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Universities and Innovation in a Factor-Driven Economy: The Performance of Universities in Egypt.

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20 October 2015

Dear Dr El Hadidi

Re: 'Universities and innovation in a factor-driven economy: the performance of universities in Egypt' by Hala El Hadidi and David A. Kirby

This is to confirm that the final version of the above paper has been fully accepted for publication in *Industry and Higher Education*.

The paper will be published in the an issue of the journal in the first half of 2016.

With thanks and best regards,

Yours sincerely,

John Edmondson
Director, IP Publishing Ltd
Editor, Industry and Higher Education

Universities and Innovation in a Factor-Driven Economy: The Performance of Universities in Egypt.

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Universities and Innovation in a Factor-Driven Economy: The Performance of Universities in Egypt.

Abstract

In the modern knowledge-based global economy, universities are being required to operate more entrepreneurially, commercialising the results of their research and spinning out new knowledge-based enterprises. In this article, the third in the series (El Hadidi and Kirby, 2015a and b), case studies are presented of activities in 3 Egyptian universities in order to demonstrate what is being done and the challenges Egyptian universities are facing when attempting to collaborate with industry and contribute to the innovation process. The results reveal that the initiatives are often the result of external influences and are not embedded within the core strategic planning activity of the institutions in which they are located. Accordingly they often have difficulty surviving after the initial project funding is ended, not least as the important partnership links with industry remain largely underdeveloped. The article considers the implications of the findings for policy formulation and argues for a coherent strategy that embeds the “third mission” within the core activities of each institution and facilitates university-industry collaboration.

Introduction

Universities and research institutions play a key role in the modern knowledge economy. In addition to educating students and performing research, universities have become more and more engaged with their region and business, in what has become known as the “Third Mission”. As a consequence new concepts have emerged, including those of the Triple Helix and The Entrepreneurial University, while the universities themselves have become key players in the innovation process through the incubation of new technology-based firms stemming from the commercialisation of the intellectual property generated from research. Thus the role of the modern university has changed, but quite frequently the transition from a traditional university to a more engaged and entrepreneurial one is not easy. Hence the aim of this research is to examine how Egypt’s universities are responding to the challenges.

Literature Review

Higher education is facing unprecedented challenges in the definition of its purpose, role, organization and scope in society and the economy. The information and communication technology revolution, the emergence of the knowledge economy, the political and economic turbulence and the financial crisis and its impact on university funding have all thrown new light and new demands on higher education systems across the world. One significant global response is seen in the development, in concept and practice, of the “Entrepreneurial University”. While there is no standard, accepted definition of this phenomenon, (Kirby, et. al., 2011), it is recognised that the entrepreneurial university is epitomised by its innovative research, knowledge exchange, teaching and learning, governance and external relations (Goddard, 2004; Cooke, 2001). It is also recognised as being a subset of what Etzkowitz and Leydesdorff (2000) have called the “Triple Helix University” - a symbol for university, industry and government interacting closely, while each maintains its independent identity. The Triple Helix comprises universities, firms and

governments with each assuming some of the capabilities of the other, while simultaneously maintaining their primary roles and distinct identities.

Each sphere thus gains increased ability to interact, collaborate and support innovation that arises in other spirals. Scientific knowledge becomes ever more central to innovation and the concept of innovation is broadened from the business application of new technology to enhancement of the social arrangements that enhance innovation. The university begins to play a new more direct role in the capitalisation of knowledge by organising technology transfer to existing firms and by starting new firms in addition to its traditional supporting role of transferring knowledge (Godin, 2006; Jacob, 2003).

This development of the Triple Helix and Entrepreneurial University has taken place at different rates and with different emphases in different regions. Very significant differences are found between countries, being well-developed in, for example, the United States, Switzerland, Japan, Canada, and some of the medium-sized countries in North-Western Europe and less well developed in the European-Mediterranean countries, Australia, and some Pacific-Asian countries. All of the former are advanced industrialised nations that have developed knowledge-based economies with R&D-intensive industries and large science-dependent enterprises. It is these countries that might be expected to possess the most entrepreneurial universities as they enjoy competitive advantages in terms of longstanding and close ties between the academic world and industrial research (Shinn, 1998). These have helped shape the domestic science bases that consist of high-quality research-intensive universities pursuing research programmes geared towards the immediate needs or longer-term requirements of (local) industrial R&D. As Etzkowitz (2010) has observed, such cutting-edge scientific and engineering research in these countries is likely to produce the outputs that lead to the commercial exploitation of research-based knowledge assets.

However, even in these advanced industrial economies, there are barriers to innovation and entrepreneurship development in universities and their changing roles and functions. First, as Kirby (2004) has pointed out, universities are not the most entrepreneurial of institutions, in part because of the very nature of large organisations - they are impersonal, hierarchical (requiring many levels of approval), have a need for control and adhere to rules and procedures, coupled with a lack of entrepreneurial experience and talent. All of these work against innovation and change in general and commercialisation in particular. Second, the academic staff often believe that being entrepreneurial “will drive out their other more fundamental university qualities, such as intellectual integrity, critical inquiry and commitment to learning and understanding”(Williams, 2002, p.19). Also, many university manager express concern about the potential negative impact on their institution’s research performance if their leading academics become involved in entrepreneurial activity. Thus, although some of the leading research universities are among the most successful entrepreneurially, in terms of spin-outs (Etzkowitz, 2003), for many in higher education the concept provokes “an image of shady villainy, a fifth column gnawing away at the basic values that define a university, a wolf masquerading as a milch-cow”(McNay, 2002, p.20).

While it is possible to agree with Birley (2002, p.134) that such issues do seem to be “more complicated and difficult to solve in a university than anywhere else”, as Laukkanen (2003, p 380) has recognised,

“faculty do not necessarily categorically oppose corporate cooperation or academic entrepreneurship per se, as is sometimes assumed” and “academics should never be under-estimated”(Birley, 2002, p. 152). Indeed, research at the University of Surrey (Hay, et al, 2002) suggests that academics are perhaps more similar to entrepreneurs than might first be expected. Where they differ most is in their propensity to take risks, suggesting the need to create a secure environment in which risk is perceived to be minimised (Kirby,2004).

Even so, these barriers can be overcome. In the UK, for example, pressure from the Thatcher government during the 1980s encouraged greater enterprise in universities through fiscal incentives and new policies on intellectual property that mirrored similar shifts in the USA. In both the UK and US, however, the relative independence of the university sector from the state meant that the capacity for flexible response to the new circumstances was high (Shane, 2004). Meanwhile in Italy attempts to overcome the conservatism of the classical teaching universities seems to have been assisted by the severe cutbacks in public spending and the introduction of new laws allowing universities the right to retain private funding. Hence, the financial crisis of the public sector has left the country’s universities with a new autonomy but without providing the managerial knowledge necessary to organise a for-profit range of activities (Shane, 2004). Elsewhere in Europe a gradual shift is also emerging, resulting from an increasing autonomy of the university from the state on the one hand and closer engagement with industry on the other. The transition to an entrepreneurial university is further encouraged by European Union funding programmes that provide resources to create intermediary mechanisms, such as Technology Transfer and Industrial Liaison offices (see below and note 4). Meanwhile in Latin America, programmes have been introduced which subsidise the region’s universities to take up the task of enhancing industrial technology (Shane 2004). Should these trends continue, Shane (2004) suggests, European and Latin American universities will find a new balance in their relationship with government and industry, moving apart from the former and closer to the latter.

Thus, the literature suggests that while there is a trend towards universities becoming more prominent in the innovation process, even in the advanced industrial economies there are obstacles to this development and it is not a uniform phenomenon. These barriers can be overcome in time but frequently government intervention is required in order to expedite the process which, somewhat paradoxically it would seem, benefits from universities being autonomous and free from state control. As Clark (1998, xiv) has argued, Universities need to move away from close government regulation and sector standardisation and search for their own special organisational identities, by risking being different and taking chances “in the market” - they need to believe “that the risks of experimental change...should be chosen over the risks of simply maintaining traditional forms and practices”.

The Egyptian context.

As a “Factor-driven” economy, Egypt has a low level of economic development, competes on the basis of factor endowments (primarily unskilled labour and natural resources) and is characterised by low wages and low productivity. Its economic competitiveness appears to be deteriorating and the Global

Competitiveness Report, 2010, attributes this to the decline in its capacity for innovation which, in turn, stems from the weakness of the education system in general and Higher Education in particular.

Despite having a variety of measures and instruments to support innovation (STDF, 2012) and some 43 universities with over 2 million students, the country's overall rank in terms of innovation is gradually deteriorating. According to the 2014 Global Innovation Index (Cornell University, et.al. 2014), Egypt lies 99th out of 143 countries compared with 83rd out of 139 in 2010/11. As the report recognises “successful innovation rests on a foundation of education and skills” (op. cit p. 77). However, the country is characterised by a weak university sector that is highly centralised and governed by the Ministry of Higher Education and the Egyptian Supreme Council for Higher Education, with the result that institutions have little autonomy or independence. Additionally, public spending on Higher Education has declined in recent years (Reda, 2012) and although transformations have taken place in the purpose and scope of Egyptian Universities, the country's rank in terms of the quality of higher education and training has been deteriorating, from 80 out of 114 countries in 2005/2006 to 128 out of 139 in 2010/2012 (op. cit). Similarly the Global Entrepreneurship Monitor (GEM) study for Egypt (Hattab, 2012) places the country last of the 53 GEM countries studied with respect to the contribution of education to the promotion of enterprise. Recently, however, it has been recognised that Higher Education is a means to foster economic growth and, therefore, one of the country's top priorities. Earlier research by El Hadidi and Kirby (2015a) reveals, though, that Egypt's universities are neither producing creative graduates who can innovate nor transferring and commercialising knowledge, while few universities have strong links with industry.

Aims and Methodology

Against this academic and contextual background, the aim of this research is to identify why Egyptian universities are not adapting to become more entrepreneurial and to contribute to the competitiveness of the country. The study also focuses on the challenges they face when attempting to do so, and to transform their role to that of a modern triple helix institution.

Given the developments that have occurred in Egypt since 2011, it is even more important than previously that the country relies on its own indigenous development to compete in a rapidly changing global knowledge economy. The country, as other factor-driven economies, will need to create businesses that innovate and can compete internationally, not just within the local market. Hence the research is both timely and relevant. Apart from contributing to the body of understanding in what is a newly emerging field, the study has, therefore, practical relevance and the potential to aid policy formulation in both Egypt and elsewhere.

To achieve its objective, the research project, of which this study is a part, adopts a 3 phase strategy, whereby each phase contributes to greater understanding (Kirby, 2007). Phase one (El Hadidi and Kirby, 2015a) was a qualitative analysis of the views of a panel of experts. It was based on in depth interviews and, together with the literature, it provides the basis for Phase II (El Hadidy and Kirby, 2015b), a contextual investigation based on a self-administered questionnaire survey of 560 Science, Engineering

Technology (SET) academics in 8 private and public universities in Egypt. This in turn provided the context for Phase 3, the focus of this article. It is based on a set of in-depth interviews that form the basis for three different case studies selected purposively from the Phase II survey to illustrate the issues involved.

Findings

The results of phase one of the study (El Hadidi and Kirby, 2015a, p.156) concluded that “Egyptian universities do already contribute, but that they generally lag behind those of other competitor countries”. Phase two (El Hadidi and Kirby, 2015b) concluded that this was not because of opposition amongst Egyptian academics to the concept of universities contributing to the innovation process, rather an apparent lack of understanding of, or commitment to, it. However, one respondent did suggest that *“The main goal of industry is profit, and I believe industry does not prefer to invest in a university research project that will take years to yield results”*, recognising both the different timescales of the two institutions and the different motivations. Hence, there was recognition of the need for intervention on the part of Government, thus confirming developments that have occurred elsewhere. As one respondent put it, *“we need to have a national goal which is innovation to be a way of life”*, while another suggested that *“the main reason universities are not engaged strongly in R & D is the lack of regulations that organise such relationships...”* Interestingly, though, it was not felt that there needs to be “a coherent policy towards increasing the capacity for innovation and university-industry research” nor any lessening of the control of Government, especially in the state sector, as has occurred elsewhere. Rather, there appears to be a strong need for raising the awareness of the academic community of the role of the modern entrepreneurial university. According to one respondent *“There are mechanisms to support university-industry collaboration, but they are either not effective or not applied”*. Sometimes, however, it would seem that Egyptian industry does need to recognise and appreciate the benefits of collaboration with universities and *“encourage research by allowing researchers access to data, not hiding it or dealing in a bad way”*. Thus, it was concluded that there is a need for awareness raising and capacity building in both academia and industry, as well as rewarding those academics who do innovate and collaborate with industry, thereby recognising them as important role models. Indeed, it was suggested by one respondent that the *“staff with industrial research achievements should be recognised and appointed to leadership positions”*.

As the following case studies illustrate several Egyptian universities are attempting to participate in the innovation process and collaborate with industry in accordance with the Triple Helix model. Accordingly the cases demonstrate what is being achieved, and the challenges such institutions face when attempting to bring about change and make a significant contribution

Case 1. Cairo University ⁽¹⁾ Innovation Support Office.

Founded in 2009 by Professor Dr Galal Hassan Galal-Edeen, a Computer Scientist with a Ph.D from Brunel University in the UK, the Cairo University Innovation Support and Patent Registration Facilitation Office (CUISO) is the outcome of two European Tempus projects ⁽²⁾. It was intended as the first “port of call” for academic innovators in Cairo University who wish to commercialise their

innovative ideas and for members of Egyptian industry who wish to collaborate with the University research staff and students. A year later, in 2010, a Technology Transfer Office was opened in Cairo University, also with funding from the European Union Tempus programme and with similar objectives (see case 3 below).

The mission of CUIISO is:-

“... to give the best possible institutional support to innovators based in, or collaborating with, Cairo University, and to the transfer of university-generated research and technology to the wider community”. (Galal-Edeen, 2012)

According to its Director, Professor Galal, it has five strategic aims, namely to:-

- create an effective contact point between university and industry
- initiate and systematise innovation licensing and exploitation
- spread awareness among the University’s academics about innovation, collaboration with industry and technology transfer
- support Cairo University faculties and research centres in adopting effective measures to liaise and collaborate with industry
- establish and publicise the relative importance of the various technology transfer options available to university researchers.

To achieve its mission and aims, the Centre has introduced, or supported, a variety of initiatives targeted at the academic staff, students and industry. These include:-

- Staff
 - o Creativity and Innovation training
 - o Awareness and dissemination events
 - o Cairo University Innovation Support Strategy
 - o University IP policy
- Students
 - o Awareness sessions
 - o Competitions
 - o Innovators Club (in the Faculty of Computers and Information)
- Industry
 - o Professional training and seminars
 - o Template representing successful university-industry collaboration.

Since its foundation, the Centre has been responsible for 5 disclosures and 2 patents while it has also brought 3 projects to market and there is now, in the University, a better understanding of the value of problem-oriented research. From an industry perspective, there has developed greater awareness of the

value of open innovation and the benefits of in-depth analysis of both the problem and the market. Meanwhile, some of the University's students have developed improved research and problem solving skills leading to innovation and commercial exploitation, as well as greater enthusiasm to innovate and become entrepreneurs.

However, ever since its foundation, the Centre has faced challenges, mainly in the form of funding and space. When the shared Tempus and University funding expired in 2011, there were no mechanisms within the University that enabled the Centre to charge for its services, while the lack of suitable space meant that the Centre's equipment resource, valued at approximately 50,000 Euro, could not be utilized. This is seen, by the Director, as a transition phase as the Centre has been designated, recently, as a Special Unit within the University, which should enable it to provide its planned income-generating consultancy and training activities. However, it will still need around 150 square metres of space, plus funding for administrative staff.

On the basis of his experience since 2009, Professor Galal believes there needs to be more long-term strategic co-ordination and planning at the institution level in higher education, plus a change in the mindset of senior managers, enabling them to recognise the importance of the role of universities in the innovation process. At the same time, he suggests, there needs to be a change in the Egyptian University law so that universities and academics can take ownership of university spinout companies based on the intellectual property stemming from their research. He also advocates the creation of a national entity, operating at a level higher than individual ministries, to coordinate various innovation and exploitation-related actions more effectively. He believes that the current activities are very weakly coordinated, leading to inefficiencies and wasted opportunities.

Case 2. Technology Innovation and Commercialisation Office (TICO) at Zagazig University⁽³⁾

In accordance with its mission to contribute to the technological and economic development of Egypt, Zagazig University opened its Technology Innovation and Commercialisation Office in July 2013, in response to a call for bids from the Academy of Scientific Research and Technology (ASRT). In total, 30 such offices were created around the country and Zagazig University received a grant of 600,000 EGP to establish the office over a period of two years. Apart from paying for the facilities, which are housed on the University's main campus, the grant is used, together with a further 300,00 EGP from the University, to employ a Director and 6 part-time staff, plus three administrators.

The vision of the Office is very much that of a Triple Helix institution whereby the University, Industry and Government work in partnership. Its aim was, and is, to

- Channel University outputs (from Science, Technology and Research) to industry
- Promote innovation both within and outside the University.

The TICO operating model sees the office as a bridge transferring expertise, problem solutions, student training, pilot projects, consultation and product invention and development to industry, while industry transfers experience, needs analysis, worker training, project application, joint supervision and product evaluation and implementation to academia.

To do this, the TICO has three departments, namely GICO (an office for Grants and International Collaboration), TTO (Technology Transfer Office) and TISC (Technology Innovation and Support Centre). Together these three departments

- Promote knowledge and awareness on patent processing
- Facilitate patent applications
- Create intellectual property agreements between the University and Industry
- Encourage connections between the University's research laboratories and industrial production units
- Enable technology transfer between the University and industry
- Map the University's competence in technological and scientific research
- Help transform innovative ideas into products
- Bring new ideas and products to market.

Since its formation, the Office has created 26 innovative student ventures (13 innovations for school pupils age 13-18 years and 13 innovations for university students) and 12 staff projects. The office has also raised awareness on the campus of the importance of innovation, so that academic colleagues, students and graduates now come to the TICO for help and promotion. Despite this, the TICO has faced numerous challenges, most notably

- Lack of confidence in the capabilities of the University and its ability to deliver solutions or products
- Conflicts of interest and potential disengagement
- Licensing complications
- Incompatibility between the needs of industry and research interests
- Lack of appropriate expertise
- Political and economic instability
- Lack of a spirit of innovation and entrepreneurship..

To overcome these challenges the Office has acted primarily as a broker/arbitrator between the University and industry and has run training programmes for the University's academics to help raise their awareness and equip them with the requisite skills.

According to the Director of TICO, Professor Mahmoud Sitohy, a Biochemistry specialist, Egyptian "economic development cannot happen without systematic innovative applied research that reaches the market". This is what the TICO is attempting to do and its future plans include:-

- Greater penetration of the industry market, particularly the pharmaceutical, food and handicrafts industry sectors.
- National and international inter-university cooperation
- Building a Science Park
- Offering student training programmes on innovation and entrepreneurship,
- Working with schools to encourage pupils (10-18 years olds) to produce innovations

In 2015 the ASRT funding will cease. An extension to the contract has been negotiated but the TICO is not yet sustainable. Therefore, further funding is required and the University will look to external funding sources, such as aid from the European Commission under Horizon 2020 and Erasmus + ⁽⁴⁾ as well as the Newton Mosharafa Fund ⁽⁵⁾. To date, it has not done so in part because it has not been fully aware of the support available and in part because of the time needed to apply.

The staff members of TICO recognise that they have learned a great deal over the first two years of operation but suggest that if universities are to play a significant role in the innovation and economic development process, Government Policy is required to encourage the country's universities to engage more and industry to cooperate more widely with universities. Among their various suggestions were that the law on staff spinout companies needs to change, the Supreme Council should require entrepreneurship and innovation modules to be introduced into all degree programmes, the criteria for staff promotion needs to be changed to include research application not just publication and firms should be required to work with the country's universities.

Case 3. American University in Cairo (AUC) Technology Transfer Office. ⁽⁶⁾

The idea to establish a Technology Transfer Office (TTO) at AUC was that of Professor Ehab Abdel Rahman, based on his experience at the University of Utah. It was one of four TTOs established in Egypt in 2010 as part of an Enterprise - University Partnership (EUPART) project funded under the European Union Tempus programme. AUC was the lead partner in the project, which included Cairo, Assiut and Helwan universities in Egypt and the Freie Universitat in Berlin, the Polytechnic University of Turin, Linkoping University in Sweden, and the Technical University of Vienna. Other partners included the European Patent Office, the Egyptian Patent Office, the Science and Technology Development Fund and 6th of October City Investors Association.

The mission of the TTO is *“to benefit the global public by creating opportunities for AUC’s innovators to maximize the impact of AUC innovative technologies, breakthrough and discoveries through licensing to companies or spinouts while generating revenue to support research and education”*. Its purpose is to serve the AUC community by helping those Faculty, staff or students who have creative and/or innovative ideas to initially protect, then commercialise, through licensing or the creation of spinning out companies.

To achieve its mission the TTO undertakes a number of activities including:-

- Managing the University's patent portfolio
- Developing the University's IP management policies, strategies and procedures
- Scouting University technologies to find high potential projects
- Evaluating patentable ideas and assessing their commercial value
- Providing advice and consultation
- Raising awareness of AUC innovative technologies
- Liaising with industry and fostering confidence and trust between them
- Licensing AUC Intellectual Property to companies or entrepreneurial teams
- Helping incubate technology and facilitate the growth, development and success of new technologies
- Promoting entrepreneurship

As a result of its activities, the TTO concluded its 1st deal in 2013, with what was Egypt's first University spinout company, D-Kimia, a start-up company that develops novel and affordable diagnostic solutions to detect a broad range of diseases, initially focusing on the identification of hepatitis C. Its co-founders are Professor Hassan Azzazy, Professor of Chemistry at AUC, and Karim Hussein, a serial entrepreneur. Under the agreement between the AUC and D-Kimia, the company has the exclusive licence for 4 patent pending technologies developed at the AUC Novel Diagnostics and Therapeutics Laboratory and, through a separate agreement, can access laboratories and equipment in the University's School of Sciences and Engineering.

Since this early activity, the TTO, which employs 4 staff including a Director, an administrator and two licensing officers, has filed 78 patents in 32 patent families. Its activities, now that the Tempus funding has ceased, have been funded by the University, though, in 2013, it was one of the 30 universities and research centres that successfully bid for TICO funding. Apart from funding, the lack of industry interest/ support is seen as a challenge, as is the relatively low level of funded, cutting-edge research, together with the university, labour, commercial and intellectual property regulatory framework in Egypt. While the AUC is not directly subject to the Egyptian Supreme Council, it is sensitive to the country's regulations with respect to those hindering university and industry innovation. Hence, its Director, Ahmed El Laithy, suggests that for Egyptian universities to participate more effectively in the innovation process there needs to be greater understanding on the part of industry of the need to collaborate with universities, a change in a number of laws and implementation mechanisms to better manage IP prosecution and permit universities to take equity in ventures resulting from their research and an update of the relationship/contract between the university and the academic at public universities. Among the aspirations that the TTO Director has for the future is the creation of a national association of university technology managers similar to those already existing professional networks, such as AUTM (Association of University Technology Managers) and the Japanese University Technology Transfer Association.

Discussion

The three cases triangulate and complement the findings of the earlier research by El Hadidi and Kirby, (2015a and b) and demonstrate the sort of things being done in Egypt's universities to involve them in the innovation process. While they acknowledge the achievements, they also illustrate the limitations and difficulties involved. They reinforce the need to raise awareness and understanding of the process both within universities and externally, within the business community. They suggest some success in raising internal awareness, amongst both university staff and students, but it would seem that the Egyptian business community still does not acknowledge the role the modern university can play in innovation, appearing unaware of, in particular, the benefits that can be derived from research collaboration. Hence, there remains only limited collaboration between the two.

Second although TICOs have been established in some 30 of the country's 43 universities, the cases suggest an often piecemeal and unco-ordinated programme of activity, frequently the result of individuals and institutions taking advantage of external funding programmes, sometimes external to the country. While such programmes are intended to bring about change, and modernisation, their effectiveness is often relatively limited. First they are usually short- or fixed- term and tend not to be sustainable, lasting only for the duration of the project. Second, they tend to be "bolt on" not regarded as a core activity of the institution. Accordingly, there is often no sense of corporate ownership and not, therefore, something in which all of the staff engage. Third, on occasions, they actually conflict or compete with, rather than reinforce or complement, other, similar initiatives within the institution. This is not unique to Egypt and in part results from the initiatives not being integrated into the institution's core strategic planning framework. As a consequence, there is often little coherence and institutional change is thereby limited. As a result, the institutions continue to focus mainly on the two traditional activities of teaching and learning and research.

All three cases demonstrate, also, the constraints imposed by the criteria for the promotion of university academics and the constraints on spin-out activity resulting from the fact that academics and their employer universities are not able to secure equity in the ventures created to exploit, commercially, the outcomes of their research.

Conclusion

The study is intended to provide specific examples of how Egyptian universities are contributing to innovation in the country and the challenges they encounter in so doing. The intention is to learn from their experience, contribute to the body of understanding on the topic and, importantly, inform policy formulation.

Contrary to the findings of the earlier research based on experts' opinions (El Hadidi and Kirby 2015a) many Egyptian universities are attempting to engage in the innovation process. Since 2010 some 30 university technology innovation commercialisation offices (TICOs) have been opened, for example, along with other projects. However, the impact of these appears somewhat limited as discussed above. Hence, to bring about the necessary changes in its universities, the Egyptian government needs to intervene as the earlier research has recognised (El Hadidi and Kirby, 2015 a and b). While possibly permitting its universities to be more autonomous and responsive to their markets, the Egyptian Ministry of Higher Education needs to formulate a policy that requires its country's universities to incorporate the "third mission" into their institution's core activities. At the same time it needs

capacity building to raise the awareness of the academic staff and, importantly, the senior university management of the need for the university to engage in this core activity..

Simultaneously, the promotion criteria for academics needs to be addressed and there is need for recognition of the value of research exploitation, not just publication. Many academics will not engage in knowledge commercialisation if they believe it will have a negative, or even a neutral, affect on their promotion opportunities. Importantly, if they publish their “inventions/discoveries” or present their findings at research conferences, as is customary, it becomes difficult, if not impossible, to protect the intellectual property. Hence, policy needs to address this issue. Equally, the law regulating the ownership of university spinout companies, based on the intellectual property stemming from university research, needs to be amended to permit both the individual researchers and their employers to take equity in the resultant new ventures.

University-industry collaboration also needs to be encouraged in accordance with the Triple Helix model. As proposed by the expert panel in the initial research (El Hadidi and Kirby, 2015a) fiscal incentives to industry in the form of tax breaks might be needed. However, this implies there is no benefit to industry from collaboration – that the benefit is to academia only. This is not the case as many of the multinational companies, represented in Egypt, appreciate. Firms like BG, BP, Google, Shell, Siemens and Vodafone all have, at least in their home environments, extensive university-industry programmes that go beyond graduate recruitment and include collaborative research and corporate venturing. These organisations may be used both to demonstrate the benefit of collaboration and to introduce the concept through their local activities as well as their supply chains, thereby extending the concept to domestic firms including SMEs. At the same time, the Government might, as recommended earlier (El Hadidi and Kirby, 2015b, p.302), “consider creating a permanent national academic-industry-government forum in which members can explore areas of mutual interest and benefit, together with opportunities for collaboration”. The US Business-Higher Education Forum (<http://bhef.com>) is an example of such an initiative as is AURIL (Association for University Research and Industry Links) in the UK (auril.org.uk).

Finally, the Government may wish to continue to avail itself, and its universities, of the support being made available from external sources such as the European Union and the UK Newton –Moshara fund. However, when so doing, it needs to ensure that these projects fit into coherent institutional frameworks intended to bring about change that promotes and enables sustainable university-industry collaboration and participation in the country’s innovation process, leading to increased innovation and greater economic and social competitiveness.

Notes

1. Cairo University is a state university founded in 1908. It has some 280,000 students and 12,158 staff in 17 Faculties plus Schools of Law and Medicine. QS ranked it 551-600 in the world in 2015 and second in Egypt, 9th in the Arab world.
2. Tempus was, from 2007-2013, the European Union’s programme supporting the modernization of higher education in the EU’s surrounding area including the Mediterranean region.
3. Zagazig University was established in 1974 as a state university. It has over 170,000 students and some 7000 academic staff in 17 Faculties and 2 Institutes. It was ranked by QS as 8th in Egypt, 48th in the Arab World and 701+ globally.

4. The EU is working to develop closer scientific ties between Egypt and the European Research Area particularly through increased Egyptian participation in Horizon 2020, the on-going EU Framework Programme for Research and Technological Development. Horizon 2020 is the biggest EU Research and Innovation Programme ever with nearly 80 billion Euro of funding available between 2014 and 2020 intended for collaboration with third world partners such as Egypt. The programme is intended to ensure Europe produces world class science, remove the barriers to innovation and make it easier for the public and private sectors to work together to deliver results.
5. The UK's Newton-Mosharafa Fund is a 20million pound sterling fund over five years intended to bring together the British and Egyptian scientific research and innovation sectors to find solutions to the challenges facing Egypt in economic development and social welfare. It is part of the UK's 375 million pound sterling Newton Fund to support science and innovation partnerships between the UK and emerging powers
6. The American University in Cairo is an independent American style University with some 6642 students and 423 full-time academic staff. It was founded in 1919 and has five schools plus a Graduate School of Education and 18 research Centres. In 2014 it was ranked by QS as 360th in the world, first in Egypt and 5th in the Arab World.

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