people for the benefit of the host nation (Vaaland, 2015).

Resource-extractive industries in developing countries are dominated by powerful, large foreign enterprises with an abundance of technological, fiscal and managerial resources. These enterprises are governed by international standards and formal requirements, with a significant effect on sourcing strategies and ability to include indigenous companies as suppliers. Although local content requirements may stimulate the inclusion of local firms, inclusion requires the firms to comply with international branch standards. Nonetheless, the local industrial base in a developing country context is hampered by disadvantages compared with their global competitors. Some of these disadvantages include small-scale disadvantages and a lack of operational efficiency (OECD, 2005)[2]. Furthermore, weak organizational structures and formalities in business processes have led to a significant gap between expectations from global "big oil" and the reality of the local firm. This implies that the inclusion of local firms requires innovation processes within the boundaries of the local firm.

In emerging or transition economies, domestic firms that were formally protected from international competition are now experiencing not only significant changes in their business environment, but are also facing considerable challenges in competing with established and internationally recognized firms (Acquaah *et al.*, 2008). A lack of relative competitiveness can be offset by improving or introducing new capabilities and value-adding activities. These processes aiming to enhance relative competitiveness are strongly related to innovation, which can be categorized into two interconnected constructs: technological and organizational or managerial innovation (OECD, 2005). Innovation activities play an important role in closing the gap between the current level of the local industrial base and international requirements and expectations in the petroleum sector and mining industry.

The innovation environment, particularly in Sub-Saharan Africa, is usually harsh and hampered by weak infrastructure, human capital and institutions required for learning and capacity building (Egbetokun, 2015). The role of the African university as a vehicle for local firm innovation is also very limited, if not non-existent (Oyebisi *et al.*, 1996). Still, many scholars emphasize the universities' vital role in having a capacity to nurture innovation (e.g. Fu and Li, 2010; Hershberg *et al.*, 2007; Alves *et al.*, 2007; Etzkowitz, 2002; Ball, 1995). In line with this, governments throughout the industrialized world have launched numerous initiatives based on university research, creating science parks located near universities, business incubators and seed capital funds, to link universities to industrial innovation more closely (Mowery and Sampat, 2005). In accordance with this, it is argued that partnerships between universities, business and civil society are prerequisites for improved economic development and for enhancing innovation (Feng *et al.*, 2011; Hansen and Lehmann, 2006). Developing and transition economies need enhanced national innovation systems to create healthy and competitive economies and improved living conditions for their citizens (Hansen and Lehmann, 2006). According to Mowery and Sampat (2005), a growing number of developing country governments seek to use the universities as instruments for knowledge-based economic development and change.

The rest of the paper is organized into five sections. First, a literature review is carried out with a focus on innovation, and the role of universities and UILs. In the following section, a methodology is presented, followed by findings, a discussion and the implications, before the paper is concluded.

2. Literature review

In the following, prior conceptualizations and empirical findings are related to five aspects of innovation, which are connected to the university domain. These are: theoretical background and typologies of innovation, key features of innovation in developing economies, the innovation role of the university, the university graduates as "agents of innovation" and the modality groups forming the UILs. Lastly, these elements are summarized in a conceptual model.

2.1 Innovation – theoretical background and typologies

Even though studies of innovation have grown rapidly in recent years, the core of innovation is still based on the Austrian-American economist Schumpeter, who advanced a theory in which innovations, as well as the social agents underpinning them, were seen as the driving force of economic development (Fagerberg *et al.*, 2012). In line with this innovation is portrayed as a dynamic force that causes a continuous

transformation of social, institutional and economic structures. Aspects from Schumpeter's early work include the definition of innovation as "new combinations" of new knowledge and resources, the distinction between the invention (new ideas) and implementation of these in practice, and the classification of innovations into product, process and organizational innovation (Fagerberg *et al.*, 2012). In line with this, the OECD (2005) sharpens the definition of innovation as the implementation of a new or significantly improved product or process, a marketing method or a new organizational method in business practices, workplace organization or external relationships. The introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses is labelled product innovation (OECD, 2005). The implementation of a new or significantly improved production or delivery method is labelled as a process innovation and marketing innovation, which includes new marketing methods (e.g. product design, packaging and pricing). The last main type, organizational innovation, is associated with increasing a firm's performance by reducing administrative costs or transaction costs and labour productivity. Among the generic types of innovation, studies of innovation in a developing country context emphasize the importance of non-technological innovation, i.e., those related to marketing and organizational changes (e.g. Egbetokun, 2015). This study therefore includes informants from both technological and business studies within the university system.

2.2 Innovation in developing economies – key features

The national innovation system in developing countries is typically inefficient and/or ineffective in their task of producing and exploiting knowledge (Marin and Arza, 2009). Innovation studies have therefore acknowledged the importance for developing countries to remain open and receptive to knowledge and technologies created abroad. (Lundvall *et al.*, 2009). Foreign companies enable the host country to not only have more direct or smoother access to existing technological and managerial competencies originating from outside the national systems, but to also be part of international processes of knowledge creating and diffusion (Marin and Arza, 2009). The MNE operating in the host country is therefore both a part of the global knowledge networks and the national systems of innovation (Marin and Arza, 2009), in which the university and the local firm are embedded.

There are a large number of studies exploring the role of the university in stimulating innovation in the industrial base. According to Hershberg *et al.*'s (2007) study of "world class" universities in the USA, Western Europe and Japan, they found few business startups associated with a university, nor any significant linkages of local businesses to universities. Even the most dynamic universities account for a very low share of the total patents issued. According to Cohen *et al.*'s (2002) study among US industrial firms in most industries, university research results play little if any role in triggering new industrial R&D projects. Patents and licensing involving inventions from university and personnel exchange were reported to be of very little importance, as earnings from fees and contractual research are small overall (Hershberg *et al.*, 2007).

When moving towards more emerging economies, Brimble and Doner's (2007) study of UILs in Thailand indicates a very low level of innovation linked up with universities. Thai universities have also not exhibited the incentives or institutional capacities for UILs. (Brimble and Doner's, 2007). At most universities in emerging economies, the faculty does not conduct research at all (Hershberg *et al.*, 2007). For example, in Korea and Singapore leading universities have only recently begun paying attention to research and its commercialization. Where UILs do exist, they are limited to consulting and small-scale contract research (Hershberg *et al.*, 2007). Meredith and Burkle's (2008)

study from Mexico identified a positive attitude among industry and university informants on the joint benefit of building bridges between universities and industry. In a developing country context, a study by Egbetokun (2015) also provides a positive view on UILs and the relationship between interactive learning and the development of innovative capacities in Nigeria. He found a generally positive relationship between the formation of external linkages and the probability of a firm innovating. According to Gagoitseope and Pansiri's (2012) study of Botswana firms, younger people (including student age cohorts) displayed more entrepreneurial and managerial innovation motives than other age cohorts.

In sum, the role of the university (and UILs) in innovation systems is associated with governmental ambitions and good intentions, but at the same time provides ambiguity with respect to effectiveness and results. This is even more challenging in a developing country context, in which the universities are hampered with lack of resources and innovative capabilities.

2.3 The innovation role of the university

While firms are the primary agents of innovation, they also interact with a host of other organizations and institutions (Lorentzen and Barnes, 2004). Some of these are universities that provide the firm with knowledge resources and a base for the future recruitment of young employees, which may be a vehicle for change and innovation. Hence, the innovative effects of linkages between the firm and educational institutions are worth further exploration.

In line with this view, our theoretical perspective of innovation is related to the literature cluster, "innovation systems" and positioning innovation into the context of national and regional development (Lundvall *et al.*, 2009). Innovation literature defines the national innovation systems as "the institutions and actors that affect the creation, development and diffusion of innovations" (Mowery and Sampat, 2005, p. 212). A related array of innovation literature focusses on the innovation absorptive capacity of the firm (e.g. Cohen and Levinthal, 1990) and the SMEs specifically (e.g. Corral de Zubielqui *et al.*, 2015). This is relevant for the (developing country) local firm's ability to apply innovation transferred through the university. However, our focus is more on the UILs between the foreign company and the university as part of the whole innovation system (of Tanzania).

One stream of literature positions the university in the "tripe helix" paradigm, which emphasizes innovation as a part of the university's purpose, thus supplementing the traditional teaching purpose (Etzkowitz, 2002). Another stream of literature emphasizes the national innovation system, in which the university plays a developmental role as an integrated element in a broader national innovation system (Brundenius *et al.*, 2009). They further emphasize that one principal task for higher education is to contribute to general skills, thereby supporting an interaction with others that result in innovation. In developing countries, this role is hampered by scarce resources, the low quality of a resource base that is often badly adapted to the developmental context, while brain drain is also common, and high unemployment among graduates is a problem. Many studies (e.g. Alpert *et al.*, 2009; Decter, 2009; Perkmann *et al.*, 2011; Afonso *et al.*, 2012; Corral de Zubielqui *et al.*, 2015) assessing the role of universities were conducted in relatively advanced countries where universities possess a strong infrastructure and adequately skilled personnel and funds for conducting research and development activities. On the other hand, most of the universities in developing economies in Africa suffer from a weak learning and research infrastructure, limited skilled personnel and insufficient research funds (Mpehongwa, 2013; Makulilo, 2012).

2.4 University graduates as "agents of innovation"

While science is a strategic input for many industries, it is not the ongoing research at the university level that matters most, but instead is embodied in the general scientific knowledge of graduates coming out of the university (Brundenius *et al.*, 2009). While graduates contribute to innovation, they will do so most successfully in a context where there is ongoing technical and organizational change (Brundenius *et al.*, 2009).

Empirical studies confirm that the hiring of graduates has an impact on the innovativeness of firms. In Nielsen's (2007) study of Danish SMEs, the first-time hiring of a graduate with an engineering background has a significant positive impact on the propensity to introduce a new product, and that the hiring of a graduate with a management training background has a significant positive impact upon the frequency of organizational change. This is especially important for a developing country, where the "absorptive capacity" in relation to new technology is a major bottleneck (Brundenius *et al.*, 2009). The low demand for graduates in the private sector reflects cultural barriers that restrict the hiring of graduates, but more important is stagnation in terms of technical and organizational change. When it is realized that almost all knowledge relevant for innovation has tacit as well as codified elements, it becomes obvious that the flow of graduates into industry is the most powerful mechanism through which knowledge creation at universities can contribute to innovation in business (Brundenius *et al.*, 2009).

2.5 UIL modality groups

As a theoretical background, UILs are viewed in terms of institutional theory, in which the UIL is influenced by regulatory, cognitive and normative dimensions (Busenitz *et al.*, 2000). The regulatory dimension is related to local content requirements, in which the foreign company is required to increase host country capabilities and resources through the knowledge sector. The cognitive dimension consists of the knowledge and skills possessed by others, the university students and faculty members, and their ability to collaborate with foreign companies operating in the host country. The normative dimension measures the degree to which faculty and students admire innovation activities among local enterprises in need of technological and non-technological improvements.

Goosen *et al.*'s (2001) investigation of UILs in Oman suggests three areas of activities, namely, research and development projects, technical training and short courses and graduate education. Brimble and Doner (2007) follow a similar categorization by suggesting three modality groups of UILs corresponding to the three broad missions of the university sector: training- and education-related activities, the provision of services and other consulting activities, and research-related activities. The content of these categories will be presented in the following, based on a brief summary of the literature.

Training and education-related activities include visits by students to industrial premises and the organization of career talks by industrialists for university graduates (Suraweera, 1985). A second group can be labelled as student working experience programmes or university-student internships, in which the student, as an organized part of the educational programme, works in the company for a few months under joint faculty/industry supervision (Goosen *et al.*, 2001; Ayarkwa *et al.*, 2011; Hamdan *et al.*, 2011; Alpert *et al.*, 2009; Padilla-Perêz *et al.*, 2009). This could also be organized as vacation employment and a provision to do research projects on industrial premises (Suraweera, 1985). A third sub-group of activities involves industrial practitioners in

teaching assignments through part-time assignments (Goosen *et al.*, 2001; Oyebisi *et al.*, 1996; Suraweera, 1985; Toor and Ofori, 2008). Lastly, the UILs can include the organization of short refresher courses for industry personnel (Suraweera, 1985).

Internships and student working experience programmes in internationally competitive firms (e.g. an international oil company) can expose students to modern managerial and organizational processes and structures that can supplement the theoretical understandings provided at their university. Furthermore, the corporate attitudes and mindsets (e.g. quality management, sourcing and industrial buying behaviour) within the host firm might also be highly useful later (e.g. as an employee in a local firm). The blending of generic technological and business skills with practical experience can help improve technological and managerial/organizational innovation processes in the local industrial base. This is in line with Ball (1995), who emphasizes the value of providing students with innovative real-life learning exercises. The introduction of part-time lecturers from the industry into university courses can also add industrial insight and understanding, which further improve the student's ability to introduce or actively support innovation processes when entering the local labour market.

Services and other consulting activities can also include initiatives to provide faculty members with industrial experience through sabbatical arrangements (Oyebisi *et al.*, 1996) or lecturers spending short periods working in the industry (Suraweera, 1985). Others bring in personnel from industry for helping to formulate specific university courses (Suraweera, 1985) and assistance in designing a curriculum (Oyebisi *et al.*, 1996). In a third sub-group, the university provides simple technological support and advice to firms (Vega-Jurando *et al.*, 2008; Suraweera, 1985) or carries out feasibility reports and analytical assignments (Oyebisi *et al.*, 1996; Hamdan *et al.*, 2011). Lastly, a more mutual contribution includes the co-arrangements of workshops, conferences and seminars (Oyebisi *et al.*, 1996; Hamdan *et al.*, 2011).

Building innovation capabilities among students is influenced by the curriculum and learning material, but also include attitudes among professors and lecturers. Mulinge and Munyae's (2008) study of innovation and organizational change among faculty members in a Botswana university indicates a modest attitude to change among faculty members. The lack of innovative attitudes among the teaching staff could have a spillover effect on students, and at a later stage hamper the local firm's ability to innovate. This "ivory tower" syndrome can be offset by sabbatical arrangements, in which faculty members are exposed to real-life problems and solutions in a competitive firm, which at the end of the day breed the ground for innovative students. Moreover, by involving industrial practitioners in curriculum-developing processes, university programmes and courses might be more aligned with industrial needs, and influence the students' abilities and attitudes toward innovation and employment in local firms.

Research-related activities include joint research, contract research and the interchange of research personnel (Hamdan *et al.*, 2011; Vega-Jurando *et al.*, 2008), which implies a collaboration between a university scientist and his counterpart in industry (Suraweera, 1985). A second group is related to sharing physical assets such as equipment, facilities and application packages between the parties (Oyebisi *et al.*, 1996; Suraweera, 1985).

Research collaboration can enhance the university as a research-based educational provider, and more specifically open up access to new technology and processes of relevance to both faculty and students. A viable research environment can also

include local firms, thus increasing the diffusion of new materials and processes into practical applications. Access to joint industry-university laboratories can also improve the relevance of educational programmes and sustain innovation among local firms.

2.6 A conceptual model

Porter *et al.* (2002) distinguish innovation-driven economies (i.e. developed nations) from efficiency-driven economies in pursuit of higher productivity and economies of scale (i.e. developing nations). As an economy develops further, the emphasis on industrial activity gradually shifts towards the emergence of innovative, opportunity-seeking entrepreneurial activities and economic growth (Iakovleva *et al.*, 2011). The two types of economies have implications for the role of the university and industrial actors. In an innovation-driven economy, the university is considered as a source of creation and diffusion of innovation towards industrial adoption and commercial application. A majority of studies assumes the university as a research university, and holds a "from university-to-industry" focus when describing UILs (e.g. Cohen *et al.*, 2002; Mowery and Sampat, 2005; Hershberg *et al.*, 2007; Decter, 2009; Corral de Zubielqui *et al.*, 2015).

In a developing country context, or in efficiency-driven economies, the role of the university and industrial actors are different. In this context, there are two sets of industrial actors with a very different role to play in relation to the university. The foreign company (e.g. international oil companies and collaborating global suppliers) has capabilities that can be transferred to the university through UILs. Instead of a "from-university-to-industry" focus, the direction is now reversed "from-industry-to-university", whereas the local, indigenous firm is the second set of industrial actors. Their role is to adopt and apply innovation capabilities from the university (e.g. Egbetokun, 2015; Meredith and Burkle, 2008; Brimble and Doner, 2007; Oyebisi *et al.*, 1996), as in this study the university is considered as an intermediary or connective link in the national innovation system, which is gained from UILs with foreign firms.

This study rests on the assumption that foreign firms in efficiency-driven economies with interests in host country natural resources can improve the university (through faculty members and students), which in the end provide local firms with a highly competitive and innovative workforce. In simple terms, the innovation absorption capabilities in the local firm are affected by UILs to the university, which are made possible through UILs with foreign firms. It is worth mentioning that in addition to UILs, the local firms are also affected by inter-firm linkages with the foreign company through, e.g., supplier development programmes. These linkages are emphasized by Barr (2002) and Corral de Zubielqui *et al.* (2015), which argue that firms tend to interact more with customers and suppliers than research-based ones such as universities and research organizations. However, innovation through inter-firm linkages is not further investigated.

Summing up, a diffusion of innovation from foreign firms to the local firms can be materialized in two ways: either through direct inter-firm linkages (e.g. supplier development) or indirectly through UILs, via the university and graduate employability. This study focusses on the UILs with the foreign firms and the university, with an assumed long-term effect on the local firm. The key concepts are illustrated in Figure 1.

The connectedness between the literature review and the study design is summarized in Table I.

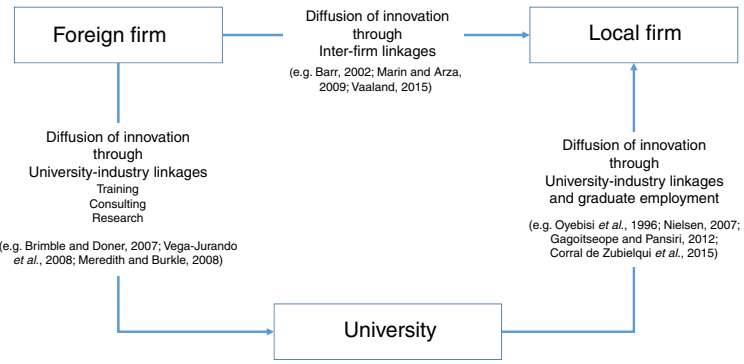

Figure 1.
Conceptual model

Source: Derived from Barnard *et al*. (2009)

Literature review	Study design implications
Innovation is about technology and non-technology- (i.e. business-) related improvements	Both technology- and business-related schools/departments are included, and are reflected in questions to informants
Weak innovation systems in emerging economies Lack of absorbing capacities in industrial base Importance of MNE diffusion of innovation and Innovation "from industry-to-university" in Africa	Emphasis on foreign firms/MNEs and UILs as intermediaries to local firm innovation; and foreign firms included as informants
Innovation role of the university hampered by lack of institutional support and infrastructure	Faculty members are included as informants
Students/graduates are useful "agents of innovation"	Students are included as informants
Innovation takes place within three modality groups	Data includes all three modality groups

Table I.
Literature review implications

3. Methodology

Quantitative/survey data collected at the beginning of 2014 by means of a structured questionnaire was utilized. The application of this survey was based on the deductive nature of the phenomenon, as well as the need for inclusion of a large number of informants from three stakeholder groups.

The target population included employees representing the views of extractive companies, students and faculty members from the University of Dar es Salaam and Ardhi University. More specifically, the students and faculty members targeted were involved in academic programmes categorized into social science (namely, business administration and economics) and mining, natural and applied science (namely, mining engineering, mineral processing engineering, geology, engineering geology and environmental science and technology). The selection of these programmes was based on the fact that they have some linkages with the resource-extraction companies and are therefore relevant for the focus of this study, as is focussed on in the extractive industry. The duration for selected programmes in social science is three years, while for those in engineering, natural and applied science, it is four years. According to the University of Dar es Salaam's regulations, students in selected social science programmes are required to do their three months of practical training in companies, among which could be the extractive companies. Students in these programmes also

have very active associations that organize exchange forums and work closely with companies. Students in engineering, natural and applied science are required to do industrial training at the end of each of their first three academic years. In line with their field of study, they obtain a placement in extractive companies. As a result, the target students for data collection were those in either the third or fourth year of their studies, or in the first year of full-time postgraduate programmes. Students in the second year of full-time postgraduate programmes had left the university compounds for the writing of theses during the time when the data were collected.

Tanzania has four of the oldest universities in Africa (namely, the University of Dar es Salaam, which has been involved in nurturing all public universities in Tanzania, Ardhi University, the Sokoine University of Agriculture and the Muhimbili Health Science). The latter two have nothing to do with the extractive (mining, oil and gas) industry, while other universities are young and depend on manpower from the University of Dar es Salaam. Thus, the study focussed on the University of Dar es Salaam and Ardhi University because they are the oldest institutions in Tanzania, have some programmes related to the extractive industry and would therefore have more experience in UILs, which would enable their staff and students to offer reliable perspectives about the role of UILs in enhancing innovation. Moreover, the choice of students in their postgraduate and final year (i.e. at least in the third year) of undergraduate studies is based on the assumption that with their experience in their studies, seminars, workshops and internships in companies, they would be able to provide objective and accurate perspectives about the role of UILs.

In 2014, there were 203 faculty members from the two universities in target programmes as instructors and researchers, of which 121 were in social science and the rest in engineering, natural and applied science (Tables I and II). In the same year, there were 720 students either in their third year or postgraduate students in selected programmes in social science, while there were 320 in selected programmes in engineering, natural and applied science, thereby comprising a total of 1,040 students. A list of faculty members and students was provided by the administration offices of target departments. Based on the lists, a simple random sampling was applied to select 100 lecturers (i.e. 49 per cent of target lecturers) and 235 students (22 per cent of target students) (Tables I and II). There was a deliberate attempt made to have more academic members and students from engineering, natural and applied science, as 100 employees from 20 extractive companies were targeted for data collection, though due to a lack of a sampling framework for companies in the extractive industry operating in Tanzania, we compiled a list of 20 firms from the website of the Tanzania Petroleum Development Corporation (www.tpdc-tz.com), as well as that of the Tanzania Chamber of Minerals and Energy (www.tcme.or.tz). In total, there were 26 (nine in mining and the rest in oil and gas) companies. The management of the 20 companies (six in mining and the rest in oil and gas) was approached for the data collection, which selected the employees who provided their views that represented the perspectives of the companies. Therefore, 69 employees (with at least one respondent from each of the 20 companies) filled in the questionnaire, with the paper utilizing data from 404 respondents (Tables I and II).

As indicated in Tables I and II, respondents in the three categories (students, faculty members and company employees) were from the field of social science (29 per cent) and engineering, natural or applied science (71 per cent). Approximately 54 per cent of respondents were males, while the rest were females. At the industry level, females only comprised 13 per cent, which could be because there are few experienced females with

	Student Respondents	Student Population	Company respondents Respondents	Faculty Respondents	Faculty Population	Sum Respondents	% of total
Education background							
Social sciences	91	*720*	4	24	*121*	119	29.5
Courses: business administration, economics							
Engineering/natural sciences	144	*320*	65	76	*82*	285	70.5
Courses: mining engineering, mineral processing engineering, geology and engineering geology, environmental science and technology							
Total	235	1,040	69	100	203	404	100.0
Sample as % of population		*22.60*			*49.26*		
Gender							
Male	153		61	6		220	54.5
Female	82		8	94		184	45.5
Total	235		69	100		404	100.0
Employment position							
Professor/senior lecturer	na		na	29			
Lecturer/assistant lecturer	na		na	71			
Foreign expatriate	na		4	na			
Local	na		65	na			
Total	na		69	100			
Sub-sector							
Minerals	na		25	na			
Oil and gas	na		44	na			
Total	na		69	na			

Table II.
Description of target population and respondents

advanced technical knowledge in the extractive industry. Because initiatives have been taken to increase females in engineering and natural or applied science, the number of female students in these programmes has increased, with female students in the sample accounting for 35 per cent of the total number of students. For the case of faculty members, females comprised 94 per cent. At the company level the data are skewed to males, while at the faculty level they are skewed to females. This could affect the results if gender matters at all as far as the perception of the importance of UILs on innovation is concerned. Therefore, descriptive results should be taken with precaution. In total, 29 per cent of faculty members (academics) were professors or senior lecturers, whereas 79 were lecturers or assistant lecturers. The respondents from the companies consisted of Tanzanians (94 per cent) and foreigners (6 per cent).

The development of the research instrument was based on Brimble and Doner's (2007) framework of the UIL activities which were categorized into three broad

areas: training and education, service and consulting activities and research. Detailed questions on the perceptions of respondents on the innovation effects of UIL activities in the area of training and education, such as students' internships in companies, is according to Goosen *et al.* (2001), Ayarkwa *et al.* (2011), Hamdan *et al.* (2011), Alpert *et al.* (2009) and Padilla-Perêz *et al.* (2009). Company collaboration with students during their theses or project assignments was according to the observations by Suraweera (1985), while part-time lecturers from industry teaching at the university was according to Goosen *et al.* (2001), Oyebisi *et al.* (1996), Suraweera (1985) and Toor and Ofori (2008).

Regarding the innovation effects of UIL activities in the area of services and consulting, activities such as industry assistance in modernizing and developing university curriculum and programmes, as well as university lecturers' sabbatical arrangements in industries, follow the observation by Oyebisi *et al.* (1996) and Suraweera (1985). Furthermore, university-industry collaborations in arranging seminars, conferences and short-term courses were in line with Oyebisi *et al.* (1996) and Hamdan *et al.* (2011). Regarding innovation, the effects of UIL activities in the area of research activities such as joint collaborative research, was in line with Hamdan *et al.* (2011), Vega-Jurando *et al.* (2008) and Suraweera (1985), whereas others such as the sharing of physical facilities was according to Oyebisi *et al.* (1996) and Suraweera (1985).

As a result, questions on the innovation effects of UIL activities in the three categories as described above were set in such a way that they required the respondents to indicate (rate) their perceptions on the importance of UIL activities in enhancing innovation. Ratings were done on a Likert scale from 1 to 5, in which a score of 5 = strongly agree, a score of 4 = agree, a score of 3 = neutral, a score of 2 = disagree and a score of 1 = strongly disagree. The application of Likert scale questions in rating respondents' perceptions about phenomenon under study has been applied by several studies in this area of UILs, including those by Alpert *et al.* (2009) and Hamdan *et al.* (2011).

After the development of the questionnaire, the pre-testing of the questionnaire to the three categories of the respondents was conducted, and questions were improved to increase the validity and reliability of the research instrument and data collected. For the same reason, the Cronbach's α value test was conducted for each category of UILs activities as reported in Table III. The results from the test show that for each category of UILs activities, the Cronbach α value was greater than 0.7, meaning the instrument and data collected were reliable.

The main objective of this paper was to assess the perceptions of both universities and the resource-extractive companies on the influence of UILs on innovation. As argued in previous studies (Feng *et al.*, 2011; Hansen and Lehmann, 2006), UILs are expected to enhance innovation. This is expected to happen much in developing countries where innovation systems are ineffective or inefficient (Marin and Arza, 2009), which could be due to a limited investment in research and development and a

Table III. Test for the reliability of the instrument/data

UILs category of activities	Anchor	Cronbach's α	Cronbach's α based on standardized items	No. of items
Training and education	5 points	0.719	0.720	5
Consultancy services	5 points	0.788	0.791	5
Research	5 points	0.798	0.799	5

lack of resources (research funds, physical infrastructure and research facilities, highly trained personnel such as lab technicians, in addition to limited access to new knowledge/information on recent innovations) for the case of Tanzania (see Mpehongwa, 2013). Thus, cooperation with international companies in extractive industries is likely to enable universities to have access to new ideas and advanced research infrastructure (see Marin and Arza, 2009), both of which are important in enhancing innovation. It is therefore generally assumed that universities and extractive companies in emerging economies like those of Tanzania are more likely to view UILs in all areas as important for enhancing innovation. However, faculty members', students' and extractive companies' levels of perceptions on the importance of UILs activities in enhancing innovation may differ based on the interests of the groups and individuals as determined by their attributes or background (see Alpert *et al.*, 2009; Hamdan *et al.,* 2011). Hence, it is also expected that the perceptions of faculty members, students and extractive companies on the importance of UILs activities in enhancing innovation are likely to be diverse. Moreover, individual attributes (status, education background and gender) are likely to determine the perceptions of the respondent on the importance of UILs in enhancing innovation. This is in line with Hamdan *et al.*'s (2011) argument that respondents' perceptions on the importance of UILs will depend on how they foresee their level of participation in the UILs' activities, given the nature of the industry they are involved in.

To test the general hypothesis, data were analysed using descriptive statistics, whereby mean scores for each factor were estimated and used to rank the importance of factors for each group of the respondents (students, faculty and industry). This analytical approach has also been used by previous studies similar to ours (see e.g. Alpert *et al.*, 2009; Hamdan *et al.*, 2011; Ayarkwa *et al.*, 2011). The test for the distribution of responses from students, employees and academics was done, and the results (not reported in this paper) show that the distributions for all the activities were similarly skewed to the right for all three groups. Because responses/values on factors/variables for UIL activities were not normally distributed, the Kruskal-Wallis test, which is an alternative to a one-way ANOVA test, was applied to establish the existence of overall differences in perceptions among the three categories of respondents.

Moreover, the multinomial logistic model was utilized to find out whether a respondent's attributes influence his/her perception of the influence of UILs' activities on innovation. As presented below, the model specifies the perception of a respondent as either agree or strongly agree relative to neutral/disagree as a function of his/her attributes. It is assumed that a respondent's education background and gender determine the way respondents perceive the role of UILs' activities on innovation:

$$P_{ij} = \frac{e^{X'_{ij}\beta_j}}{\sum_{k=1}^{J} e^{X'_{ij}\beta_j}}$$

where:

$$X'_{ij}\beta_j = \beta_0 + \sum_{k=1}^{2} \beta_k \text{status}_{ki} + \beta_3 \text{gender} + \beta_4 \text{education}$$

where P_{ij} denotes the probability for the ith respondent's perception as either agree or strongly agree relative to neutral and disagree. The respondent's average perception as

either agree, strongly agree or neutral/disagree for each category of UIL activities (i.e. training/education, consultancy and research) was established by calculating the average score for each category of activities. The average score below or equal to 3.5, between 3.6 and 4.49, and at least 4.5, were considered as neutral/disagree, agree and strongly agree, respectively. Table IV indicates the distributions of responses in the three categories of perceptions (i.e. neutral/disagree, agree and strongly agree) by the three classes of UIL activities.

X'_{ij} is the set of respondent's attributes, status, gender and education background. β_0, $\sum_{k=1}^{2} \beta_k$, β_3 and β_4 are parameters that were estimated and stand for the intercept and coefficients of status, gender and education. The above model was estimated for each of the three categories of UIL activities, i.e., education/training, consultancy and research. Status was captured by two indicators as industry being dummy 1 if the respondent was an employee from the extractive companies and 0 otherwise, as well as a faculty member being dummy 1 if the respondent was an instructor from the university and 0 otherwise. This implies the category of students was left as a reference category. Gender was captured as dummy 1 if the respondent was male and 0 if female. Education was captured as dummy 1 if the respondent's educational background was engineering, natural or applied science and 0 if social science, including business. Significant positive (negative) coefficients of dummy variables indicate the existence of differences in a respondent's perception as either agree or strongly agree relative to neutral/disagree, which was the reference response.

4. Findings

Generally speaking, respondents had a positive view regarding the influence of UIL training activities on innovation as an overall mean score for UIL activities in training, consultancy and research, ranging from 3.7 to 4, 3.8 to 4.13 and 3.9 to 4.23, respectively. The results support the general hypothesis that universities and extractive companies in emerging economies like Tanzania are more likely to view UILs in all areas as important for enhancing innovation, and corroborate with the argument by Feng *et al.* (2011) and Hansen and Lehmann (2006). The results could be explained by the fact that ongoing UIL activities in Tanzania could be enabling faculty members and students to have access to research infrastructure, which are important in innovation (see Marin and Arza, 2009), and thus an expected transfer of knowledge to local firms as according to Brundenius *et al.* (2009). The positive skewness of the views of respondents regarding the benefits of UILs has also been reported by Hamdan *et al.* (2011).

The sub-sections below report and discuss results from Kruskal-Wallis tests on the presence of differences in the perceptions of faculty members, students and industry. They also present and discuss findings from the multinomial logistic models, which test the influence of individual attributes on respondents' perceptions of UILs importance.

	Training	Consultancy	Research
Neutral/disagree	33.1%	25.0%	22.3%
Agree	45.2%	43.8%	44.9%
Strongly agree	21.7%	31.2%	32.8%
Total	100%	100%	100%
n	404	404	404

Table IV. Distribution of respondents in three categories of perceptions

4.1 UIL training activities and perceived effect on innovation

Results comparing the perceptions between students, employees (industry) and academics about the importance of UIL activities under training reveal interesting results. The Kruskal-Wallis test reveals highly significant differences ($p < 0.01$) on the perceptions of students, industry and academics on the importance of all UILs in training activities on innovation (Table V, Panel 1).

Descriptive statistics (means) indicate that the industry as represented by employees has a strong opinion on the importance of all UIL training activities in enhancing innovation, as their average scores in all activities are above 4 (Table V, Panel 1). Compared to the industry, universities (students and faculty members) have weak perceptions on the positive innovation effect of UIL training activities (with the exception of short courses for small businesses and entrepreneurs, which was ranked first by all groups), as their average scores ranged from 3.3 (nearly neutral) to 3.8 (slightly below agree). The Kruskal-Wallis test reveals the presence of significant differences among the three groups' (students, faculty members and industry) perceptions on the role of UILs in enhancing innovation. Compared to industry, universities' weak opinion on the positive innovation effects of UIL in training activities could be because of a low employment of graduates in local firms, and possibly the absence of a large industrial base of suppliers of international companies in the extractive industry.

Results from rankings show that all groups have a strong opinion on short-term courses to small businesses in enhancing innovation in local firms. While students rank students internships in companies in second place, faculty and industry rank them near the bottom. Students' strong opinions are in line with their foreseen direct participation in the UIL internships, which is according to Hamdan *et al.* (2011). However, students and faculty members had a weak opinion on the role of students' collaborations with industry during the development of their master theses, which could be because some local companies are reluctant to provide information to students due to reasons of confidentiality.

Tables VI (Panel 1) and VII (Panel 1) indicate the results from the multinomial regression logistic analysis regarding the influence of individual attributes on determining the perception of UIL training activities in enhancing innovation. The results in Table VI (Panel 1) reveal that individual attributes, i.e., status of the respondent (being an employee representing the industry, and a faculty member relative to student education background in social science relative to engineering, natural or applied science) significantly determine respondents' perception on the innovation effects of UIL training activities.

In Table VII (Panel 1), the results indicate that compared to industry (as represented by employees), students are 1.15 and 2.5 times less likely to, respectively, agree and strongly agree relative to neutral/disagree that UIL training activities enhance innovation. Similarly, compared to faculty members, students are 0.792 times less likely to agree relative to neutral/disagree that UIL training activities enhance innovation. A weak opinion by students could be because they have a relatively limited experience with UILs when compared with industry and faculty members. The results further indicate that gender plays no role in determining the perceptions of respondents regarding the innovation effects of UIL activities in training.

4.2 UIL in consultancy services and perceived effect on innovation

Descriptive statistics (means) indicate that the industry, as represented by employees and faculty members, has a strong opinion on the importance of all UIL consultancy activities in enhancing innovation, as their average scores in all activities (except a

Table V.
Perceptions of the role of UILs in enhancing innovation

Training activities	Mean (rank) by respondent status: Students	Employees	Faculty	All	Kruskal-Wallis test: mean rank by status: Students	Employees	Faculty	χ^2	Asymp. sig.
Panel 1: perceptions of UIL in training activities in increasing innovation									
Student internships in companies	3.775 (2)	4.087 (5)	3.687 (4)	3.807 (2)	197.680	238.990	186.470	10.193	0.006
Company collaboration with students during their work with their master's thesis	3.612 (5)	4.088 (4)	3.825 (2)	3.747 (4)	178.990	237.790	208.530	17.323	0
Part-time lecturers from industry teaching at a university	3.721 (3)	4.206 (3)	3.358 (5)	3.717 (5)	196.110	256.790	154.270	36.989	0
Short courses for small businesses and entrepreneurs	3.838 (1)	4.391 (1)	4.237 (1)	4.030 (1)	174.620	248.360	231.230	34.685	0
Limited UIL in training for local firms hampers their innovation	3.661 (4)	4.232 (2)	3.750 (3)	3.783 (3)	182.690	251.160	189.870	22.342	0
n	233	68	100	401	233	68	100		
Panel 2: perceptions of UIL in consultancy activities in increasing innovation									
Industry assistance in modernizing and developing university curriculum and programmes	3.85 (4)	4.22 (4)	4.02 (4)	3.95 (4)	182.16	234.77	212.93	15.577	0
Sabbatical arrangements, in which university teachers spend time in the local industry or abroad	3.79 (5)	4.21 (5)	3.67 (5)	3.83 (5)	190.48	244.13	181.92	16.758	0
Lecturers doing consulting for industry	4.03 (1)	4.27 (1)	4.08 (2)	4.09 (1)	187.45	226.76	205.27	7.832	0.02
Seminars and conferences arranged by university and industry	3.93 (3)	4.24 (3)	4.13 (1)	4.03 (3)	183.9	229.44	214.71	12.412	0.002
Joint projects between students and industry	3.94 (2)	4.26 (2)	4.06 (3)	4.02 (2)	190.22	230.69	206.09	7.827	0.02
n	234	68	99	401	234	68	99		
Panel 3: perceptions of UIL in research activities in increasing innovation									
Research carried out for local companies by faculty members	4.12 (1)	4.46 (1)	4.33 (3)	4.23 (1)	180.48	234.53	225.91	21.362	0
Joint or cooperative research projects with industry	4.05 (2)	4.42 (2)	4.49 (1)	4.22 (2)	173.35	228.69	246.79	39.172	0
Interchange of personnel between industry and university	3.90 (4)	4.25 (5)	4.06 (4)	4.00 (4)	181.98	229.22	213.03	13.47	0.001
Sharing of specialized equipment or research facilities between industry and university	3.91 (3)	4.33 (3)	3.95 (5)	3.99 (5)	186.39	249.47	197.05	18.622	0
Joint industry-university research increases innovation among local firms	3.81 (5)	4.26 (4)	4.37 (2)	4.02 (3)	167.97	232.3	248.5	48.457	0
n	233	69	99	401	233	69	99		

Effect	Model fitting criteria −2 log likelihood of reduced model	Likelihood ratio tests χ^2	df	Sig.
Panel 1: likelihood ratio tests on perceptions of the role of UIL in training in enhancing innovation				
Intercept	93.872	0.000	0	
Industry	133.338	39.466	2	0.000
Faculty	100.503	6.631	2	0.036
Gender	94.498	0.626	2	0.731
Education2	104.046	10.174	2	0.006
Model fitting information				
Intercept only	146.033			
Final	93.872	52.161	8	0.000
Panel 2: likelihood ratio tests on perceptions of the role of UIL in consultancy in enhancing innovation				
Intercept	1.105E2	0.000	0	
Industry	120.023	9.487	2	0.009
Faculty	123.953	13.417	2	0.001
Gender	129.040	18.504	2	0.000
Education2	121.304	10.768	2	0.005
Model fitting information				
Intercept only	148.732			
Final	110.536	38.196	8	0.000
Panel 3: likelihood ratio tests on perceptions of the role of UIL in research in enhancing innovation				
Intercept	82.054	0.000	0	
Industry	100.040	17.985	2	0.000
Faculty	101.815	19.761	2	0.000
Gender	85.361	3.306	2	0.191
Education2	88.677	6.623	2	0.036
Model fitting information				
Intercept only	118.383			
Final	82.054	36.328	8	0.000

Table VI.
Likelihood ratio tests on perceptions of the role of UILs in enhancing innovation

sabbatical for faculty) are above 4 (Table V, Panel 2). Compared to industry and faculty members, students had a weak opinion on the importance of UIL consultancy activities (except lecturers doing consulting for industry) in enhancing innovation, as the average scores ranged from 3.79 to 3.94. The ranking of activities is somewhat similar for all three groups as industry, and students ranked lecturers doing consulting for industry in first place, whereas faculty placed it at number 2. Similarly, all groups placed sabbatical arrangements in the last position. The Kruskal-Wallis test reveals the presence of significant differences among the three groups' perceptions on the role of UIL consultancy activities in enhancing innovation.

Tables VI (Panel 2) and VII (Panel 2) report the results on the role of individual attributes in determining his/her perception about UIL consultancy activities in enhancing innovation. The results reveal all individual attributes (status, educational background and gender) in the model significantly determine respondents' perception on the role of UIL consultancy activities in enhancing innovation (Table VI, Panel 2).

Compared to industry (employees), students are 0.69 times less likely to agree relative to neutral/disagree that UIL consultancy activities enhance innovation (Table VII, Panel 2). Similarly, compared to industry (employees), students are 1.25 times less likely to strongly agree relative to neutral/disagree that UIL consultancy activities

Perceptions of UILs in training influence on innovation[a]	*B*	SE	Wald	df	Sig.	Exp(*B*)	95% confidence interval for Exp(*B*) Lower bound	Upper bound
Panel 1: parameter estimates of individual attributes and perceptions of UIL training activities in enhancing innovation								
Agree								
Intercept	1.886	0.512	13.596	1	0.000			
(industry = 0.00)	−1.151	0.423	7.384	1	0.007	0.316	0.138	0.726
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	−0.792	0.321	6.077	1	0.014	0.453	0.241	0.850
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−0.038	0.277	0.019	1	0.892	0.963	0.560	1.657
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	0.230	0.264	0.761	1	0.383	1.259	0.750	2.113
(education2 = 1.00)	0[b]			0				
Strongly agree								
Intercept	2.008	0.595	11.410	1	0.001			
(industry = 0.00)	−2.563	0.453	32.010	1	0.000	0.077	0.032	0.187
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	−0.733	0.440	2.768	1	0.096	0.481	0.203	1.139
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−0.276	0.364	0.573	1	0.449	0.759	0.372	1.549
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	1.032	0.332	9.673	1	0.002	2.808	1.465	5.383
(education2 = 1.00)	0[b]			0				
Panel 2: parameter estimates of individual attributes and perceptions of UIL consultancy activities in enhancing innovation								
Agree								
Intercept	1.276	0.521	6.006	1	0.014			
(industry = 0.00)	−0.691	0.415	2.767	1	0.096	0.501	0.222	1.131
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	−0.255	0.344	0.546	1	0.460	0.775	0.395	1.523
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−0.212	0.299	0.500	1	0.479	0.809	0.450	1.455
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	0.725	0.302	5.750	1	0.016	2.065	1.142	3.734
(education2 = 1.00)	0[b]			0				
Strongly agree								
Intercept	2.622	0.574	20.868	1	0.000			
(industry = 0.00)	−1.252	0.427	8.619	1	0.003	0.286	0.124	0.660
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	−1.394	0.419	11.037	1	0.001	0.248	0.109	0.565
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−1.406	0.375	14.039	1	0.000	0.245	0.117	0.511
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	1.040	0.333	9.751	1	0.002	2.829	1.473	5.434
(education2 = 1.00)	0[b]			0				

(*continued*)

Table VII. Parameter estimates of individual attributes and perceptions of UIL in enhancing innovation

Perceptions of UILs in training influence on innovation[a]	*B*	SE	Wald	df	Sig.	Exp(*B*)	95% confidence interval for Exp(*B*) Lower bound	Upper bound
Panel 3: parameter estimates of individual attributes and perceptions of UIL research activities in enhancing innovation								
Agree								
Intercept	0.929	0.539	2.973	1	0.085			
(industry = 0.00)	−0.251	0.422	0.354	1	0.552	0.778	0.340	1.778
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	0.004	0.368	0.000	1	0.992	1.004	0.488	2.065
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−0.296	0.305	0.941	1	0.332	0.744	0.409	1.353
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	0.462	0.305	2.284	1	0.131	1.587	0.872	2.887
(education2 = 1.00)	0[b]			0				
Strongly agree								
Intercept	2.657	0.559	22.589	1	0.000			
(industry = 0.00)	−1.466	0.429	11.666	1	0.001	0.231	0.100	0.535
(industry = 1.00)	0[b]			0				
(faculty = 0.00)	−1.400	0.404	12.037	1	0.001	0.247	0.112	0.544
(faculty = 1.00)	0[b]			0				
(gender = 0.00)	−0.650	0.361	3.246	1	0.072	0.522	0.257	1.059
(gender = 1.00)	0[b]			0				
(education2 = 0.00)	0.844	0.335	6.359	1	0.012	2.327	1.207	4.485
(education2 = 1.00)	0[b]			0				

Table VII.

Notes: [a]The reference category is: neutral/disagree; [b]this parameter is set to zero because it is redundant

enhance innovation. Compared to faculty members, they are also 1.39 times less likely to strongly agree relative to neutral/disagree that UIL consultancy activities enhance innovation. Compared to males, females are 1.4 times less likely to strongly agree relative to neutral/disagree that UIL consultancy activities enhance innovation. This finding could be explained by the fact that females employed in the extractive industry are fewer than males, so hence they foresee a limited participation in UILs and therefore have a weak opinion, as observed by Hamdan *et al.* (2011). Compared to respondents with an engineering, natural and applied science background, those with a social science background are 1.04 times more likely to strongly agree that UIL consultancy activities enhance innovation.

4.3 UIL in research, perceived effect on innovation

In Table V (Panel 3), mean statistics indicate that the industry (employees) and faculty members have a strong opinion on the importance of UIL research activities in enhancing innovation, as the average scores are above 4. The ranking of the UIL research activities by the three groups seems to follow the same trend. Students and industry ranked research carried out for local companies at number 1, whereas faculty members placed it at number 3. Faculty members ranked joint cooperative research projects at number 1, while students and industry ranked it number 2. The Kruskal-Wallis test reveals the presence of significant differences among the three groups' perceptions on the role of UIL consultancy activities in enhancing innovation.

Tables VI (Panel 3) and VII (Panel 3) report the results on the role of individual attributes in determining his/her perception about UIL research activities in enhancing innovation. The results reveal all individual attributes (except gender) significantly determine respondents' perception on the role of UIL consultancy activities in enhancing innovation (Table VI, Panel 3).

Compared to industry (employees), students are 1.46 times less likely to strongly agree relative to neutral/disagree that UIL research activities enhance innovation (Table VII, Panel 3). Similarly, compared to faculty members, they are also 1.4 times less likely to strongly agree relative to neutral/disagree that UIL research activities enhance innovation. Compared to males, females are 0.65 times less likely to strongly agree relative to neutral/disagree that UIL research activities enhance innovation. The same reason as indicated in Section 4.2 could help explain this result. Compared to respondents with an engineering, or natural and applied science background, those with a social science background are 0.84 times more likely to strongly agree that UIL research activities enhance innovation.

5. Discussion and implications

The findings indicate different attitudes related to UILs and innovation between foreign companies and university informants, as foreign firms display a generally more positive attitude to UILs than their counterparts. Foreign firms are exposed to the dilemma of host country expectations to help actively support the national innovation system, whereas at the same time facing an inadequate local industrial base and inferior suppliers. The industry informants support Mowery and Sampat (2005), Busenitz *et al.* (2000) and Plewa *et al.* (2013) in relation to the significance of the university in the national innovation system, not as a centre of gravity for innovation, but as an intermediary between competitive and resource-rich foreign companies and innovation in local firms. This is what Brundenius *et al.* (2009) characterize as the "midwife" role of the university, which also supports Nielsen (2007) on the innovative effect of graduates regarding local firm innovation. The findings also indicate that an improved and competitive local supplier base requires an educational system aligned with industrial requirements and demanding customers (i.e. foreign companies).

The faculty members are more reluctant as to the innovative effect of UILs, thereby indicating a more pessimistic view on close collaborative activities with foreign firms, particularly on training and educational-related activities. This is in line with, e.g., Mulinge and Munyae (2008), Vega-Jurando *et al.* (2008) and Brimble and Doner (2007), showing a resistance among faculty members in engaging industry within academic spheres. The faculty view can also be interpreted in terms of weak links between what the foreign firms can contribute to UILs (e.g. the internship programme of an international oil company) and the "agents of innovation" role of the graduating student.

The students' views on the innovative role of the UILs are more surprising. Why are students reluctant to perceive themselves as "agents of innovation", fuelled by internships in a global company, a more work-life-relevant curriculum and guest lecturers from world-class MNEs? This can be interpreted in terms of what Brundenius *et al.* (2009) refer to as: stagnation in terms of technical and organizational change among local firms, which hampers the absorption of graduates from the universities. The findings may also indicate a weak current level of UILs, and thus the potential for being an agent of innovation when entering their work life.

The implications for host country innovation through UILs can be addressed to five major stakeholder groups. These include the host country policy makers, university management, foreign firms, students and faculty members.

5.1 Host country policy makers

The findings indicate that policies targeting public universities should encourage closer linkages with foreign firm operating in the developing country with the purpose of strengthening the university as an "agent of innovation" towards the local industrial base.

In relation to MNEs, the policy makers should strengthen incentives to actively develop UILs in order to connect faculty and students with "real-life" problems and solutions. This can be achieved by connecting MNEs' contribution (i.e. diffusion of innovation) though UILs with incentives such as natural resource concessions and awards of exploration and exploitation licenses. Measures of "innovation diffusion" from MNEs to the learning sector should be established in order to monitor the effectiveness of the linkages, and enable adjustments of incentives.

5.2 University management

University faculty and students should be enabled to learn more from foreign multinationals and implement into what Brundenius *et al.* (2009) label "the developmental university". The universities should improve communication lines with MNEs through "liaison offices", and establish guest lecturing positions within faculties to assist in improving innovation diffusion through MNE employees. In order to strengthen faculty support for UILs, it is necessary to improve time allowances and practical support to the faculty members to invest time and a dedication to breed linkages with MNEs.

5.3 Foreign firms

A focus should be targeted towards training and educational activities since the findings indicate the strongest effect on the diffusion of innovation in this modality group. Passive financial contributions should be replaced with conditional support towards training and internship schemes. Consultancy and research within the UILs are dependent on a more fundamental support from faculty than indicated by the findings, and deserve less of an emphasis.

5.4 Students

Through student organizations, the students should approach MNEs, and show a pro-active role as potential employees or "agents of innovation". The findings indicate that MNEs will appreciate such initiatives. In line with this, students should also acknowledge and prepare for the cultural and industrial language of foreign firms operating within a developing country.

5.5 Faculty members

Relatively low scores on the innovation effect of UILs indicate an "ivory tower" syndrome. Initiatives should therefore be taken to recognize foreign firms, in particular MNEs and international oil companies, as providers of managerial and technological innovation. Fighting the "ivory tower" syndrome is crucial in a developing country, and a necessity to access innovation capabilities (see e.g. Vega-Jurando *et al.*, 2008 for further reading).

6. Concluding remarks

Prior studies have highlighted the importance of developing UILs as a means of enhancing the diffusion and absorption of innovation. In a developing country context foreign firms, particularly MNEs and international oil companies with their network of internationally competitive suppliers, play a significant role. Whereas innovation diffusion/absorption often takes place between firms, this study has focussed on the UILs and innovation absorption in the learning sector, as perceived from the industry, the faculty and students. The findings revealed significant differences between the three informant groups across the three main groups of linkage activities, i.e., education/training, consultancy arrangements and research. Moreover, there are also some differences between the sub-elements within each linkage group.

However, the most surprising finding is that the industry generally expresses more positive perceptions of an innovation effect within UILs than key stakeholders within the university (i.e. students and faculty). The industry informants consider all three groups of UILs important for enhancing innovation, in terms of bringing students into the industry through internships, involving the faculty in consultancy arrangements and in joint research. Taking into consideration that resource-extractive companies (MNEs and international oil companies) are embedded in global networks and have access to an almost unlimited resource base, they acknowledge the importance of sustainable and diverse UILs in their host country. This is hampered by barriers to UILs from students and faculty, which corresponds with, e.g., Bruneel *et al.* (2010), thereby indicating a reluctance in actively involving industry in the internal life of the university.

In order to strengthen the industrial base of the host country, and thus increase local participation in the value chain, the potential of innovation absorption through students and faculty member requires action. The study suggests specific action points from host country policy makers, university management, foreign firms, students and faculty members in order to benefit from MNEs' innovation diffusion capacity. This would help improve the university status in general, but also improve the role of the university as a vehicle for economic development.

This study has its limitations. The perceptions of how UILs can help improve the absorption of innovation are not the same as an ability and willingness to implement actions, and to develop and maintain UIL activities. The MNEs are profit-seeking entities and UIL investments can easily be jeopardized by a lack of incentives, while the university can be willing to develop the linkages, but be hampered by policy makers. This leads to two important issues for further research: First, a more comprehensive study of mechanisms to breed UILs for the absorption of innovation into the learning institutions within developing countries. Second, a study of how host country governmental policies can be designed in order to breed MNE contributions to strengthen innovation diffusion into the learning sector. There is still a ways to go for a natural resource-rich developing country to actually develop a competitive local industrial base for sustaining economic growth, in which the learning institutions play a crucial role.

Notes

1. URT: United Republic of Tanzania.
2. OECD: The Organization for Economic Co-operation and Development.

References

Acquaah, M., Adjei, M.C. and Mensa-Bonsu, I.F. (2008), "Competitive strategy, environmental characteristics and performance in African emerging economies: lessons from firms in Ghana", *Journal of African Business*, Vol. 9 No. 1, pp. 93-117.

Afonso, A., Ramirez, J.J. and Diaz-Puente, J.M. (2012), "University-industry cooperation in the education domain to foster", *Procedia – Social and Behavioral Sciences*, Vol. 46, pp. 3947-3953.

Alpert, F., Heaney, J.-G. and Kuhn, K.-A. (2009), "Internships in marketing: goals, structures and assessment – student, company and academic perspectives", *Australasian Marketing Journal*, Vol. 17 No. 1, pp. 36-45.

Alves, J., Marques, M.J. and Saur-Amaral, I. (2007), "Co-ownership active interfaces between academia and industry", *European Planning Studies*, Vol. 15 No. 9, pp. 1233-1246.

Ayarkwa, J., Adinyira, E. and Osei-Asibey, D. (2011), "Industrial training of construction students: perceptions of training organizations in Ghana", *Education+Training*, Vol. 54 Nos 2/3, pp. 234-249.

Ball, S. (1995), "Enriching student learning through innovative real-life exercises", *Education +Training*, Vol. 37 No. 4, pp. 18-25.

Barnard, H., Bromfield, T. and Cantwell, J. (2009), "The role of indigenous firms in innovation systems in developing countries: the developmental implications of national champion firms' response to underdeveloped national innovation systems", in Lundvall, B.A., Joseph, K., Chaminade, C. and Vang, J. (Eds), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Edward Elgar, Cheltenham, pp. 241-279.

Barr, A.R. (2002), "The functional diversity and spillover effect of social capital", *Journal of African Economy*, Vol. 11 No. 1, pp. 90-113.

Brimble, P. and Doner, R.F. (2007), "University-industry linkages and economic development: the case of Thailand", *World Development*, Vol. 35 No. 6, pp. 1021-1036.

Brundenius, C., Lundvall, B.Å. and Sutz, J. (2009), "The role of universities in innovation systems in development countries: developmental university systems – empirical, analytical and normative perspectives", in Lundvall, B.Å., Joseph, K.J., Chaminade, C. and Vang, J. (Eds), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Edward Elgar, Cheltenham, pp. 311-336.

Bruneel, J., D'Este, P. and Salter, A. (2010), "Investigating the factors that diminish the barriers to university-industry collaboration", *Research Policy*, Vol. 39 No. 7, pp. 858-868.

Busenitz, L.W., Gòmez, C. and Spencer, J.W. (2000), "Country institutional profiles: unlocking entrepreneurial phenomena", *Academy of Management Journal*, Vol. 43 No. 5, pp. 994-1003.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-152.

Cohen, W.M., Nelson, R.R. and Walsh, J.P. (2002), "Links and impacts: the influence of public research on industrial R&D", *Management Science*, Vol. 48 No. 1, pp. 1-23.

Corral de Zubielqui, G., Jones, J., Seet, P.-S. and Lindsay, N. (2015), "Knowledge transfer between actors in the innovation system: a study of higher education institutions (HEIS) and SMES", *Journal of Business & Industrial Marketing*, Vol. 30 Nos 3-4, pp. 456-458.

Decter, M.H. (2009), "Comparative review of UK-USA industry-university relationships", *Education+Training*, Vol. 51 Nos 8/9, pp. 624-634.

Egbetokun, A.A. (2015), "Interactive learning and firm-level capabilities in latecomer settings: the Nigerian manufacturing industry", *Technological Forecasting & Social Change*, Vol. 99, October, pp. 231-241.

Etzkowitz, H. (2002), "Networks of innovation: Science, technology and development in the triple helix era", *International Journal of Technology Management and Sustainable Development*, Vol. 1 No. 1, pp. 7-20.

Fagerberg, J., Fosaas, M. and Sapprasert, K. (2012), "Innovation: exploring the knowledge base", *Research Policy*, Vol. 41 No. 7, pp. 1132-1153.

Feng, C., Ding, M. and Sun, B. (2011), "A comparison research on industry-university-research strategic alliances in countries", *Asian Social Science*, Vol. 7 No. 1, pp. 102-105.

Fu, X. and Li, J. (2010), "The dual role of universities in industrial innovation in emerging economies: a comparative study of China and the UK", TMD Working Paper Series No. 045, University of Oxford, Oxford.

Gagoitseope, P.K. and Pansiri, J. (2012), "Evaluation of critical success factors for developing small and medium sized enterprises in Botswana", *Journal of African Business*, Vol. 13 No. 1, pp. 51-61.

Goosen, M.F.A., Al-Hinai, H. and Sablani, S. (2001), "Capacity-building strategies for desalination: activities, facilities and educational programs in Oman", *Desalination*, Vol. 14 No. 1, pp. 181-189.

Hamdan, H., Yousef, F., Abdullah, F., Nasruding, N. and Abullah, I.C. (2011), "University industrial linkages: relationship towards economic growth and development in Malaysia", *World Academy of Science, Engineering and Technology*, Vol. 58 No. 10, pp. 785-792.

Hansen, J.A. and Lehmann, M. (2006), "Agents of change: universities as development hubs", *Journal of Cleaner Production*, Vol. 14 No. 9, pp. 820-829.

Hershberg, E., Nabeshima, K. and Yusuf, S. (2007), "Opening the ivory tower to business: university-industry linkages and the development of knowledge intensive clusters in Asian cities", *World Development*, Vol. 35 No. 6, pp. 931-940.

Iakovleva, T., Kolvereid, L. and Stephan, U. (2011), "Entrepreneurial intentions in developing and developed countries", *Education+Training*, Vol. 53 No. 5, pp. 353-370.

Lorentzen, J. and Barnes, J. (2004), "Learning, upgrading, and Innovation in the South African automotive industry", *The European Journal of Development Research*, Vol. 16 No. 3, pp. 465-498.

Lundvall, B.Å., Joseph, K.J., Chaminade, C. and Vang, J. (2009), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Edward Elgar, Cheltenham.

Makulilo, V.B. (2012), "The proliferation of private universities in Tanzania: quality compromised?", *Wudpecker Journal of Educational Research*, Vol. 1 No. 4, pp. 51-66.

Marin, A. and Arza, V. (2009), "The role of multinational corporations in national innovation systems in developing countries: from technology diffusion to international involvement", in Lundvall, B.Å., Joseph, K.J., Chaminade, C. and Vang, J. (Eds), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Edward Elgar, Cheltenham, pp. 280-310.

Meredith, S. and Burkle, M. (2008), "Building bridges between university and industry: theory and practice", *Education+Training*, Vol. 50 No. 3, pp. 199-215.

Mowery, D.C. and Sampat, B.N. (2005), "Universities in national innovation systems", in Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds), *The Oxford Handbook of Innovation*, Oxford University Press, Oxford, pp. 209-239.

Mpehongwa, G. (2013), "Academia-industry-government linkages in Tanzania: trends, challenges and prospects", *Academic jornals*, Vol. 8 No. 21, pp. 2093-2100.

Mulinge, M.M. and Munyae, M.M. (2008), "Managing organizational change in higher education: lessons from the university of Botswana", *Journal of African Business*, Vol. 9 No. 1, pp. 167-190.

Nielsen, R.N. (2007), "Innovation, human resources, and academic labour: introduction of highly educated labour in small Danish firms", PhD dissertation, Department of Business Studies, Aalborg University, Aalborg.

OECD (2005), *The Measurement of Scientific and Technological Activities. Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data*, 3rd ed., Organisation for Economic Co-operation and Development (OECD) Publishing, Oslo, available at: www.oecd.org/science/inno/2367580.pdf (accessed 2 December 2014).

Oyebisi, T.O., Ilori, M.O. and Nassar, M.L. (1996), "Industry-academic relations: an assessment of the linkages between a university and some enterprises in Nigeria", *Technovation*, Vol. 16 No. 4, pp. 203-209.

Padilla-Perêz, R., Vang, J. and Chaminade, C. (2009), "Regional innovation systems in developing countries: integrating micro and meso-level capabilities", in Lundvall, B.Å., Joseph, K.J., Chaminade, C. and Vang, J. (Eds), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Edward Elgar, Cheltenham, pp. 140-182.

Perkmann, M., King, Z. and Pavelin, S. (2011), "Engaging excellence? Effects of faculty quality on university engagement with industry", *Research Policy*, Vol. 40 No. 4, pp. 539-552.

Plewa, C., Korff, N., Johnson, C., MacPherson, G., Baaken, T. and Rampersad, G.C. (2013), "The evolution of university-industry linkages – a framework", *Journal of Engineering and Technology Management*, Vol. 30, pp. 21-44.

Porter, M.E., Sachs, J.J. and McArthur, J. (2002), "Competitiveness and stages of economic development", in Porter, M.E., Sachs, J.J., Cornelius, P.K., McArthur, J.W. and Schwab, K. (Eds), *The Global Competitiveness Report*, Oxford University Press, New York, NY, pp. 16-26.

Suraweera, F. (1985), "A framework for university-industry interaction in computing in developing countries", *Computer Education*, Vol. 9 No. 2, pp. 135-139.

Toor, S.R. and Ofori, G. (2008), "Developing construction professionals of the 21st century: renewed vision for leadership", *Journal of Professional Issues in Engineering Education and Practice*, Vol. 134 No. 3, pp. 279-286.

Tordo, S., Warner, M., Manzano, O.E. and Anouti, Y. (2013), "'Local content policies in the Oil and Gas Sector", A World Bank Study No. 78994, World Bank, Washington, DC.

URT (2014), "Local content policy of Tanzania for oil and gas industry – 2014", Draft One, available at: https://mem.go.tz/wp-content/uploads/2014/05/07.05.2014local-content-policy-of-tanzania-for-oil-gas-industry.pdf (accessed 15 October 2014).

Vaaland, T.I. (2015), "Petro stimulated corporate citizenship in developing countries", *Journal of Corporate Citizenship*, Vol. 59, September, pp. 92-111.

Vega-Jurando, J., Fernández-de-Lucio, I. and Huanca, R. (2008), "University-industry relations in Bolivia: implications for university transformations in Latin America", *Higher Education*, Vol. 56 No. 2, pp. 205-220.

Appendix

Modality group	Type of linkage activity	Description of linkage activity
Training and education	Cooperative education	Involving students spending a significant portion of their academic programme in private companies, student working experience programmes, student internships
	Industrial training (continuing education)	Practical training of students and faculty on industry premises with the purpose of understanding application of new technologies and methods
	Small business training	Collaboration in developing and operating a programme targeting small or nascent entrepreneurs or businesses. Short courses
	Student assignments	Supporting master students with access to information sources during assignments and theses. Provisions to stimulate students to carry out university assignments/ theses within the company
	Visiting lectureships	Formal arrangements where private companies support staff to participate in teaching activities. Part-time teaching, industrial guest lecturers
Services and consulting	Modernizing programmes	Assisting university in developing and modernizing curriculum and programmes aligned with industrial needs. Industry participation in university boards and committees
	Technology brokerage/ licensing	Assistance in obtaining or licensing technologies and intellectual products from the university
	Seminars and conferences	Collaboration in developing seminars, conferences and symposia with the purpose of enhancing the Tanzanian industrial base
	Sabbatical	Facilitate faculty member's sabbatical in the industry, either in Tanzania or abroad
	Direct or indirect investments	Through equity investments and venture capital schemes
	Student recruitment	Participation in students arrangements, business presentations, recruitment events, etc.
	Coordination of technology-related issues	Through such inter-organizational entities as regional technology councils
	Industrial extension services	Including testing, calibration, repair services, production trouble-shooting, simple design modification
	Business/consulting services	From business schools, or through research parks, science parks or incubators
Research	Research consulting	Contractual research carried out for a private company with specified terms
	Joint or cooperative research projects	Often carried out in dedicated laboratories, centres or institutes
	Partnership contract	Long-term arrangement between university and company to build up research facilities
	Personnel interchange or industrial fellowships	On a regular or long-term basis to sustain interchange of research personnel
	Shared equipment or facilities	Loan of equipment and facilities for university research use, on a regular or long-term basis

(*continued*)

Table AI.
UIL activities

Modality group	Type of linkage activity	Description of linkage activity
Activity-based sponsoring	Equipment donations	Laboratories, teaching equipment, etc.
	Endowment contributions	Sponsorship of prizes, awards and competitions to students and/or faculty
	Financing professorial chairs	With relevance to local participation in the petroleum industry
	Financing PhD candidates	Salaries and expenses
	Financing master theses	Travel expenses and direct costs (not salaries)
	Financing foreign support	Support from foreign university with the purpose of developing new programmes or improve alignment with petroleum-related industrial needs
	Donations for university infrastructure	Endowments for buildings and grants for the purchase of equipment offered to the university
	Financing stays abroad for student or faculty	With the purpose of increasing the local industrial base (thus avoiding "brain-drain")

Table AI.

Source: Modified from Brimble and Doner (2007)

About the authors

Dr Terje I. Vaaland is a Professor at the University of Stavanger within the areas of strategy and industrial marketing and management. In recent years he has been involved in national content research and development in emerging petroleum nations with a weak industrial base. He has been the Dean at a leading Norwegian Business School, and has experience in managing oil-related industry-learning programs. Dr Terje I. Vaaland is the corresponding author and can be contacted at: terje.vaaland@uis.no

Dr Esther Ishengoma is a Senior Lecturer in the Department of Finance at the University of Dar es Salaam Business School and a Senior Research Fellow at the GIGA-German Institute of Global and Area Studies through research projects funded by GIGA, Alexander von Humboldt and the Volkswagen Foundation. She has done research on university-industry linkages, global value chains and industry linkages, linkage banking, microfinance and enterprise development.