What are the university-productive sectors links that matters in a small island country? the case of Cabo Verde

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Abstract

Even though there is extensive literature on university-firms links, it is mostly based on empirical evidence from advanced countries, emerging economies and developing countries that already have certain capabilities of the public research system and an important set of mature firms (of different sizes and even some exporters). This explains the use of a set of channels of interactions based on knowledge generation activities. In the case of African countries, the two agents that interact have specific characteristics, which affect the bases of their interactions. This paper explores the channels of interactions between university and the productive sector (not only firms) in the context of a small country like Cabo Verde, elaborates policy implications in terms of a sequential path of evolution of the channels from the existing interaction based on the formation of human resources to other more knowledge based.
Keywords: university-industry links, human resources, national innovation system, small insular countries, Cabo Verde, Africa

Resumo

Apesar de haver uma extensa literatura sobre a vinculação universidade-empresa, esta se baseia principalmente em evidências empíricas dos países avançados, as economias emergentes e os países em desenvolvimento que já têm certas capacidades acumuladas nos seus sistema público de investigação e um conjunto importante de empresas maduras (de tamanhos diferentes e até mesmo algumas orientas á exportação). Isto explica o uso de um conjunto de canais de interação baseadas em atividades de geração de conhecimento. No caso dos países africanos, os dois agentes que interagem têm características específicas, que afetam as bases de suas interações. Este artigo explora os canais de interação entre a universidade e o sector produtivo (e não apenas empresas) no contexto de um pequeno país como Cabo Verde e, elabora implicações políticas em termos de um percurso sequencial da evolução dos canais da interação existente com base no formação de recursos humanos para outros mais baseada em conhecimento.
Palavras-chave: relações universidade-indústria, recursos humanos, sistema nacional de inovação, pequenos países insulares, Cabo Verde, África

1. Introduction

Countries differ in terms of levels of development and maturity of the National Innovation Systems (NIS). There is general agreement that it is necessary to develop capabilities of NIS agents and strengthen the ties between them. One of the most important links is between universities and firms.

There is extensive literature on university-firms, based on empirical evidence from advanced countries, emerging economies and developing countries that already have certain capabilities of the public research system and an important set of mature firms (of different sizes and even some exporters). This literature has identified determinants, channels, motivations and benefits of interaction.

Evidence from developing countries has led to the emergence of a new line of research on the role of universities in development, which takes on a developmental approach to university (Arocena and Sutz, 2005; Göransson, Maharajh and Schmoch, 2009) or an entrepreneurial approach to university (Etzkowitz and Dzisah, 2007).

In the case of African countries, the two agents that interact have specific characteristics. On the one hand, universities account for a significant portion of the well trained people, have a reduced capacity for research associated with a poor scientific and technological infrastructure and highly qualified human resources, depend heavily on the political power, and in many cases are very young institutions. These features suggest that they have the opportunity to focusing on problems-oriented research and contribute to upgrading the productive sector through the formation of skills and the generation of knowledge adapted to local needs, and hence to contribute to the development process, but still lack basic scientific capabilities to do it. On the other hand, the productive sector is not dominated either by firms or by industry, but there is a significant participation of other forms of productive organization in different economic sectors. Even in the case of firms, many of which are more oriented towards local markets (in different economic activities) than to international markets. For this reason, it is more important to focus the analysis in the productive sector that in firms or industry. The productive sector has low technological capabilities.

Overall, the evidence suggest that there are limited links between these two agents, and these links differ from those found in more developed countries. (Etzkowitz and Dzisah, 2007; Kruss, et al., 2009; Vera-Cruz, Dutrénit and Torres, 2008; Petersen and Rumbelow, 2008; Morakinyo, 2009; Ssebuwufu, Ludwick and Béland, 2009; Mwamila, 2009; Adeoti, Odekunle and Adeyinka, 2010)

This paper analyses university-productive sector linkages from the case Cabo Verde, a small African island country, which have an infant public research system and higher educational system, firms with low technological capabilities that are starting to adopt market practices (Vera-Cruz, Dutrénit and Torres, 2008), and a higher level of education and a more organized public administration as compared to most of the Sub-Saharan countries.

In this context, the aim of this paper is two fold, first to explore the channels of interactions between university and the productive sector in the context of a small country like Cabo Verde, and second to elaborate policy implications in terms of a sequential path of evolution of the channels from the existing interaction based on the formation of human resources to other more knowledge based.

After this introduction, section 2 review relevant literature on university-industry linkages;

section 3 describe the methodology; section 4 analyses the evidence of the case of Cabo Verde; section 5 discusses ways for strengthening the linkages; finally section 6 concludes.

2. On the university-industry links literature

There is two recognized functions of universities: the formation of human resources and knowledge generation. The activities undertaken in universities can generate useful knowledge to improve production processes and contribute to technological advances, which may be used by companies as a mean to optimize their capabilities and create new products and processes. Hence, universities can make important contributions to increase firms' competitiveness. But universities also generate knowledge that can contribute to solve national problems, and then support the development process. The idea of the so-called third mission has generated some consensus, from the entrepreneurial role of universities (Etzkowitz and Leydesdorff, 2000) to promote economic and social development and contribute to the satisfaction of social needs (Arocena and Sutz, 2005, Göransson, Maharajh and Schmoch, 2009).

One of the key links between actors of the National System of Innovation (NSI) is the university-industry interaction. Unlikely most developed countries, these interactions in developing countries are still very week, and this is at the base of the feebleness of their NIS (Dutrénit et al, 2010; Lorentzen 2009; Cassiolato, Lastres and Maciel, 2003; Lall and Pietrobelli, 2002; Muchie, Gammeltoft and Lundvall, 2003).

The focus on university-industry interaction is limited for capturing the scope of interactions in developing countries and particularly in African countries. In these countries, industrial sector is small, as it is the number of industrial firms. Most firms are SMEs in traditional sectors producing for local markets, so their demand for knowledge is very limited, while the largest are subsidiaries of transnational corporations that benefit from the capabilities of R & D from their headquarters. In addition, there are many other forms of productive organizations than are not firms in the industry and they are related to other economic sectors. Thus, this paper focuses more broadly on universities-productive sector interactions.

There is large body of studies on university-industry linkages, which include drivers, channels and benefits of such interactions; these studies are largely based on countries with an established public research system, a higher educational system, and firms with certain level of technological capabilities. They largely focus on linkages with industrial firms. These studies include the perspective of both side of the coin: researchers/universities and firms.

Studies examining university-industry interaction have found that the most important drivers motivating interaction from the perspective of the firms are the following: (i) structural factors such as size, age, technological intensity and industrial environment; (ii) behavioral factors including the type of research and development (R&D) conducted by the firms, the intensity of this activity, and the firms' opening strategy; and (iii) policies related factors including support to incubators, promotion of innovative clusters and launch of joint research projects. Additionally, several authors have found that firms that invest in

R&D are more likely to interact with universities and have a greater absorptive capacity. (Cohen, Nelson and Walsh, 2002; Etzkowitz, de Mello and Almeida, 2005; Motohashi, 2005; Laursen and Salter, 2004; Fontana, Geuna and Matt, 2006; Eom and Lee, 2009; Giuliani and Arza, 2009; Dutrénit, De Fuentes and Torres, 2010; Torres et al, 2011; De Fuentes and Dutrénit, 2012)

Institutional and individual factors explain the probability of engagement in university-industry interaction from the perspective of universities and researchers. As referred to the institutional factors, the literature analyzes factors such as: institutional affiliation, the mission of the university, previous technology transfer experience of the department, scale of research, sources of funding, and quality of research. Among the individual factors it is analyzed: previous experience of researchers, researcher's academic status and research fields, academic collaboration, etc. (Boardman and Ponomariov, 2009; Etzkowitz and Leydesdorff, 2000; Mowery and Sampat, 2005; D'Este and Patel, 2007; Schartinger et al., 2002; Dutrénit, De Fuentes and Torres, 2010; De Fuentes and Dutrénit, 2012, amongst others).

Concerning to the channels of interaction, the literature has proved that interactions occur through multiple channels such as human resources formation, publications, assistance to conferences, personnel mobility, informal contacts, consultancy, collaborative and contract research, patenting and spin-offs (Cohen, Nelson and Walsh, 2002; Bierly, Damanpour and Santoro, 2009; Narin, Hamilton and Olivastro, 1997; Laursen and Salter, 2004; Mowery and Sampat, 2005; Hanel and St-Pierre, 2006; Fontana, Geuna and Matt, 2006; Schartinger et al., 2002; Bekkers and Bodas Freitas, 2008). Differences have been found according to the agent analyzed (firms or universities/researchers) and sectors.

The literature based on evidence from advanced economies has largely focused on those channels of interactions related to the generation and commercialization of knowledge (collaborative and contract research, patenting and licensing) (Cohen, Nelson and Walsh, 2002). However, even in this context, other authors found that the human resources flow is an important channel of knowledge flows (Mowery and Sampat, 2005; Narin, Hamilton and Olivastro, 1997). Dutrénit and Arza (2010) found a similar result based on the analysis of 4 Latin American countries.

There are different grouping of the channels, according to the degree of formality, the degree of interaction, the direction of knowledge flow and the potential to obtain applied results. Even though the evidence shows that informal channels matter (Vedovello, 1998; Fritsch and Schwirten, 1999; Schartinger et al., 2002; D'Este and Patel, 2007; Perkmann and Walsh, 2009; Eun, 2009), the literature focuses more on formal channels as they are interested on those links associated with research collaboration (Dutrénit and Arza, 2010).

The literature on university-industry in Africa is scarce. As argued by Morakinyo (2009), for the African productive sector would be more profitable and efficient in the long-term collaboration with local universities, as they are the place for the training of human resources and the generation of the knowledge required. But these are neither equipped to conduct cutting edge research nor to form the type of human resources that are needed for thse specific conditions. In the same vein, several authors note that the relationship between universities and the productive sector can generate economic and social benefits

that contribute to development in African countries, enhance linkages to clusters and provide a platform for firms' formation. These interactions can also provide tools for firms to optimize the production processes through consulting and training activities, and also universities can benefit with the ability to access external funds to finance its research, providing them with a better scientific and technological infrastructure. All this would contribute to strengthening the NIS and the development process (Etzkowitz and Dzisah, 2007, Kruss, et al., 2009, Vera Cruz, Dutrénit and Torres, 2008, Petersen and Rumbelow, 2008). Despite these potential advantages, knowledge of Linking is still limited.

Evidence from some African countries shows that the tendency to link depends on specific economic motivations of the agents: universities seek external funding to conduct research and improve its infrastructure by building more and better laboratories, researchers seeking to supplement their income, and companies seek more efficient production, reduce costs, and in some cases increase their innovation activities. (Kruss et al 2009, Etzkowitz and Dzisah, 2007).

Other authors argue that emerging university-industry interactions are much more associated with human resources formation and traditional sectors than with other channels more knowledge intensive. (Lorentzen, 2009; Lall and Pietrobelli, 2002; Muchie, Gammeltoft and Lundvall, 2003) According to Kruss, et al. (2009), these specificities, researchers have privileged more a case study approach than surveys, which makes it difficult comparison across regions.

In line with the literature, and based on empirical evidence of Nigeria, Morakinyo (2009) argues that collaboration between universities and industrial firms can be successful as the industry can provide a practical learning environment where students gain experience before leaving school, and also the industry can fund academic staff and students to carry out research tailored to the specific needs of companies. However, for the university-industry relationship to be effective and successful is very important that this relationship takes into account three elements: (i) the mission of each institution should be respected in the collaboration, (ii) both agents must seek to establish long-term partnerships, that is, the institutionalization of university-industry relationship, and (iii) finally, both agents must be focused on achieving the goals of each party, ensuring the timely the commercialization of the results. But the author recognizes some constraints in the case of Nigeria, the existent SMEs cannot build or finance their R&D activities, as multinational corporations does, so these are more likely to have links with universities and higher education institutions. Another limitation for the university-industry interaction is the lack of information about the capabilities and expertise available in universities, therefore, for universities to strengthen collaboration it is necessary that universities collect and diffuse information of their academic strength.

Using a triple helix approach the Nigerian government has established quite successful schemes of indirect collaboration between universities and technology based firms through public centres of technology incubation. As part of the business support, these centers fund universities to conduct research projects in products and processes development for the firms incubated. So the universities receive funds for R & D by the incubation centers and deliver the results to those companies (Morakinyo, 2009).

Another study of the Nigerian case revealed that informal information exchange and open science (publications and assistance to meetings) are the most important channels of interaction between universities and the productive sector. Concerning to the constraints to interactions, the limited R&D capabilities and firms' perception that the quality of knowledge from the universities is low are the most important constraints to interact of the Nigerian firms. The country also reports failures in the science and technology policy to foster private R&D investment. (Adeoti, Odekunle and Adeyinka, 2010; Kruss et al, 2009)

As argued by Ssebuwufu, Ludwick and Béland (2009), there is little evidence on linking processes in the small African countries in the Take-off stage, where innovation first appears in the field of policy makers. For example, many countries in this stage of development in Africa lack of an enabling environment for the reorientation and alignment of the universities to link with companies with a more entrepreneurial approach. Apart from South Africa, most sub-Saharan Africa lacks high-tech industries and a true culture of investment in technology, which normally arises from the constant pressure to upgrade and expand the use of more efficient technologies in order to survive in a competitive market. They also highlight that there are limiting factors for the development of strong programs of university-industry linkage, given the type of companies. They mention that there are other limiting factors such as lack of highly qualified human resources (specific areas), the existence of a weak research infrastructure, little research funding, and even the influence of donors on the priorities of research. In such a situation, there are difficulties for the articulation between supply and demand of knowledge. (Ssebuwufu, Ludwick and Béland, 2009)

There is even less evidence on the linkage in small island countries in the take-off stage, where the universities are emerging, companies are in an infant stage that does not require knowledge, while innovation appeared in the field of policy makers recently, society has not yet internalized.

Overall, the literature on university-Industry interactions in African countries the linkages are characterized by:
- Very limited collaboration through R&D activities
- The linkages tend to be simple short-term linkages of collaboration, with low technological content
- Many informal linkages between a small segment of the population
- A small segment of the population, who is well trained, occupies positions in the academia, government and productive sector, and they circulate within these three sectors

There is a set of questions relevant to these countries: How important is the issue of links between universities and the productive sector in these contexts? What role can these links play to consolidate the take off? What is the knowledge content of the existing links? What are the relevant channels of interaction, and how they can evolve in complexity and knowledge content? This paper is inserted into the debate on this latter question.

3. Research methods

This research is based on a phenomenological (interpretive) methodology, employing qualitative data. The research method is case studies. The case is the channels of interactions between universities and the productive sector, mostly firms. The unit of analysis was defined as the interactions. Three sources of evidence were used: (1) interviews with managers, owners and personnel of the firms, policy makers and researchers, (2) casual meetings and informal conversations and (3) printed materials internal and external to the firms. Interviews were the main source of information, 20 interviews were carried out (see table 1). The main topics of the interviews were: the channels used for interaction, the reasons for establish interactions and benefits obtained through them.

Table 1. List of interviewees

Organization	Position
UNI-CV (University of Cabo Verde)	Rector
UNI-CV	4 Researchers
ENG (Business school) of the UNI-CV	Director
DCT (Science and Technology Department) of the UNI-CV	Director
Consultant	Ex-Minister of education
Ministry of Economics	Vice-Minister of Economics
Ministry of Economics	Director General of Industry and Energy
Ministry of Economics	ADEI (Agency for Enterprise Development and Innovation)
NOSI (Operational Unit for the Information Society)	President
Tecnicil & Promitur, firms	Executive Manager
Shell, firm	Manager
Compta, firm	Manager
Compta, firm	Commercial Director
ADA, firm	Director
Prime, firm	Director
ISCEE (Higher Institute of Economics and Business)	Studies Coordinator
University Jean Piaget of Cabo Verde	Rector

4. The case: channels of university-productive sector interactions

4.1 The main features of the national innovation system

Cabo Verde is a very small country integrated by 10 islands, covering a total of 4,030 km^2. It was a Portuguese colony until 1975, when it obtained its independence. 55.9% of a total of 567,000 inhabitants live in urban spaces.

Until its independence in 1975, Cabo Verde was essentially an agricultural country, based on subsistence production. The industrial activities were basically the extraction of salt, the production of "grogue" -a distilled drink made from sugar cane, like rum-, the desalinization of water, the cooling industry for fish conservation, a firm of canned fish that was created in 1930, and a few other facilities. Commerce was the most important activity, and it was based mostly on import products. The country independence brought new activities, and a strong concern for the development of the industrial sector.

During the first years of independence, the nationalist government built up a planned economy supported on a strong intervention of the State on the economy, which was funded by external aid. Several public firms were created in the key sectors. A strong effort was made to create the most basic institutions and the infrastructure of a modern country. In 1990, the nationalist party lost power and the new government implemented a liberal model. Economic reforms were introduced, which meant a change in the development model led by the State until then. Three characteristics of the new development model were: (i) a tight control over the public expenditure to ensure a limited budget deficit; (ii) an economic management approach with a market orientation instead of a central planning approach, along with trade liberalization; (iii) a reduction of the participation of the State in the direct economic operations and privatization of public assets.

The privatization of public assets, such as those in energy generation and telecom services, brought different kinds of problems, such as high prices and irregularities in the provision of services. It is not clear to what extent these problems are associated with the privatization of public assets or the way this process was carried out in the country, but the result was that the population and the firms' performance were affected. Since economic reforms were introduced, the private sector has been considered the engine for national development. However, the State couldn't avoid its participation in direct economic operations. For instance, in 1993 it created the interinstitutional commission for innovation and the information society (CIISI), whose mission was to implement the electronic government and the information society. CIISI promotes the use and development of the Information and Telecommunication Technologies (ICT) in Cabo Verde. In the case of the fishing sector, the State possesses and has increased its participation in the fishing infrastructure (modern fishing boats, a pier with a cooling system, and freezing facilities).

At present, Cabo Verde is implementing a development strategy based on growth, reduction of poverty and good governance. The private sector is still seen as the engine for economic development in the government's plans and programs. However, this is a weak sector and Cabo Verde is still lacking an incentives structure for facilitating the growth and strengthening of the private sector, which would enable it to play the role assigned by national plans.

The country is characterized by a small industrial sector; the industry and energy sectors together only contribute with 7.7% of the GDP. In contrast, commerce (wholesale and retail trade), transport and communications sectors contribute with almost 20% each. Agriculture is also a small sector, explaining only 8.0% of the GDP, showing a decreasing participation in the economy while construction and other services have gained importance.

Table 2 describes the profile of Cabo Verde in terms of its resources, industrial organization, institutional set-up and incentives structure for learning and technological capability building. There is a limited endowment of natural resource and a very small local market. Micro and small sized firms, some of them with State participation, characterize the industrial organization. The private sector is reduced in size and, in spite of the economic reforms of the 1990s; the State continues to play an important role in economic development.

Table 2 Cabo Verde profile in terms of resources, industrial organization, institutional set-up and incentives structure for learning

Topic	Characteristics
Physical resources	• Limited endowment of natural resources. A poor and expensive transport infrastructure (cooling tracks, fishing boats with cooling systems, etc.)
Human resources	• Well-trained human resources, as compared with SSA, and a young population (e.g. high rates of Scholl enrolment at secondary and tertiary levels as compared to SSA. • Even though Cabo Verde has a number of technically well-trained human resources, they do not have skills for creating and consolidating the new institutions that Cabo Verde needs for the development process.
Market size	• A reduced local market. It is one of the smallest countries of SSA, with about 0.06% of the total population of this region.
Industrial sector and entrepreneurship	• There are only 1888 industrial firms, most of them micro and small firms, having 20 employees in average. • The entrepreneurial culture is more oriented towards commerce than to industry, which limits the long-term investments, the assumption of risk, etc.
Technology and higher education institutions	• There are two research institutes: the Instituto Nacional para o Desenvolvimento Das Pescas (INDP), and the Instituto Nacional da Investigacao e Desenvolvimento da Agriculture (INIDA). • The national university (Universidade de Cabo Verde) is still in the early days, it was founded in 2006; there is another public, the Universidade de Santiago; there are several private schools of higher education: the Universidad Jean Piaget de Cabo Verde (a campus of the Portuguese Instituto Jean Piaget), the Instituto Superior de Ciências Económicas e Empresariais (ISCEE), and the Instituto the Ensino Superior Isidoro Da Graça, Universidade Intercontinental de Cabo Verde, Escola de Negocios y Tecnologias de Cabo Verde, Instituto Superior de Ciencias Juridicas e Sociais and Universidade Lusófona de Cabo Verde. • A poorly developed surrounding industrial and technological infrastructure, lacking suppliers in engineering and technological services. In general, there is a big dislocation from the sources of technology supply.
Institutional setting and incentives structure	• It is in an early stage of the institutional building. With the independence process, many of the old institutions were disarticulated and new institutions were created. • A limited incentives structure to strengthen the private sector: (i) Incentives for the generation of employment for young people, (ii) Incentives for telecommunications and Internet, and pharmaceutical firms, (iii) Fiscal incentives for new firms. No incentives are been designed for export or productivity gains. • Tight dependence on the international aid under project finance, which contributed to the macroeconomic stability and to develop

	the infrastructure, but limited the national capacity to design a development strategy.

Source: Own elaboration based on information from interviews with Cabo Verde policy makers and researchers, and various printed materials from diverse sources such as EFA, IMF, World Bank and UNESCO.

Concerning to the education and research system, it is worth to briefly describe some of the main institutions. The UNI-CV is a young national university that is promoting the integration of the existent research and teaching institutes. In this line, UNI-CV integrated the Instituto Superior de Engenharia e Ciências do Mar (ISECMAR), the Instituto Nacional de Administração e Gestão (INAG), and the Instituto Superior de Educaçao (ISE).

The ISECMAR was created in 1996, after the reorganization of the Centro de Formação Náutica. It is a polytechnic institute that initially offered careers in the areas of Engineering and Ocean Sciences. Later on, it diversified its offer, including Informatics and Automation Engineering, Electric and Electronic Engineering, and Telecommunications Engineering. It was integrated to the UNI-CV in 2006.

The Universidade Jean Piaget de Cabo Verde Instituto Piaget is a Portuguese higher education institute. It has 3 campuses in Africa: Angola, Mozambique and Cabo Verde. The Universidade Jean Piaget de Cabo Verde was created in 2001. Two careers related to software are offered: Engineering Systems and Informatics, and Communication Sciences, both at technical and university degree levels. At the end of their studies, the students carry out a practice at NOSI and firms of the sector

Cabo Verde is at an early stage of the institutional building, with a limited incentives structure to foster private investment. Firms also confront a poorly developed industrial and technological infrastructure, as highlighted by Muchie, Gammeltoft and Lundvall (2003) and Oyelaran-Oyeyinka (2006) for other African countries. Although it has got higher rates of school enrolment than those of the SSA and a number of technically well-trained human resources, the amount of people with skills and abilities required to foster the development process is still scarce.

4.2 Links experiences

There is a set of characteristics of society and market in Cabo Verde that particularly affect the university-productive sector: Small country, Small market, Rotating people between public and private sector, and The existence of a dense network of informal relationships. These characteristics suggest it is more appropriate to speak of the ties between the university and the productive sector rather than with industry. There are private and public companies, and small farmers who have links with universities.

The interviews identified a set of interaction channels that are operating widely with different public and private universities:
- Internships of students in firms and the public sector
- Students write final course papers based on practical cases of firms, the results are made available to companies as an independent thinking about the reality

- Entrepreneurs or officials teach some courses at the universities (UNI-CV, Jean Piaget, ISCCE, etc.)
- Academies in specific sectors (e.g. Software with Microsoft). For instance, Academy already was negotiated with Microsoft and there is an offer of PRIME (Cabo Verdean small business) to establish another smaller
- Joint projects with NGOs to develop activities focused on solving problems of inclusiveness

These mechanisms are simple forms of interactions, which are mostly related to human resources formation. They neither require a high degree of maturity of the research capabilities nor demand an inclination towards R&D by the firms. They cover a broader set of agents and tend to be based on informal links between students, researchers/teachers and entrepreneurs. In some cases they have moved towards the formalization of the links to ensure the quality of the process (internships of students in firms).

5. Proposal for strengthening the linkages based on the existing capabilities

The literature has documented the importance of linking mechanisms differ according to the degree of development of the country, the maturity of the scientific and technological capabilities of academia and the level of technological capabilities of the productive sector. The evidence in the case of Cabo Verde suggests that could identify three stages of implementing a program of university-productive sector in the university:

Stage 1. Immediate implementation.
Includes mechanisms related to the basic training of human resources, requiring low levels of maturity of the scientific and technological capabilities from the university and technological capabilities of firms.

Stage 2. Implementation with a horizon of 2-3 years.
Includes mechanisms associated with interaction for research and knowledge flows in one direction (the company sought and the University respond, or departing from identifying certain demands for itself the university offers, without previous interaction with firms) this require higher levels of scientific and technological capabilities of the university and innovation capabilities of the enterprises and the construction of a degree of trust in the relationships.

Step 3. Implementation at 5-10 years, depending on the progress seen in the agents.
Includes mechanisms related to collaboration between companies and universities for R & D, and two-ways knowledge flows between universities and firms; require high levels of skills both at the university and in the firms and mutual trust in the relations.

Learning in Stage 1 allows to move towards more advanced stages (Stage 2 and then to Stage 3). However, through partnerships, that allow strengthen scientific and technological capabilities of the UNI-CV, would be possible to move in a faster implementation of some mechanisms, a mechanism that is included in Stage 3 could be implemented from the Stage

2. For example, the planned creation of the Software Technology Center (including a certification and a practical training centre for students, a center for electronic governance and incubators) in partnership with NOSI allows to advance towards interaction mechanism that would be typical of the step 2.

This gradual implementation of linkages programs at the university have policy implications, for it marks which should be the focus of policy programs aimed at strengthening university-productive sector linkages, according to the maturity of the scientific and technological capabilities of the academia and the level of technological capabilities in the productive sector.

Table 3 lists the linkages mechanisms according to the 3 stages, says the cost of implementation for the university and if additional resources are generated and the locus of responsibility.

6. Conclusions

Even though the link between the university and the productive sector can play a major role in contributing to the development process of African countries, it is necessary to consider the most suitable channels of interaction taking into account initial conditions in these countries. This paper argues that the channels of interactions are highly dependent of the structural conditions of the countries, the level of development and the capabilities of the agents.

This paper has analyzed the university-productive sector links in the case of Cabo Verde, a small African island country. The evidence suggests that links are more related to human resources formation and informal flows of information and knowledge than to R&D collaboration.

The literature based on evidence from advanced economies has recognized the importance of human resources related links (Cohen, Nelson and Walsh, 2002; Mowery and Sampat, 2005; Narin, Hamilton and Olivastro, 1997), however, it has largely focused on those channels related to the generation and commercialization of knowledge (collaborative and contract research, patenting and licensing). Evidence coming from developing countries has also pointed to the importance of knowledge flows related to human resources formation (Dutrénit and Arza, 2010; Kruss et al, 2009). The evidence from Cabo Verde shows that those links related to human resources formation are the most important and have a potential to more forward towards more complex and knowledge intensive channels of interactions. The present links are highly connected to the level of capabilities of both universities and firms/other productive organizations.

In line with the findings of several authors from other regions (Vedovello, 1998; Fritsch and Schwirten, 1999; Schartinger et al., 2002; D'Este and Patel, 2007; Perkmann and Walsh, 2009; Eun, 2009; Dutrénit and Arza, 2010), the evidence suggests that at this level of capability building and development, informal channels matter more than formal channels.

This paper also elaborates on the policy implications. First of all, this papers proposes a strategy for the university based on a sequential path of evolution of the channels from the existing interaction based on the formation of human resources to other more knowledge based. The evidence suggests that it is necessary to think in a gradual evolution of the nature of the channels and avoid coping international instruments based on the experience of countries with opposite initial conditions. This paper proposes three stages:

- Stage 1. Immediate implementation,
- Stage 2. Implementation with a horizon of 2-3 years, and
- Step 3. Implementation at 5-10 years, depending on the progress seen in the agents.

This proposal has policy implications, as it highlights which should be the focus of policy programs aimed at strengthening university-productive sector links, according to the maturity of scientific and technological capabilities of academia and the level of technological capabilities of the productive sector.

The proposed strategy for strengthening university-productive sector in Cabo Verde is rooted in the specific conditions of a small island country, where the frequent circulation of highly trained people between government, university and the productive sector generate strong informal links. This may constitute an important intangible to erect a strategy of interactions between these three agents to support a new role of the university for the development process. The design of such strategy requires specific research.

Table 3. Stages and forms of university-productive sector links
(Note: L=Low, M=Medium, H=High)

Forms of linkages	Implementation stages	Cost for UNI-CV	Resources creation	Locus of the responsibility
Interaction with graduates of UNI-CV to: Promote the formation of an association of graduates, Organize together an annual dinner, Organize an annual meeting with presentation of work experiences for students, or Organize talks of graduates for students from different carriers	1	L		Rectory: create a database of graduates
Public lectures on topics of interest for different sectors taught by recent postgraduates	1	L		Each department organizes
Practical training for students	1	L		Rectory: engage the larger firms to receive internships and give them coaching, Each department manages
Encourage undergraduate and postgraduate students in certain disciplines such as management, computing and engineering, etc. to undertake work aimed at solving practical problems and current, of a firm or of public sector dependence	1	L		Each department organizes
Training through short courses	1	L		Each department organizes
Participation of entrepreneurs and managers in training at the UNI-CV (formal or short courses based largely on experiences of firms), and in the design and upgrade of undergraduate curricula and short courses. Invite entrepreneurs from the diaspora to give speeches	1	L		Each department organizes
Certification of consultants aiming to work at the development of business skills	1	L	YES	Business School
Create a Vice Chancellor Advisory Board, composed of senior business executives, chambers of industry and commerce, public sector officials, researcher / entrepreneur of the diaspora, some researchers at the UNI-CV	1	L		Rectory: more strategic approach
Create and Advisory Council of departments, faculties and schools, composed of senior business executives, chambers of commerce, senior and intermediate public sector officials, and researchers.	1	L		Departments, faculties and schools: more operational approach
Program of "academies" jointly organized with firms, software certifications and joint organization of annual training with business associations / chambers etc. (eg software tools for managers of ICT)	1	M	YES	Departments and schools: organize
Business week: presentations of business experience, research work by teachers	1	M		Business School

Forms of linkages	Implementation stages	Cost for UNI-CV	Resources creation	Locus of the responsibility
and students, incorporating speakers from the diaspora. These can be focused on one area at a time, or organized in sections and cover different sectors				
Workshops of demand identification for defining areas of research. They may have a multidisciplinary approach and can be organized by sector. Participation of academicians, entrepreneurs and graduates from UNI-CV.	1	M		Business School
Partnership Program oriented to fundraising, which enable the university to develop the following activities: seminars, conferences, lectures, exhibitions, forums, conventions, academic research, publications, awards and related activities. Option of having: Chairs sponsored by companies and Donations.	2	L	YES	Business School
Participation in networks of firms (associations, business chambers, etc.)	2	L		
Short stays of researchers in firms	2	L		Each department organizes
Technological services	2	L	YES	Each department organizes, Requirement: laboratories
Workshops and Clinics with the involvement of entrepreneurs, technicians and academicians, both local and from the Diaspora	2	M		
Research contract to solve punctual problems of firms	2	M	YES	Each department organizes, Requirement: workshops of demand identification
Consultancy by individual researchers	2	M	YES	Rectory: create and disseminate a database on the researchers specialization
Firms' incubators. A different degree of development of the incubation process can be envisaged, from pilot tests to internships to the creation of firms.	2	M	YES	Business School and other departments
Technological centre focused either on a specific technology or a set of technologies for one sector	2	M	YES	Several departments
Joint R&D projects to develop new areas	3	M	YES	Each department organizes
Technology licensing	3	M	YES	
Scientific and Technological Parks, and spin off created by the university	3	H	YES	Business School

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