Innovation, market failures and policy implications of KIBS firms

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Innovation, Market failures and Policy Implications of KIBS firms: The case of Trinidad and Tobago's Oil and Gas Sector

Abstract

Trinidad and Tobago's oil and gas industry is well established and ~~is~~ one of the oldest in the world, which has led to a large and growing number of oil and gas Knowledge Intensive Business Service (KIBS) firms. These firms provide advanced technological or professional knowledge as intensive inputs into the business processes of other organizations. This paper aims to investigate innovation in KIBS firms in the oil and gas sector in Trinidad and Tobago, and also ~~identifies~~ identify market and government failures that hinder their development to inform policy making. Our results suggest that while KIBS firms operating in Trinidad and Tobago have introduced new products and processes, they rely mainly on external sources of knowledge and adopt and adapt existing technology and processes. The factors that increase KIBS firm's likelihood of introducing an innovation are firm size, age, number of customers, internal research and development, and the use of external information. Moreover, several market failures hinder their potential for innovation and technology diffusion, including information asymmetries, difficulty in obtaining finance, lack of appropriate skills, and limited partnerships/collaboration with research institutions. This study recommends the development of a national innovation policy and program, greater dialogue, and clear communication channels among all industry stakeholders, and the expansion of several existing local policy initiatives, including trade missions and corporate governance programs and training and skills through tertiary educational institutes.

Keywords: Knowledge Intensive Business Services; Oil and gas; Developing country

1. Introduction

Evidence from developed countries suggests that the reliance on natural resources can foster economic growth when underpinned by efforts to increase technological innovation and accumulation of capabilities to innovate around natural resources. More specifically, the development and deployment of Information and Communications Technologies (ICT) has allowed for traditionally vertically integrated global value chains in natural resource based sectors to be reconfigured and new production routines established based on outsourcing and subcontracting. In this regard, the demand pull, together with changes in the production function, has induced the rise of new sectors of dedicated knowledge intensive suppliers that serve special demands for large natural resource companies, referred to in this paper as Knowledge Intensive Business Services (KIBS). In more developed, natural resource endowed, countries, such as Finland, Norway, Canada and Australia, these KIBS firms are evolving to satisfy a growing demand for new technology and innovation in natural resource sectors and serve as "providers of solutions" for technological and organizational problems faced by natural resource firms. KIBS firms developed around natural resource firms are thus central for innovation and technology diffusion across the natural resource sector, and for diversification towards related higher value products and activities.

The oil and gas sector requires very experienced and highly knowledgeable skilled labor, together with highly advanced and specialized equipment. Oil and gas exploration and production companies do not typically complete all the tasks in the oil and gas value chain since they are difficult and costly and involve the use of highly specialized knowledge, skills, equipment and technology. These companies, instead, generally find it more convenient and profitable to hire expertise and source equipment externally from oil and gas service providers than to maintain them internally. These service companies provide specialized equipment, technology and services needed, throughout the value chain for exploration and production and transport of oil and gas to the refinery, and to the final consumer, but do not typically produce oil and gas themselves.

Evidence from developed countries, however, also suggests that several market failures might hinder the development of KIBS firms in natural resource sectors. Given the complexity and tacitness of knowledge, innovation in these sectors requires intense interaction and cooperation between the users (the natural resource firms) and the knowledge providers (the KIBS firms). In

this interaction, asymmetric information problems may ~~emerge~~ emerge, affecting~~,~~ first~~,~~ the match-making process and~~,~~ then~~,~~ hindering investment decisions (moral hazard and hold-up). The situation becomes more complex if spillovers are present and the intangible nature of the transaction makes contracting very difficult. It is due to these problems that developed countries that are heavily natural resource based have established specific programs to tackle these market failures. Arguably, understanding these market failures matters particularly for policy makers in resource based developing countries as changes in world conditions provide resource rich countries with a new "window of opportunity" to use natural resource abundance, both to fuel new knowledge intensive related sectors and to use them as a source for productivity growth. Importantly, while these failures might be even more binding in developing countries, no systematic evidence has been gathered so far so as to assess their pervasiveness. In order to fill this knowledge gap, this paper aims to improve the understanding of the dynamics of KIBS companies, their interaction and relationship with natural resource firms, and market and government failures that may hinder their development in the~~a~~ Caribbean small island developing state~~, namely~~ Trinidad and Tobago, whose economy is based largely on the production and export of oil and gas.

Arguably, the oil and gas sector in Trinidad and Tobago serves as an ideal case study of KIBS firms. Trinidad and Tobago is highly dependent on the oil and gas sector, where~~.~~ i~~I~~n 2013 the energy sector accounted for 43% of GDP, 50% of government revenue, and 85% of total merchandise exports (Central Bank of Trinidad and Tobago, Annual Economic Survey 2013). More specifically, as a result of its well-developed oil and gas sector, Trinidad and Tobago has been home to a growing number of oil and gas service firms, currently consisting of 200 formally registered firms with an international reputation for excellence and high skill levels and ability (Trinidad and Tobago Energy Chamber 2009). These companies offer technical services to the oil and gas sector locally, regionally, and internationally, along the entire oil and gas value chain, including the provision of specialist equipment, tools or processes such as services associated with the exploration and production of hydrocarbons, pipeline transmission, transportation, storage, retail of fuels and electricity generation and transmission.[1] This paper aims specifically to examine

[1] http://stcic.org/ftpcontractorsdb/cdbstart.php

product and process innovation and innovative activity in KIBS firms in the oil and gas sector in Trinidad and Tobago, and to also identify~~ies~~ government, regulation and market failures that hinder their development to inform policy making. In particular, the sources of ideas for the innovation, the balance between internal and external research and development, intellectual property issues and obstacles, both internal and external to the firm, are assessed.

~~The paper has 7 sections including the introduction.~~ The rest of the paper is structured as follows. Section 2 outlines briefly the exiting literature on KIBS. Section 3 provides an overview of the oil and gas services sector in Trinidad and Tobago; Section 4 gives the data and methodology used. Section 5 presents the empirical findings on innovation and innovative activity. Section 6 examines innovation policy in the oil and gas services sector and market and government failures. Finally, Section 7 provides the conclusion and policy implications.

2. KIBS literature

The concept of KIBS emerged in the late 1980s as researchers identifiedy~~-~~ specific traits of businesses found in the services sector. Moreover, since the mid-1990s the literature has seen an increase in the attention paid to KIBS and their role and function in innovation (Figueiredo et al. 2017). Firstly~~,~~ the theoretical literature developed, which recognized KIBS as a peculiar sector, separate and apart from all others. Secondly, an interest in empirical papers advanced using firm level survey data which investigate the innovation process and innovative patterns of these businesses. Nevertheless, KIBS remain under studied, particularly with regard to innovation and technological change in the oil and gas sector, and ~~its~~ their future development has rarely been considered in terms of policies and roles in the wider national innovation system (and den Hertog 2000 and Figueiredo et al. 2017).

KIBS firms provide advanced technological or professional knowledge as intensive inputs into the business processes of other private or public sector organizations. More specifically, Miles et al. (1995, p 18) define KIBS as "services that involve economic activities which are intended to result in the creation, accumulation or dissemination of knowledge". In a more precise definition, den Hertog (2000, p 505) states that KIBS firms are "private companies or organizations who rely heavily on professional knowledge, that is, knowledge or expertise related to a specific (technical)

discipline or (technical) functional-domain to supply intermediate products and services that are knowledge based".

With regard to KIBS and innovation, these firms act as facilitators, carriers, and sources of innovation as they seek to supply innovative solutions to suit clients' needs and play an important role in the innovation process of clients (Camacho and Rodriguez 2008, den Hertog 2002, den Hertog 2000, Naranjo-Valencia et al. 2011 and Tether 2005). KIBS firms are described as "bridges to innovation" as they provide specific and localized solutions to meet the requirements of and solve technological and organizational problems of their customers (Czarnitzki and Spielkamp 2000). KIBS firms may assist with client innovation by suggesting that they adopt solutions previously developed by competitor firms or firms in other sectors (Miles 2008). KIBS firms are facilitators of innovations if they support a client in its innovation process, but the innovation does not originate from KIBS firms, nor is it transferred (from other firms) by this KIBS firm to the client firm (Miles 2008). They are carriers of innovation if they play a role in transferring existing innovations from one firm or industry to the client firm or industry, even though the innovation does not originate from the KIBS firms (Miles 2008). Additionally, KIBS firms are a source of innovation if they play a major role in initiating and developing innovations in client firms, usually in close interaction with the client firm (Miles 2008).

KIBS also assist in knowledge creation and transfer between different economic agents in a country's national STI system. YOU NEED TO DEFINE STI HERE KIBS firms cooperate with their clients, disseminate and absorb knowledge from numerous sources, process it and pass it on in the most appropriate way to suit their clients' needs. They act as an interface between their clients and knowledge generators such as universities and public and private research institutions and the knowledge base of the entire economy, and may act as a catalyst for countrywide knowledge diffusion and innovation (Castaldi 2009 and Castellacci 2008). Nonaka et al. (2000), Nonaka and Takeuchi (1995) and Nonaka (1994) state that explicit and tacit knowledge transformation processes can occur within KIBS firms and develop a knowledge creation function to illustrate their knowledge creation capabilities. Since knowledge generation and transfer are considered a pre-requisite for successful innovation, innovative activity is related to the generation and transfer of explicit and tacit knowledge. Furthermore, den Hertog and Bilderbeek (1998) view KIBS firms as a type of second knowledge infrastructure which complement and fuse with

universities, think tanks and public research institutions that make up the first or traditional knowledge infrastructure.

The literature offers no established theoretical framework for KIBS and its role in innovation and technological change in the energy sector. Nonetheless, KIBS firms are considered to be among the most innovative within the sector since they are viewed as knowledge creating entities, which can help with knowledge transfer and consequently innovation (Gallego and Jaramillo 2015 and Nählinder 2002). KIBS firms provide intermediate products and services that are knowledge based and knowledge intensive support for the business operations of oil and gas exploration and production companies and renewable energy companies. KIBS businesses provide energy firms a wide variety of services, including scientific and technological knowledge such as ICT, R&D, engineering and environmental solutions, as well as traditional professional services for instance advertising, procurement, legal, accounting, management, consulting and marketing. The impact of KIBS companies on knowledge provision and transfer and innovation in the oil and gas sector would depend on the type and intensity of the relationship between the firms that provide the service, users of the service and the national STI system (Muller and Zenker 2001 and Verdú 2007).

There is limited but growing empirical evidence which suggests that KIBS firms increase technological and organizational innovation and the accumulation of capabilities to innovate in oil and gas endowed countries, such as for Norway, Canada, Chile, Colombia and Brazil, and transfer innovation and technology across the national STI system (Aslesen and Isaksen 2010, Doloreux et al. 2008, Engen 2009, Ferreira and Quadros 2006, Gallego and Jaramillo 2015, and Noreng 2005). The development and widespread use of ICT in the oil and gas sector has allowed for traditionally vertically integrated global value chains to be reconfigured and new production paths established based on outsourcing and subcontracting performed by KIBS. The demand pull, together with changes in the production function, has induced the rise of KIBS firms that serve the special demands of oil and gas exploration and production companies. There is, however, a paucity of empirical research in small developing countries like Trinidad and Tobago.

Market failures may nevertheless hinder the development of KIBS firms in the energy sector, especially in developing countries, given the complexity and tacitness of knowledge (Ferreira and

Quadros 2006 and Gallego and Jaramillo 2015). Innovation requires intense interaction and cooperation between the users (energy firms) and the knowledge providers (KIBS firms). In this interaction, asymmetric information problems may emerge, affecting the matchmaking process and then hindering investment decisions (moral hazard and hold-up). The situation becomes more complex if spillovers are present and the intangible nature of the transaction makes contracting very difficult. While developed countries have established specific programs to tackle these market failures, such programs are limited in oil and gas based developing countries where there is limited research.

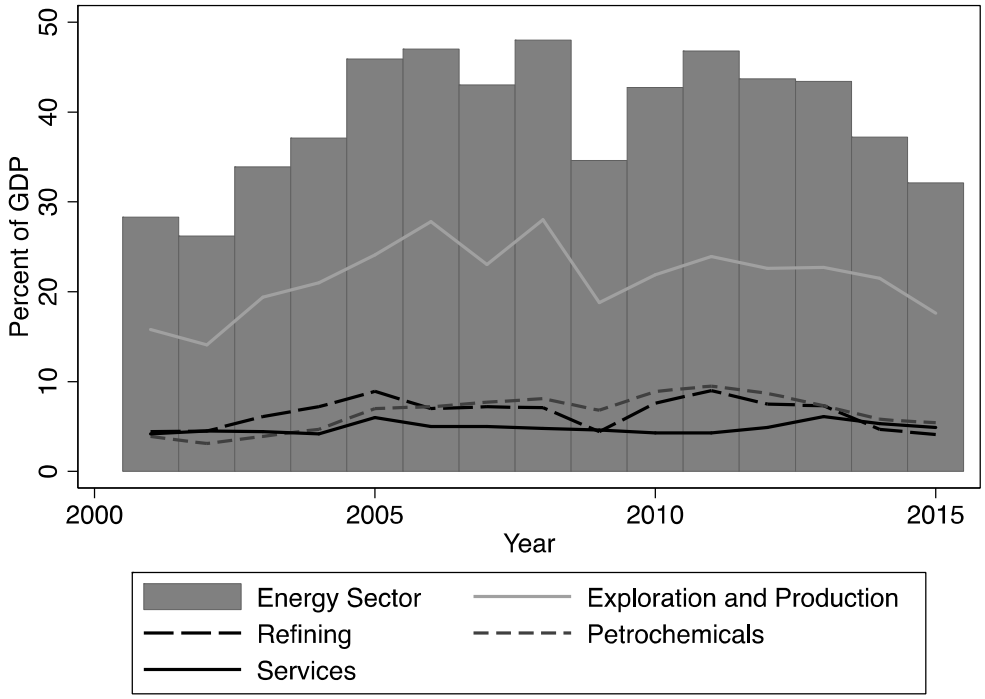
3. Trinidad and Tobago's Oil and Gas Service Industry

This section presents the secondary data collected to provide background information and context on Trinidad and Tobago's oil and gas service industry and the role and characteristics of KIBS. Trinidad and Tobago has a large and growing oil and gas sector which has given rise to a burgeoning number of KIBS firms. The energy sector refers primarily to the oil and gas sector in the country, since the renewable energy sector contributes less than 1% of the country energy's supply (The Energy Chamber of Trinidad and Tobago 2015). Figure 1 shows that the contribution of energy to GDP increased from 28% in 2001 to as high as 47% in 2011, followed by a decline to 32% in 2015, while the contribution of service firms increased from 4% to 5% during the same period with a high of 6%. Figure 2 shows that ~~the~~ dDirect capital investment by oil and gas service providers has increased threefold from $US 59 million to $US 171 million from 2001 to 2012. Moreover, while the oil and gas sector only accounts for around 3% of total employment (CBTT 2013), the services sector is a major employer within the oil and gas sector and employs about one third of energy sector workers (The Energy Chamber of Trinidad and Tobago 2009). ~~Moreover~~Additionally, the majority of the workers in the oil and gas services sector are nationals of Trinidad and Tobago, in both the local and foreign companies (The Energy Chamber of Trinidad and Tobago 2009). Importantly, the oil and gas services sector is described as the most dynamic and competitive services sector in Trinidad and Tobago, with an international reputation for excellence and high skill levels and ability.[2] The oil and gas services sector in Trinidad and Tobago has also been identified as a sustainable route to long-term economic transformation and

[2] http://www.energy.tt/index.php?categoryid=258&p2_articleid=27

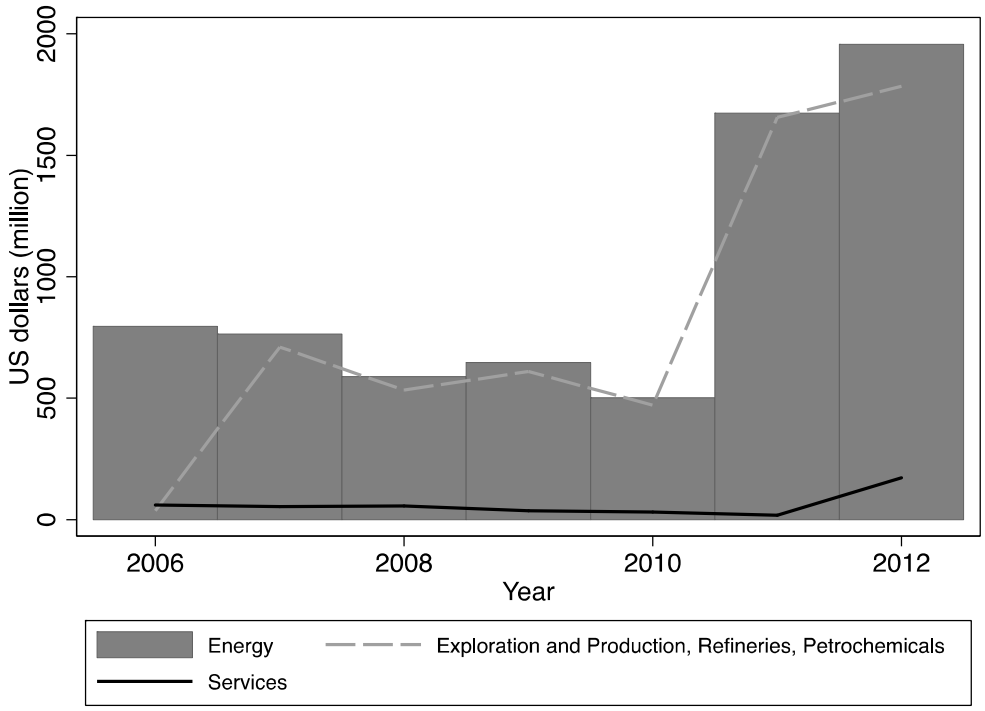
competitive advantage since the sector could provides considerable employment and export opportunity when oil and gas reserves becomeare depleted.

Figure 1: Energy Sector, Percent of GDP



Source: Central Bank of Trinidad and Tobago Annual Economic Survey 2015, 2013, 2009 and 2005.

Figure 2: Direct Investment Capital in Private Sector Enterprises, $US million



Source: Central Bank of Trinidad and Tobago.

The Energy Chamber estimates that there are approximately 300-400 local and foreign owned firms in oil and gas services sector in Trinidad and Tobago. These firms operate along the entire oil and gas value chain. They offer technical services and provide supplies of equipment rental or consumerables and maintenance and advisory services. These firms are well established and are mainly small to medium sized privately-owned, family-run firms, although some are subsidiaries of major conglomerates. Domestic firms compete with large multinational corporations which operate in the Trinidad and Tobago energy services sector, including Baker Hughes, Schlumberger, Halliburton, and Weatherford. Local companies compete against these international companies without the benefit of any trade barriers and minimal government support, which has contributed to their competitiveness.

While most of the local oil and gas service companies primarily serve the domestic market, there is a significant number of local KIBS firms that export services, though mainly in the Caribbean region. The Energy Chamber states that there are approximately 30 local companies which have been successful in entering foreign markets in the Caribbean, Venezuela, Columbia, Brazil, the

US, Canada, Africa, Indonesia, Bahrain, ~~Dubai~~United Arab Emirates, and Vietnam. There is therefore significant potential to increase exports of energy services by these domestic firms, particularly since Trinidad and Tobago has developed a global reputation in the oil and gas services sector, especially in services around drilling exploration and development of wells (The Energy Chamber of Trinidad and Tobago 2009).

The Energy Chamber of Trinidad and Tobago has been encouraging oil and gas services exports and has undertaken Energy Service Trade Missions to Guyana and Suriname (October-November 2007), Cuba (November 2008), West Africa (June 2009), and Ghana (March 2015). These companies subsequently began work, particularly in Suriname. This has resulted in the Energy Chamber assisting a company from Suriname to provide heavy equipment maintenance services in Trinidad and Tobago. Local firms which export oil and gas services are Tucker Energy Services, TOSL Engineering, Kenson, Damus, Lennox Petroleum, Sadhna Petroleum, SCORE, Massy Energy and Industrial Gases and HOLE.

Local oil and gas service firms have identified the level of international competition, ineffective local content policy, a bias towards multi-nationals, the level of demand, and the availability of technical and professional staff as key obstacles they face in growing and developing the industry (Energy Chamber of Trinidad and Tobago 2009). Moreover, growth in oil and gas services is dependent upon the oil and gas sector having a constant stream of projects, such as exploration and drilling and maintenance and construction of plants. Whenever there is a slowdown in energy projects, growth in the services sector is limited or may even decrease. Also, the recent fall in oil and gas prices has created uncertainty in demand for oil and gas services and highlights the importance for local service firms to export their service to international markets (The Energy Chamber 2014). The Energy Chamber states that one of its member companies earned US$ 253 thousand by providing training services to East Africa, while another earned US$7 million for the export of pipe recovery, production logging, and stimulation services.[3] There is a wide range of oil and gas services that Trinidad and Tobago has the expertise ~~for~~ to potentially export~~s~~, as shown in Table 1: T~~t~~his includes expertise in construction, port development, rig positioning, logistics, inspection, pipeline and subsea services. However, a lack of capacity and knowledge of foreign markets may be restricting these firms from entering.

[3] http://www.energy.tt/index.php?categoryid=355&p2001_articleid=1216

Table 1: Oil and Gas Services for Export

Services for Export
Heavy construction
Service- Port development
Surveying Services
Rig Positioning
Logistics
Laboratory services
Inspection Services
Pipeline construction
Sub-sea services
Equipment supply and maintenance
Health, safety and environmental consulting services
Engineering advisory services
Engineering services for specific projects
Civil Engineering Works

Source: The Energy Chamber of Trinidad and Tobago.[4]

4. Data and Methodology

Our goal is to investigate innovation in KIBS firms in the energy sector in Trinidad and Tobago, and to understand the government and market failures that have hindered their development. To achieve this the paper collecteds primary data on a sample of firms to investigate how oil and gas service providers adopt new technologies, use information and innovate, and the consequent impact on firm performance, as well as innovation barriers and recommendations. The primary data ~~are~~ were collected through interviews with the owners or managers of KIBS firms, using an articulated questionnaire. The interview aimeds to determine how the oil and gas service provider is able to develop and deliver innovative services through the processes of external technological acquisition, internal processing and, finally, transfer of the relevant knowledge to oil and gas exploration and production companies. The innovation obstacles faced by firms in this process ~~are~~ were also explored and recommendations from the firms that could help boost innovation ~~are~~ were sought out. The full questionnaire is shown in the appendix.

The primary data collected ~~are~~ were then analyzed using various descriptive statistics. More specifically, the results provide information on firm characteristics, product and process

[4] http://www.energy.tt/index.php?categoryid=355&p2001_articleid=1216

innovation, various types of innovative activity, innovation and various firm performance indicators, innovation barriers and recommendations for improving innovation.

The primary data were also analyzed using econometric analysis to investigate the factors that ~~would~~ associated with an increase in the probability that a firm would introduce a product/process innovation. The following model was used to estimate the relationship between innovation and firm characteristics, innovative activity and government local content policy:

$$Y = f(Part, Size, Customers, Age, Value\ Chain, Export, Foreign, R\&D, internal\ information, external\ information, local\ content\ policy)$$

The probability that a KIBS firm with the related characteristics above as~~is~~ represented by vector Z introduced a product innovation/process innovation is given by:

$$Pr(Y = 1|\, Z = \Phi(\alpha + \beta' Z)$$

where *y* is a binary variable equal to 1 if a firm introduced a product innovation/process innovation and 0 if the firm did not, β' is a vector of coefficients of firm characteristics, innovation related variables and government local content policy, α is an intercept, and $\Phi()$ is the standard normal distribution function. DO YOU REPORT MARGINAL EFFECTS IN THE TABLE OR JUST COEFFICIENTS? I GUESS MARGINAL EFFECTS (SINCE YOU INTERPRET THEM AS PROBABILITIES), SO I GUESS WE NEED TO SAY THAT EXPLICITLY HERE. Robust standard errors are ~~included~~ calculated for the possible presence of heteroscedasticity. Table 2 provides a complete description of the variables used in the regression model. Finally, one may want to note that given the nature of our small and cross-sectional sample size, that may additionally be subject to sample selection bias given the voluntary interview nature of data collection, we refrain from making causal interpretation of the estimated coefficients, but rather interpret these as associative predictive factors.

Table 2: Description of regression variables

Variable	Description
Product	Dummy variable taking the value 1 if the firm introduced a new of significantly improved good or service in the last 5 years and 0 otherwise.

Process	Dummy variable taking the value 1 if the firm introduced new or significantly improved methods of manufacturing or producing goods or services in the last 3 years; introduced new or significantly improved logistics, marketing, delivery or distribution methods for inputs or goods and services in the last 3 years; introduced new or significantly improved supporting activities for processes, such as maintenance systems or operations for purchasing, accounting, or computing; and 0 otherwise.
Part	Dummy variable taking the value 1 if the firm is part of a larger establishment and 0 otherwise.
Size	Log of the number of employees of the firm.
Customers	Log of the number of customers of the firm
Age	Log of the number of years firm is in operation.
Value Chain	Number of segments in the value chain the firm operates in.
Export	Dummy variable taking the value 1 if the firm exports and 0 otherwise.
Foreign	Categorical variable taking the value 1 if the firm has local ownership, 2 if the firm has a mix of local and foreign ownership and 3 if the firm is foreign owned.
R&D	Dummy variable taking the value 1 if the firm has a Research and Development department, an innovation leader, an innovation strategy and an innovation structure and 0 otherwise.
Internal information	Dummy variable taking the value 1 if the firm uses internal information for innovation and zero otherwise.
External information	Dummy variable taking the value 1 if the firm uses information from suppliers, customers, competitors, market sources, consultants, universities, public research institutions, conferences, scientific journals and professional and industry associations for innovation and 0 otherwise.
Local content	Dummy variable taking the value 1 if local content policy improved the firm's innovation and 0 otherwise.

Source: Author's Compilation.

The paper also used secondary data to provide background information and context on Trinidad and Tobago's oil and gas service industry and the role and characteristics of KIBS used in Section 2, as well as various government, regulation and market failures which hinder innovation in Section 6. The secondary data used comes mainly from two sources. Firstly, the Energy Chamber of Trinidad and Tobago conducts a quarterly Energy Services Sector Survey of oil and gas service firms in Trinidad and Tobago which maps their performance and optimism and provides data on business confidence, plans for investment and expansion, employment and training. The Energy Chamber also has a comprehensive listing of firms operating in the oil and gas sector and their respective market segments in Trinidad and Tobago. Secondly, general macroeconomic and energy data are taken from the Central Bank of Trinidad and Tobago.

5. Empirical findings on innovation and innovative activity

While the Energy Chamber has stated that there are approximately 300-400 oil and gas service firms, we identified 200 formally registered companies with the Energy Chamber, which defined our statistical frame. 57 of these firms participated in the study and responded to our questionnaire on innovation and innovative activity, 17 firms declined participation, and no response was obtained from the remaining 126 companies, which puts the study within a 10% margin of error.

Descriptive statistics of the general characteristics of the firms interviewed are provided, followed by an analysis of their innovation and innovative activity, the effect of their innovation on firm performance, and innovation barriers and recommendations. The econometric results of the probability of introducing an innovation and firm characteristics and innovative activities and government local content policy are then provided.

5.1. Firm Characteristics

Table 3 ~~shows~~ summarizes the characteristics of firms surveyed. 79% of firms sampled are private limited liability companies, 7% are public limited liability companies and partnerships, and 4% are sole proprietorships or government-run. Only 30% of the firms are part of a larger organization, and 8 of these are headquartered in Trinidad and Tobago, 5 in the US, and 1 each in Canada, the UK, Nigeria and Ireland. 84% of the firms are locally owned, 5% are foreign owned, and 11% have mixed local and foreign ownership.

We defined four categories of firm size, using the number of employees. 24% of the firms that responded are micro, 36% are small, 27% are medium and only 13% are large. Most of the firms are young- 21% of firms surveyed are newly established, 50% are young, 24% are established and 5% and well established. There is also a level of dynamism in the sector as new firms are constantly emerging. For instance, within the last 10 years, 12 firms in the sample became operational for the first time.

We examine the distribution of firms by the number of customers with whom they do business. There are wide differences in the number of customers and we classify firms into four groups. The data show that 38% of firms have 10 customers and lower, 30% of firms have between 11-50 customers, 23% of firms have 51-200 customers, and 9% of firms have over 200 customers. In looking at whether firms export or not, 54% of firms did not export, while 46% of firms did. The largest geographic market for exports is the CARICOM region as 38% of firms export services to the region. Other markets ~~in~~ to which firms export include the Dutch Caribbean, Africa, Latin America, US, Canada and Europe.

It is important to understand how these firms are distributed along the oil and gas value chain, which may allow us to identify the degree of diversification. Of the firms surveyed, 69% are involved in production, 58% in exploration, 58% in processing, 54% in refining, 33% in transport,

and 21% in marketing and sales. In terms of firms operating in more than one segment of the value chain—: 4 firms operate along the entire value chain; 8 in exploration and production; 6 in exploration, production, processing, and refining; 3 in exploration, production, processing, transport, and refining; and 2 in production, processing, refining, marketing, and sales.

Table 3: Firm Characteristics

Firm Characteristics	Number of Firms	Percent	Firm Characteristics	Number of Firms	Percent
Firm ownership			*Number of customers*		
Private limited liability	44	79	≤ 10 customers	18	38
Public limited liability	4	7	11-50 customers	14	30
Partnership	4	7	51-200 customers	11	23
Sole proprietorship	2	4	> 200 customers	4	9
Cooperative	1	2			
Government	1	2			
Subsidiary firm			*Exporter/non-exporter*		
Yes	17	30	Yes	26	46
No	39	70	No	30	54
Local versus foreign			*Geographical market*		
Locally owned	47	84	Dutch Caribbean	1	2
Foreign owned	3	5	CARICOM	21	38
Local and foreign ownership	6	11	US	8	14
			Latin America	4	7
			Europe	4	7
			Africa	3	5
Firm size			*Value chain*		
Micro (≤ 10 employees)	13	24	Production	36	69
Small (11-50 employees)	20	36	Exploration	30	58
Medium (51-200 employees)	15	27	Processing	30	58
Large (> 200 employees)	7	13	Refining	28	54
			Transport	17	33
Firms age/experience					
Newly established (≤10 years)	12	21			
Young (11-20 years)	28	50			
Established (21-50 years)	13	24			
Well established (> 50 years).	3	5			

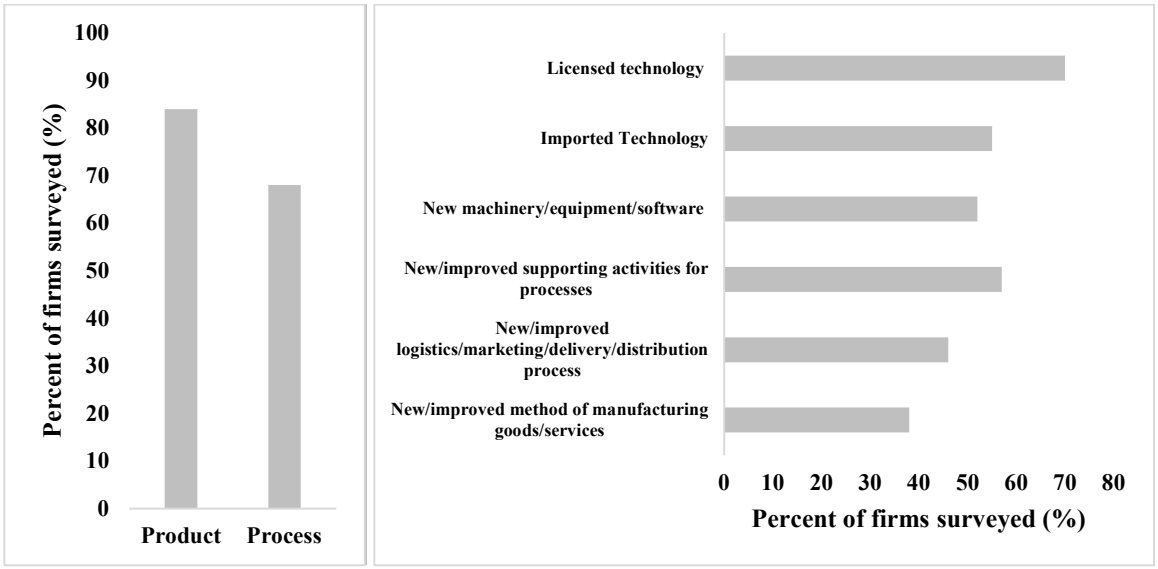
Source: Authors' compilation from survey data.

5.2. Innovation and Innovative Activity

Figure 3 displays data on firms surveyed that implemented an innovation. This study distinguishes between 'product' and 'process' innovation. From the data collected, 84% of the companies indicated that they introduced product innovations, ~~that is~~i.e., a new or significantly improved good or service in the last 5 years. In order to introduce the product innovation 55% of firms surveyed imported the technology; 70% used a licensed technology; and 52% adopted new

machinery, equipment or software. 68% of firms surveyed introduced a process innovation. For process innovations, 38% of firms in the sample introduced new or significantly improved methods of manufacturing or producing goods and services; 46% of firms introduced new or significantly improved logistics, marketing, delivery or distribution methods for inputs or goods and services; and 57% of firms introduced new or significantly improved supporting activities for processes, such as maintenance systems or operations for purchasing, accounting, and computing.

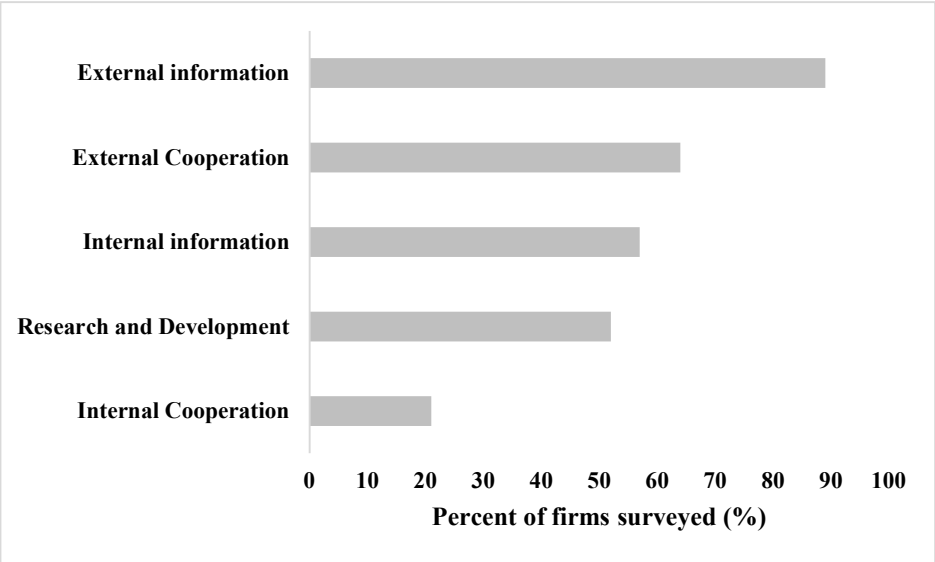
Figure 3: Product and Process innovation, percent of firms surveyed



Source: Authors' compilation from survey data.

Next we look at innovative activities, defined as all those steps necessary to develop and implement technologically new or improved products or processes~~, and are~~. Summary of these factors for our sample are exhibited in Figure 4. Accordingly, 52% of firms had a research and development department, an innovation leader, an innovation strategy and a formal structure for innovation to take place. 57% of firms used internal sources of information for innovation, while 21% of firms cooperated internally on innovation. Looking at external innovative activities, 89% of firms in the study used external sources of knowledge from conferences, industry associations, customers, suppliers, competitors, consultants, scientific journals and research institutes as part of their innovative activity; and 64% of firms cooperated with external partners including customers, suppliers, competitors and research institutes.

Figure 4: Innovative activity, percent of firms surveyed

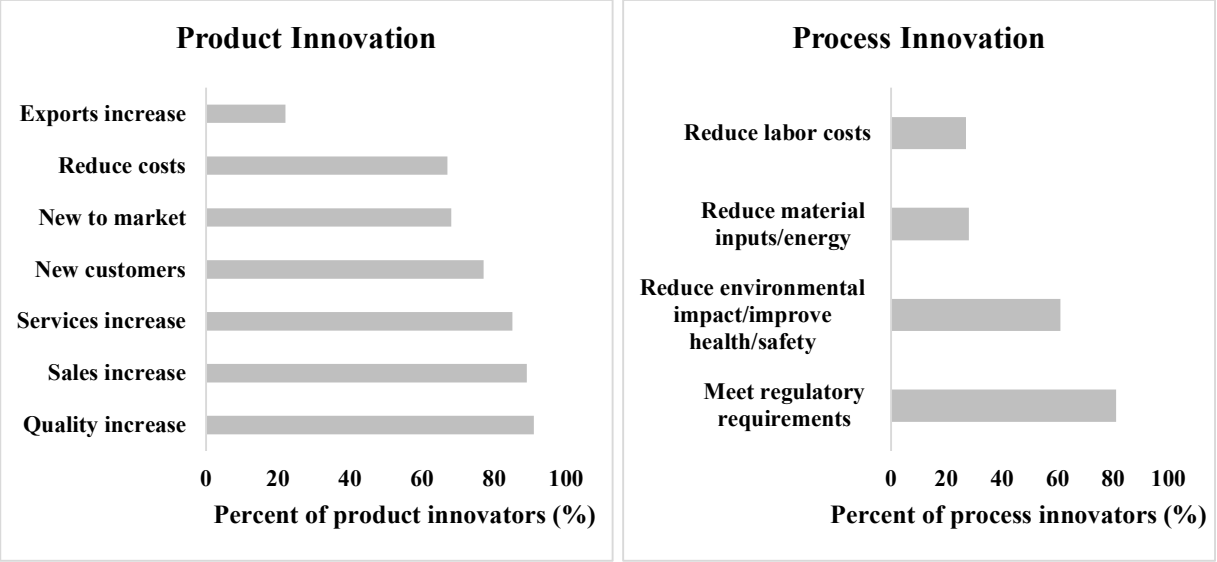


Source: Authors' compilation from survey data.

5.3. Innovation and Firm Performance

Figure 4 shows various indicators of innovation and company performance. Firms invest significant amounts of resources on innovation and as such an assessment of its impact on performance is paramount. Looking at product innovation, only 1 company indicated that their new or improved good or service was not successful. 91% of the companies that successfully introduced a product innovation found an increase in the quality of the products offered; 89% saw an increase in sales; 85% had an increase the number of services offered; 77% obtained new customers; 68% introduced products completely new to the market; 67% benefited from a reduction in their average costs of production; and 22% had an increase in exports. In terms of process innovation, 81% of firms that introduced a process innovation met regulatory requirements; 61% reduced their environmental impacts and improved health and safety in the workplace; 28% reduced material inputs and energy per unit of output; and 27% reduced labor costs per unit of output.

Figure 5: Innovation and firm performance, percent of innovative firms

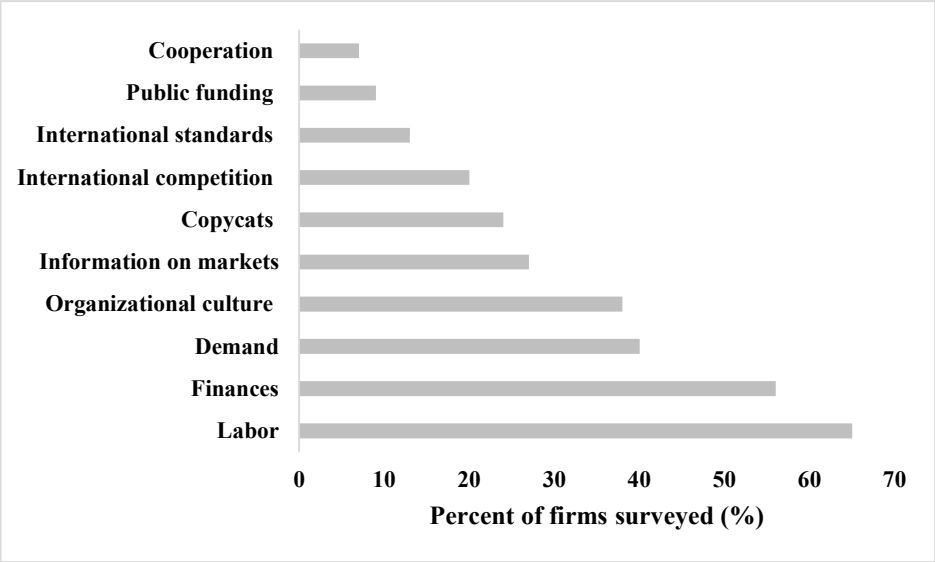


Source: Authors' Compilation from survey data.

5.4. Innovation barriers

It is important to know which barriers are particularly relevant and constraining for firms to craft their own innovation policy, and for governments to design and implement appropriate policies and incentives for the private sector to engage in innovation. Firms surveyed were thus asked about the obstacles faced in trying to implement a product or process innovation. ~~It is important to know which barriers are particularly relevant and constraining for firms to craft their own innovation policy, and for governments to design and implement appropriate policies and incentives for the private sector to engage in innovation.~~ Figure 6 illustrates innovation barriers faced by the firms surveyed. The main barrier to innovation in the study appears to be a lack of labor force skills and qualifications (65% of firms), followed by access and availability of finances (56% of firms). Other hindrances include uncertain demand for innovative goods and services (40% of firms); organizational and managerial culture (38% of firms); lack of information on markets (27% of firms); lack of protection against copycats (24% of firms); and a high level of international competition (20% of firms). The least number of firms viewed cooperation with partners (7% of firms), public funding (9% of firms) and compliance requirements to international standards (13% of firms) as barriers to innovation.

Figure 6: Innovation barriers, percent of firms surveyed

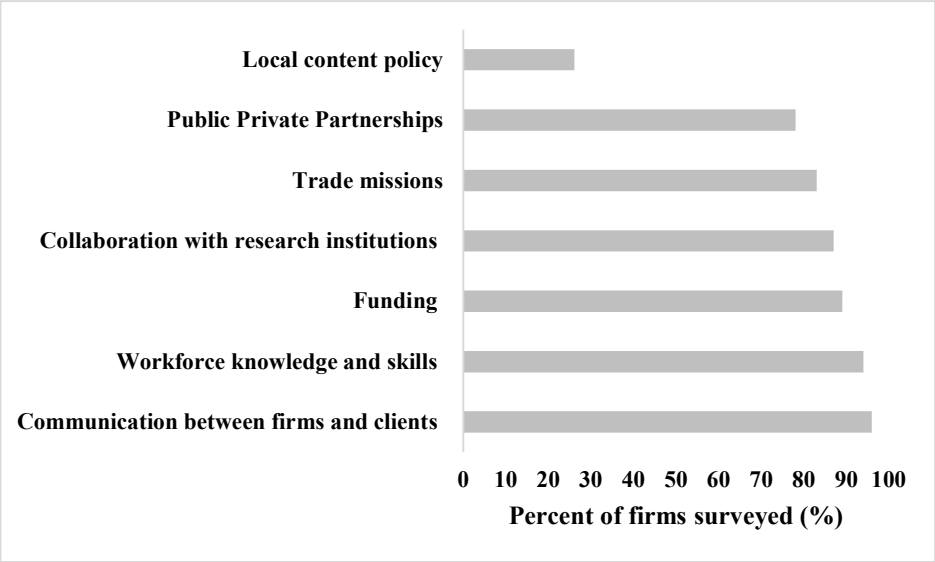


Source: Authors' compilation from survey data.

5.5. Innovation recommendations

Firms that participated in the study were asked what recommendations they would make to improve innovation in the sector. Figure 7 shows that among the suggestions for improving innovative activity in the oil and gas services sector, 96% of companies indicated that programs which increase communication between firms and clients on goods and services are necessary. 94% of firms believed that programs to increase the knowledge and skills of the workforce are also important. Additional recommendations from participants to improve innovative activity were funding for innovation (89% of firms), collaboration with universities and other research institutions (87% of firms), trade missions (83%) and Public Private Partnerships (78%). Only 25% of participants surveyed stated that government local content policy resulted in their company being more innovative. Trinidad and Tobago's local content policy may therefore need to be made more effective in encouraging innovation.

Figure 7: Innovation recommendations, percent of firms surveyed



Source: Authors' compilation from survey data.

5.6. Econometric Results

We explicitly model the ~~influence of~~predictive role of firm characteristics, innovative activity and local content policy on the probability of a firm introducing a product innovation and a process innovation using probit models. Table 4 ~~gives~~ provides the variables and summary statistics used in the probit model regressions, while~~.~~ Table 5 depicts~~gives~~ the regression results. The factors that increased a firm's likelihood of introducing a product and process innovation are firm size, age, number of customers, whether the firm has an R&D department, an innovation leader, strategy and structure, and the use of external information for innovation.

As shown in Table 5, for product innovators the coefficient for customers is significant and positive; the coefficient for age is significant and negative; and the coefficient for R&D is significant and positive. It may therefore be inferred that larger firms based on the number of employees are 4% more likely to introduce a new of significantly improved good or service to the market. The results also suggest that younger firms are 14% more likely than older firms to

undertake product innovation. Firms with a R&D department, an innovation leader, strategy and structure also increased the probability of introducing a product innovation by about 23%.

For process innovators, as seen in Table 5, the coefficient for size was significant and positive; ~~the coefficient~~ for age ~~was~~ significant and negative; ~~the coefficient~~ for R&D ~~was~~ significant and positive; and ~~the coefficient~~ for external information was significant and positive. Large firms measured by the number of employees may therefore have a higher chance of introducing a process innovation, specifically by 14%. Also, younger firms are 27% more likely to be associated with undertaking~~e~~ process innovation. In addition, firms with a research and development department, an innovation leader, strategy and structure have a higher~~increased the~~ probability of introducing a process innovation by 44%. Lastly, the use of external information is related with an increase in the chance of introducing a process innovation by 13%.

Table 4: Regression variables summary statistics

Variable	Mean	Std. dev.
Product	0.84	
Process	0.68	
Part	0.29	
Size	3.63	1.43
Customers	3.37	1.69
Age	2.99	0.64
Value Chain	2.71	1.61
Export	0.48	
Foreign	1.21	
R&D	0.52	
Internal information	0.57	
External information	0.89	
Local content	0.25	

Source: Author's Compilation.

Table 5: Regression Results

Variables	Product	Process
Part	-0.0518	0.132
	(0.109)	(0.0888)
Size	0.0466	0.136**
	(0.0353)	(0.0516)
Customers	0.0356*	0.0174
	(0.0288)	(0.0369)
Age	-0.142**	-0.271**
	(0.0941)	(0.0980)
Value chain	-0.0177	0.0389
	(0.0210)	(0.0309)
Export	0.0324	0.187*
	(0.0510)	(0.105)
Foreign		0.181
		(0.165)
R&D	0.228**	0.436***
	(0.105)	(0.137)
Internal information	-0.0150	0.119
	(0.0635)	(0.133)
External information	-0.0177	-0.133*
	(0.0549)	(0.0688)
Local content	-0.132	
	(0.149)	
Observations	41	48

*Notes: (1) Robust standard errors in parentheses. (2)*** p<0.01, ** p<0.05, * p<0.1. (3) Foreign dropped because of perfect predictions in the product innovation regression. (4) Local content dropped because of perfect prediction in the process regression.*

6. Implication for Innovation Policy in the Oil and Gas Services Sector

There is evidence in the literature that service innovation raises productivity and competitiveness and the general level of innovation in a country, in addition to creating new, and reinforcing existing, competitive advantages (Rubalcaba 2013 and Schricke et al. 2012). However, participation of service firms in research and development and innovation is relatively low compared to their economic share. The literature documents various government, regulation and market failures including market power, externalities, asymmetric information, economies of scale, resource immobility and property rights, that are hindrances to services innovation, making

the case for innovation policies and programs (Carlsson and Jacobsson 1997, Rubalcaba 2013, Sirilli and Evangelista 1998). With specific reference to energy services firms market failure hinder innovation given the complexity and tacitness of knowledge and the intangible nature of the service (Ferreira and Quadros 2006 and Gallego and Jaramillo 2015). Further, innovation requires intense interaction and cooperation between oil and gas exploration and production firms and KIBS firms, where asymmetric information problems may emerge affecting the matchmaking process and then hindering investment decisions through moral hazard and hold-up. Funding is also more difficult for service firms because of the relatively larger importance of intangible assets, which are viewed as expenditures and not assets, and the relatively smaller share of tangible assets. Lastly, the incentive for universities and other research institutions to work with service firms is generally low given that patents do not play an important role in the services sector (Rubalcaba 2013).

In the specific instance of Trinidad and Tobago's oil and gas service sector, several market failures exist and, in particular, asymmetric information failures exist at several levels. For instance, there is currently no means of sharing information with service providers and exploration and production companies in the sector. Additionally, there is no platform for dialogue among all the industry stakeholders, including government, the business chamber, and the private sector ,for crafting a national strategy to grow the industry locally and abroad.[5] These asymmetric information problems affect the match-making between the demand of the oil and gas exploration and production firms and the supply of services by KIBS firms, which may then hinder investment decisions. Moreover, given the complexity and tacitness of knowledge in service type industries, the sector requires intense interaction and cooperation among all stakeholders. Judging f~~F~~rom the survey results shown above, there is ~~hardly any~~little collaboration between oil and gas service firms and universities or government research institutions, despite external information being a key factor in increasing the introduction of innovation. Also, 96% of firms in the study indicated that programs which increase communication between firm and clients on goods and services ~~will~~ would improve innovation undertaken by them, 87% stated that collaboration with universities and other research institutions ~~will~~ would increase innovation, and 78% stated that public private partnerships ~~will~~ would improve their innovation.

[5] http://www.energy.tt/index.php?categoryid=355&p2001_articleid=1295

Asymmetric information has also resulted in limited access to finance for oil and gas KIBS firms from the local banking sector. The Energy Chamber states that this is huge problem for local service oil and gas companies as local banks do not understand the sector and are unable to assess risk and develop appropriate financial instruments.[6] Also, in general, funding is more difficult for service firms given the large amount of intangible assets, which are difficult to cost. All the firms in the study that introduced a product innovation used internal sources of finance. Also, from the firms surveyed 56% identified a lack of access to finance as an impediment to innovation and 89% stated that improved access to finance would increase their innovation.

While the government has invested significant resources in training at the graduate-level as well as at the level of technician and craft workers through various tertiary education institutions (UWI, UTT and the National Energy Skills Centre), there is ~~not a~~no close alignment between these training institutions and oil and gas KIBS providers to ensure that the labor force has the specific industry skills required. Furthermore, there is little collaboration between these tertiary education institutions and firms in the industry. The survey results show that 65% of the firms in the study identified a lack of labor force skills and qualifications as a main obstacle to innovation, and 94% of firms stated that increased skill levels and knowledge of the workforce would increase their innovative activity.

Moreover, most of the oil and gas service providers in Trinidad and Tobago are SMEs with limited human capital to focus on innovation activities. Also, the Energy Chamber points out that contracting conditions and defaults by international contractors ~~also~~ pose a problem for oil and gas KIBS firms.[7] Local oil and gas services firms provide engineering and construction services, to large international firms through 'engineer, procure, construct' (EPC) contracts. Local sub-contractors are sometimes not fully paid for work they have completed when there are problems with projects due to the fault of the large international firms. These local companies are unable to pursue legal action against the large international contractors in international courts.

[6] http://www.energy.tt/index.php?categoryid=355&p2001_articleid=1295
[7] http://www.energy.tt/index.php?categoryid=355&p2001_articleid=1295

In Trinidad and Tobago the oil and gas sector contributes the most to environmental degradation and pollution, with implication for other economic sectors like fishing, tourism and agriculture. It has been estimated that an average of 2,000 barrels of oil spill occur annually in the marine area around Trinidad and Tobago (The Ministry of Energy and Energy Affairs 2013). Renewable energy use remains close to zero given the cheap price of fuel, although the government has set a target of 10% by 2021 (The Energy Chamber of Trinidad and Tobago 2015).[8] Reducing the negative environmental impact of the sector provides opportunities to develop local capabilities and skills in the process of prevention and mitigation and can be seen as an opportunity to incorporate participation from universities, KIBS firms and local communities in the solutions. Trinidad and Tobago oil and gas KIBS firms can assist in environmental protection, renewable energy, and sustainability by offering the relevant services given that there is a large and growing demand for these ~~services~~. ~~Since the early 1990s~~ While oil and gas KIBS companies have introduced environmental services in Trinidad and Tobago since the early 1990s~~. However,~~, currently the country has no hazardous-waste disposal systems and waste from the oil and gas sector has to be exported. Environmental protection and sustainability present a significant opportunity for oil and gas KIBS firms to innovate and expand services offered.

In light of these shortcomings, the development of an innovation policy and programs targeted at the oil and gas service sector in Trinidad and Tobago is of critical importance, given the large and growing economic contribution of the sector. Furthermore, given that the majority of the country's oil fields are mature and depleted and production is on the decline and there is a drive towards deep water exploration, the innovation policy should focus on innovating and expanding services in geological evaluations, seismic surveying, and enhanced oil recovery operations. Any such initiative will benefit from the fact that the country has a long history of working in the oil and gas industry and has a skilled and knowledgeable local workforce. The government has been supporting domestic oil and gas service providers through local content policy, but this is insufficient and may even be counter-productive. Indeed, while the local content policy may allow for greater participation of domestic firms who have the capability and capacity to do so, it does not address the market failures present in the service industry outlined above. In fact from the firms

[8] https://energynow.tt/blog/target-10-renewables-by-2021

interviewed only 26% were of the view that Trinidad and Tobago's local content policy help them innovate.

As a consequence, these policies do not result in improved innovation and competitiveness since domestic KIBS firms may not be internationally competitive on price, quality, and delivery (Warner 2011). There is also no national strategy to develop the oil and gas service sector that considers differences in sub-sectors. Currently, individual companies set their own local content levels and there is no medium to create alignment between individual company strategy and national policies and programs. Furthermore, the 2004 local content policy stated an intention to create a secretariat in the Ministry of Energy to support a local content committee. This secretariat is yet to be set up. There are also currently no policies and programs to increase the export of oil and gas services. One possible solution to address these concerns is for greater dialogue between oil and gas exploration and production firms and local service providers. Currently there is no mechanism in place for sharing information and initiating dialogue among key stakeholders in the energy sector in Trinidad and Tobago.

Despite the lack of major policy initiatives in Trinidad and Tobago, its oil and gas service companies have a strong brand in international markets and have the capacity to be internationally competitive. In addition to the 'local content' initiative spearheaded by the Trinidad and Tobago Government, there has been some government-sponsored initiative to enhance the link between the oil and gas sector and the tertiary education sector, which must be developed further: the University of the West Indies~~WI~~, the University of Trinidad and Tobago,~~UTT~~ and the National Energy Skills Centre have been working towards addressing the skills gap in some sub-sectors in the oil and gas industry. However, the programs need to be expanded to cover skills across the entire industry. In addition, a communication mechanism between service providers and the educational institutions is required to identify the skills needed.

A non-government sponsored policy initiative that has met with some success is the Energy Chamber led trade missions, regionally and internationally, in an attempt to increase exports. This program has been very successful and, as such, may be expanded. In fact 83% of respondents recommended trade missions to improve innovation in the sector. The Energy Chamber also executed a project in 2011 to improve corporate governance in Trinidad and Tobago among firms

in the energy sector. [9] This has helped local service companies to better access financing and process innovations; however more needs to be done. The Energy Chamber has also initiated discussions for dealing with the problem of default payments by international firms to local sub-contractors. However, there is no agreed industry or government plan to overcome this challenge, and this is another matter that may be pursued further.

7. Conclusion and Policy Implications

Trinidad and Tobago's oil and gas industry~~, one of the oldest in the world,~~ is over 100 years old and as such one of the oldest in the world. where~~and~~ T~~t~~he accompanying services sector also dates back to the emergence of the oil and gas industry. Moreover, the oil and gas services sector is large and growing. All in all, there are approximately 300-400 service firms, with 200 formally registered, that provide goods and services across the entire oil and gas value chain. These firms are well established and are mainly SMEs that are privately-owned by families but are professionally run, ~~while some are~~with only a few subsidiaries of major conglomerates. Local firms compete with large multinational corporations without the benefit of any trade barriers, but benefit from government support through local content policy, which has contributed to their competitiveness.

The sector makes an important contribution to employment in that, although the energy sector only accounts for around 3% of total employment in Trinidad and Tobago, the oil and gas services sector is a major employer within the oil and gas industry and employs about one third of energy sector workers. The majority of the workers are Trinidad and Tobago nationals, in both local and foreign companies. Importantly, the sector is the most dynamic and competitive services sector in Trinidad and Tobago with a strong international brand. Additionally, there are approximately 30 local companies which have achieved fairly good economies of scale and who have been able to enter foreign markets regionally and internationally.

Given that the global market for oil and gas services is large and growing- for instance, in 2013, the sector was estimated to be worth about US$ 100 billion and the four largest companies employed a total of 321,000 persons internationally- the oil and gas services sector in Trinidad and

[9] http://www.energy.tt/index.php?categoryid=354

Tobago arguably represents a sustainable route to long-term economic transformation and competitive advantage. The sector could look more towards renewable energy and an expansion of environmental services, although the limited renewable energy sector in the country limits action in this regard~~here~~. Moreover, oil and gas KIBS providers in Trinidad and Tobago have tremendous potential for innovation and technology diffusion across the sector and for diversification towards related higher value added goods and services. Firms which have participated in this study have undertaken various product innovations which have increased the number of products offered, the quality of goods and services offered, sales, and exports. Firms have also implemented process innovations which allowed them to meet regulatory requirements, reduce environmental impact, ~~and~~ improve health and safety, reduce material inputs and energy, and, to a lesser extent, reduce labor costs. Further, the results suggests that the factors that ~~increased~~ are associated with an increased ~~the~~ likelihood of introducing a product/process innovation are firm size, age, number of customers, whether the firm has an R&D department, an innovation leader, strategy and structure, and the use of external information for innovation.

Several market failures, however, hinder the development of KIBS firms in Trinidad and Tobago and must be adequately addressed by government policy. More specifically, the sector requires the development of a national innovation policy and program. In other words, while the government has been supporting domestic oil and gas service providers through local content policy, these policies are insufficient in that they do not fully address market failures and in some cases are counter-productive as they can create an uncompetitive protectionist environment. In examining the market failures specifically, several stand out, namely information asymmetries among all major stakeholders, difficulty in obtaining finance, lack of appropriate skills and limited partnerships between research institutions and players in the sector. There is also need for greater dialogue and clear communication channels among all industry stakeholders. Additionally, several local policy initiatives may be expanded and improved to increase innovation and competiveness in the sector, such as the Energy Chamber led trade missions, the expansion of training across all the skills required through UWI, UTT and the National Energy Skills Centre and The Energy Chamber's corporate governance program.

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Knowledge Intensive Business Services in the Oil and Gas Sector in Trinidad and Tobago

A study by the Sir Arthur Lewis Institute of Social and Economic Studies on behalf of the Inter-American Development Bank

Questionnaire

1. GENERAL INFORMATION

1. Name of respondent: 2. Job title:
3. Phone: 4. E-mail:

5. Name of firm: 6. Year firm was established:

7. Type of firm:
□ Sole proprietorship
□ Partnership
□ Public limited liability company
□ Private limited liability company
□ Government
□ Cooperative
□ Other, **specify**

8. Is the firm:
□ Locally owned □ Foreign owned □ Mixed ownership (local and foreign)

8.1. Ownership of Equity:
% **National:**

% Foreign	**Country**

9. Is your firm part of larger establishment? □**Yes** □ **No**
(If answer is 'No', go to question 10)

9.1. In what country is the larger establishment based?

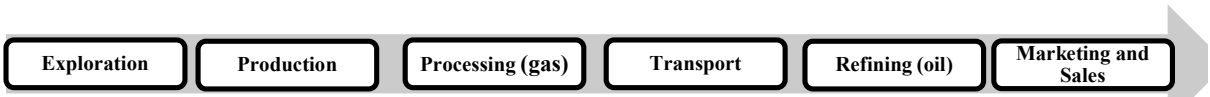
10. Please give the following basic general information on your firm:
10.1. Number of employees, as at end of last financial year:
10.2. Annual sales (in US $), as at end of last financial year:
10.3. Annual exports (in US$), as at end of last financial year:

11. How many customers do you have?

12. How many services does the firm offer?

13. At what stage of the oil and gas value chain are services offered (tick box(es) below)?

UPSTREAM **MIDSTREM** **DOWNSTREAM**



□ □ □ □ □ □

14. In which geographic markets did your firm sell goods and services in the last financial year and what is the contribution to total sales?

Geographic location		**% of total sales**
Trinidad and Tobago	□ Yes □ No	
CARICOM[10] (excluding T&T)	□ Yes □ No	
Latin America	□ Yes □ No	
US	□ Yes □ No	
Europe	□ Yes □ No	
Africa	□ Yes □ No	
Other (specify):	□ Yes □ No	

15. How much capital is invested in the firm (in US$)?

16. How much long term debt does the firm have? (in US$)

17. What do you estimate your return on capital invested to be over the last five years (2010-2014)?

2. INNOVATION[11] AND INNOVATIVE ACTIVITY[12]

2.1. Sources of information and co-operation for innovation activities

18. Does your firm have a specific, formal innovation strategy? **□Yes** **□No**

29. Does your firm have a formal structure or process for making innovation happen?
□Yes **□No**

[10] Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname and Trinidad and Tobago.
[11] An innovation has been implemented, if it has been introduced on the market (product innovation) or used within a production process (process innovation). The product or process should be new (or significantly improved) to the enterprise (it does not necessarily have to be new to the enterprise's market).
[12] Innovative activities are all those steps necessary to develop and implement technologically new or improved products or processes.

20. Does your firm have a department or a group of persons dedicated to innovative activity?
□ **Yes** □ **No**

21. Does your firm have a dedicated full-time leader for innovation projects? □**Yes** □**No**

22. Does your firm use any of the following information sources for innovation activities?

a) Within the firm enterprise or enterprise group	□ **Yes** □ **No**
b) Suppliers of equipment, materials, components, or software	□ **Yes** □ **No**
c) Clients/customers	□ **Yes** □ **No**
d) Competitors/other enterprises in your sector	□ **Yes** □ **No**
e) Market sources	□ **Yes** □ **No**
f) Consultants, commercial labs, or private R&D institutes	□ **Yes** □ **No**
g) Universities or other higher education institutions	□ **Yes** □ **No**
h) Government or public research institutes	□ **Yes** □ **No**
i) Conferences, trade fairs, exhibitions	□ **Yes** □ **No**
j) Scientific journals and trade/technical publications	□ **Yes** □ **No**
k) Professional and industry associations	□ **Yes** □ **No**

2.2. Product innovation[13]

24. What types of services are provided?

□ Only services demanded by client companies
□ Services that may not have been demanded before
□ Both

25. Do you ever offer services that a potential client company does not, at that point in time, use?
□ **Yes** □ **No**

26.1. How successful have you been in getting such new services accepted?

Never				**Always**
□ **1**	□ **2**	□ **3**	□ **4**	□ **5**

27. Has your firm introduced a new or significantly improved good/service in the last 5 years?
□ **Yes** □ **No**
If yes, please provide product innovation information on table below
If answer is 'No', go directly to Section 2.3.

28. Were any of these new of significantly improves good/service successful?

Product innovation	

[13] Product innovation is the creation and subsequent introduction of a good or service that is either new, or an improved version of previous goods or services.

Was the technology imported?	□ Yes □ No
Were new machinery/equipment/ software bought to contribute to the improvement?	□ Yes □ No
Was the improved or new machinery, equipment or software the result of the use of a licensed technology?	□ Yes □ No
Did the improvement or new service require changes in the: a)firm production methods b)firm processes c)firm organizational structure	 □ Yes □ No □ Yes □ No □ Yes □ No
Did the improvement or new service require: a) new employees b) new knowledge and skills c) training	 □ Yes □ No □ Yes □ No □ Yes □ No
Did the improvement or new service: a) increase the number of services offered to the market b) increase the quality of the services offered c) increase sales d) increase the number of new customers e) increase exports f) reduced average cost	 □ Yes □ No □ Yes □ No □ Yes □ No □ Yes □ No □ Yes □ No □ Yes □ No
How was the innovation/technology financed? a) own resources b) private partners c) public sources	 □ Yes □ No □ Yes □ No □ Yes □ No

2.3. Process Innovation

28. Did your firm introduce new or significantly improved methods of manufacturing or producing goods or services in the last 3 years? □ **Yes** □ **No**

29. Did your firm introduce new or significantly improved logistics, marketing, delivery or distribution methods for your inputs, goods or services in the last 3 years? □ **Yes** □ **No**

30. Did your firm introduce new or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing in the last 3 years? □ **Yes** □ **No**

If answer to ALL questions under 2.2 is 'No', go to section 2.4.

31. Did any of the above innovations covered under 2.2

a) Reduce input materials and energy per unit output?

No				**Significantly**
□ **1**	□ **2**	□ **3**	□ **4**	□ **5**

b) Labor costs per unit of output?

No				**Significantly**
□ **1**	□ **2**	□ **3**	□ **4**	□ **5**

c) Reduce environmental impacts or improved health and safety effects?

No				**Significantly**
□ **1**	□ **2**	□ **3**	□ **4**	□ **5**

d) Meet regulatory requirements?

No				**Significantly**
□ **1**	□ **2**	□ **3**	□ **4**	□ **5**

32. Did your firm co-operate[14] on any of your innovation activities (product and process) with the following institutions?

a) Other enterprises within your enterprise group	□ **Yes** □ **No**
b) Suppliers of equipment, materials, components or software	□ **Yes** □ **No**
c) Clients or customers	□ **Yes** □ **No**
d) Competitors or other enterprises in your sector	□ **Yes** □ **No**
e) Consultants, commercial labs, or private R&D institutes	□ **Yes** □ **No**
f) Universities or other higher education institutions	□ **Yes** □ **No**
g) Government or public research institutes	□ **Yes** □ **No**

[14] Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation.

2.4. Factors hampering innovation activities

33. Did your firm successfully file patents/trademark/industrial design/copyright registration in the last 3 years? **□ Yes □ No**

34. Does your firm have a dedicated innovation or R&D budget? **□Yes □No**

35. What percentage of annual expenses is allocated to innovation activities?

36. What are the obstacles faced by your firm for innovation?

a) □ organizational/managerial culture
b) □ finances
c) □ public funding
d) □ labor force skills and qualifications
e) □ protection against copycats
f) □ level of information on available technologies
g) □ compliance requirements to international standards
h) □ international competition
i) □ cooperation with partners
j) □ lack of information on markets
k) □ difficulty in finding cooperation partners for innovation
l) □ market dominated by established enterprises
m) □ uncertain demand for innovative goods or services

37. How much competition/rivalry is posed by foreign oil and gas service firms?

None				**A great deal**
□1	**□2**	**□3**	**□4**	**□5**

38. Is there a preference for companies to use local suppliers as opposed to foreign suppliers?

None				**A great deal**
□1	**□2**	**□3**	**□4**	**□5**

39. Do foreign oil and gas service companies enjoy any of the following benefits/competitive advantages over local firms?

a) government support **□ Yes □ No**
b) greater experience/knowledge/know-how in the sector **□ Yes □ No**
c) access to more skilled and knowledgeable workers **□ Yes □ No**
d) greater access to latest information in the sector **□ Yes □ No**
e) greater access to market information **□ Yes □ No**
f) greater access to finance **□ Yes □ No**
g) other **□ Yes (specify) …… □ No**

40. Has Trinidad and Tobago's local content policy resulted in your firm being more innovative?

□Yes □No

41. Can any of the following policies/programs improve innovation undertaken by oil and gas service providers?

a) communication between your firm and clients on the goods/services required □ **Yes** □ **No**
b) collaboration on R&D with universities and other research institutions □ **Yes** □ **No**
c) funding for innovation □ **Yes** □ **No**
d) increasing knowledge and skills of the workforce □ **Yes** □ **No**
e) trade missions □ **Yes** □ **No**
f) public private partnerships □ **Yes** □ **No**
g) other □ **Yes (specify) ……** □ **No**