Editorial: Breaking boundaries; building bridges across the Triple Helix

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1 Introduction

Economic development through technology transfer has become a third academic mission along two traditional missions of universities around the globe. Research universities have adopted an economic mission and become knowledge entrepreneurs, not only patenting and licensing technologies to the private sector but also 'spinning-off' commercial enterprises to exploit their own scientific discoveries. As academic science feeds the market, so the market feeds science, with new questions and funding to maintain the momentum. These interactions complicate the bi-lateral relations between academy, industry and public actors: the Triple Helix, breaking the boundaries and building new bridges across tri-lateral divides. Public actors (national or regional) seeking greater efficiency in their research investment aimed at sustaining competitiveness and growth. The business sector is increasingly interested and involved in university research and has become a more active stakeholder in the use of university knowledge. Universities are increasingly regarded as important engines of technological development and economic growth. Commercialisation of research results, technology transfer and academic entrepreneurship have been identified globally as the source of remedies to revive declining industries and as the nursery for the creation of new industries and new jobs.

Relations between industry and university, public research organisations have intensified within the last 20 years. These changes were stimulated by technological developments, the recognition of university knowledge as increasingly significant for innovation, industrial growth, competitiveness and job creation. University research administration has expanded from assisting in the intake of funds to arranging for the outflow of results, especially those with practical and commercial implications. The

inclusion of more contractual type of technology transfer mechanisms into the university activities raises empirical and social questions. In other words, scholars, policy-makers concerned with the question of how to balance the commercialisation of the public knowledge base and the status of universities as public, knowledge-generating organisations. In an organisation traditionally committed to pure or basic research, just how has the shift to application been achieved? How is the transfer of knowledge from public to private sectors enacted? Of course, in technologically oriented universities such as the USA land grant schools, whether agriculturally or industrially oriented, the context of application has been the founding and persisting remit. Nevertheless, in recent decades, applied research has been balanced by a shift to fundamental investigation, creating new competitors for basic research funds. As early as the 1930s, it was recognised that discontinuous innovation arising from genetics discoveries could more rapidly achieving the university's practical objectives.

Institutionalisation of technology transfer from universities to industry has been achieved in the USA by the initiation of Bayh-Dole Act (1980) and the enhancement of the mission of university technology transfer offices (TTOs) that it engendered. The Act implicitly mandated the spread of TTOs across the research university spectrum as an effort to realise the practical implications of discoveries was made a virtual condition of receiving federal government research funds. Due to it's relatively 'earlier involvement and success', institutional and organisational setups at a few elite USA universities have been modelled. Although it seems sensible to learn from current 'best practice', this seemingly logical decision may have unintended negative consequences for regions whose conditions do not match those of these leading actors. Moreover, the current innovation ecosystems of these leading universities little resemble the circumstances of the era in which they began the transition to an entrepreneurial academic model. Indeed, the early regional and academic conditions of these leaders are often closer to the current circumstances of many of their followers. Thus, it may be that more relevant learning for policy and practice can be drawn from the history of MIT and Stanford's development than their contemporary efflorescence.

2 Content of the issue

This issue will address the implications of innovations in university technology transfer practices for knowledge-based innovation and economic development in different institutional settings. Our aim is to compare and contrast the institutional and organisational frameworks behind university industry technology transfer around the world and to show how they influence or have been influenced by the rate, propensity, modes and outcomes of technology transfer in different national and regional settings. Authors address the establishment of preconditions for technology transfer in developing or developed countries and peripheral regions, such as entrepreneurial education, university reform and the development of markets for university technology will also be included. What changes can be identified in the informal and formal structures over the last 20 years in university technology transfer and entrepreneurship activities and what are their implications for university-industry-government relations in various regimes?

To what extent and why is there a convergence towards the similar mechanisms around the world? Who mediates and manages the complex commercial arrangements surrounding these transactions? What models of technology transfer and intellectual

property regimes are looked to and how are they interpreted locally? What have been the effects of government initiatives to change institutional and organisational frameworks to foster entrepreneurial universities? The papers compiled in this issue aim to address these questions by providing a variety of cases and examples from different countries with different as well as similar settings with the ultimate purpose to facilitate technology transfer, university development and economic renewal.

1 Namikawa in his paper entitled 'Intellectual property in R&D project under Japanese Bayh-Dole system' takes, as a case study, a national R&D project under the Japanese technology-transfer system, which is known as the Japanese Bayh-Dole clause (J-Bayh-Dole) and analyses the process of transferring the intellectual property to the private sector by dividing it into sub-processes. Although the clause is not supported by detailed rules, legislation or administrative action for procedure and, rights and obligations the J-Bayh-Dole has worked frequently and successfully in national R&D projects where various participants' interests are complicated. The ownership of intellectual property produced in national R&D projects has been transferred to the private sector without any trouble. Based on the legal documents issued by the government and the parties to the project, this paper attempts to find reasons why the J-Bayh-Dole works smoothly without the detailed rules etc. and model a project organisation that underpins the smoothly transfers. These findings imply that smooth transference of intellectual property to the private sector is underpinned by a non-governmental and non-profit project management organisation included in the project organisation.

2 Gulbrandsen in his paper entitled 'The relationship between a university and its technology transfer office: the case of NTNU in Norway' asks how the relationship between a university's central administration and its TTO affects the way the TTO operates and performs. The case is the Norwegian University of Science and Technology in Trondheim, which set up a TTO after legislative changes in Norway in 2003 that moved the intellectual property rights from the individual inventors to the higher education institutions. It is found that many of the challenges and problems that the TTO has encountered, may be due to how the technology transfer function was set up by the university rather than specific actions and decisions in the TTO. Unrealistic expectations and lack of a university IPR policy has probably created some problems that could have been avoided. However, the legislative changes themselves have been difficult to handle at a university where the old IPR regime was the backbone of a successful policy of entrepreneurship and industry relations.

3 Göktepe-Hultén in her paper entitled 'University-industry technology transfer: who needs TTOs?' portrays the current Swedish technology transfer system through the lenses of scientists. She underlines while the activities of TTOs in patenting, licensing and spin-off company formation are still fairly low – especially as compared to similar organisations in the USA, scientists are commercialising their research. She then investigates to what extent and how do internal (i.e., entrepreneurial skills, motives) and external factors (i.e., patent legislations and TTOs) influence, motivates and/or enables university scientists to patent? Do different inventors need different types of support and to what extent their needs are met by the existing technology transfer infrastructures? Instead of suggesting a

benchmarked TTO as the main factor behind commercialisation, she suggests customised TTOs and availability of multiple routes for technology transfer according to different types of university scientists as a main policy implication for countries which are planning to emulate the US model. Such an integrative model provides a smooth learning process not only for TTOs but also for scientists who do not need a TTO.

4 Chandra and Krishna in their paper entitled 'Academia-industry links: modes of knowledge transfer at the Indian Institutes of Technology' studies the Indian Institutes of Technology which was established on the lines of Massachusetts Institute of Technology. The relevance of MIT model for IITs was observed by coupling teaching and research and linking up with practical training and building interdisciplinary centres that reorganise research and teaching as well as bringing considerable autonomy and institutional flexibility. However, in so far as the entrepreneurial university model of MIT is concerned, it had a very limited impact. Firstly, IITs have institutionalised mechanisms to manage knowledge transfer since the 1970s. They were however mainly confined to industrial consultancy and sponsored research training of industry/government personnel and such activities. It is only in the last decade or so that IITs have become pro-active in the second mode of knowledge transfer in fostering incubation, innovation and enterprise creation. The traditional forms of knowledge transfer via sponsored research and industrial consultancy are considered more important compared to patenting and licensing. From the point of entrepreneurial culture and enterprise creation IITs and other universities in India lack appropriate 'innovation ecosystem' and a well developed venture capital support structure as is seen in the case of MIT, Stanford and Silicon Valley in USA. Further, India is still in the process of framing a national regulation and law equivalent to Bayh-Dole Act of USA which governs IPR in universities.

5 Turpin and Garrett-Jones in their paper titled 'Reward, risk and response in Australian Cooperative Research Centres' investigate first what drives a researcher to become involved in (and to stay committed to) these centres and how do researchers perceive and respond to the risks and rewards of participation in these centres? CRCs were first funded in 1990, following the example of centres like the US NSF Engineering Research Centres and the UK Science and Engineering Research Council's Interdisciplinary Research Centres in the mid 1980s. They found that personnel at all levels perceived their CRC experience as an important step in their career trajectory. They propose that a necessary part of management strategies is the negotiation and reconciliation of risk and reward for partner organisations and careers of participating scientists. Achieving a sustainable strategy carries implications for change within the partner organisations and for the endurance of CRCs as organisational arrangements. Their analysis reinforces the need for flexible management structures that respond not just to the immediate research objectives but also the mediating role of CRCs between the broader objectives of the many and varied research partners.

6 Koschatzky and Stahlecker in their paper entitled ‘New forms of strategic research collaboration between firms and universities in the German research system’ observed that based on role models like the University Industry Research Centres in the USA, Centres of Excellence or Competence Research Centres, have been established recently in Germany. They question whether the new mode of collaboration between industry and universities will develop as a new element in the German research system and argues only time may prove to what extent these structures are sustainable. Success factors for the research centres are unequivocal missions and goals shared by all members, trust and transparency, the integration of industrial ways of thinking, as well as clear structures and responsibilities regarding the organisational separation between strategic, pre-competitive research and application-oriented, short-term development. The significance of strategically oriented research cooperation in different organisational and legal structures to ensure entrepreneurial innovation competence will increase in the coming years. For the universities, these interfaces to industrial research and development are then particularly advantageous if it is co-joined to increased competence in scientific research and teaching.

7 Kondo in his paper entitled ‘From collaboration to cross-over – changing university-industry relation in Japan’ presents two Japanese historical experiences to better understand a current university-industry relation. One is that Japan was the first country that established an engineering department in a university structure in the world. The other is that a public research institute led a large number of companies to commercialise its research results. Then, after Japanese university-industry-collaboration policies are discussed comparing with the situation in the USA. The university-industry relation in Japan is changing from the collaboration between the university sector and the industry sector to the cross-over of the two sectors as seen in other countries as well.

8 Tonelli et al. in their paper entitled ‘Endogenous and exogenous features of innovation processes in Brazil: two case studies at a Brazilian university’ show Brazil has still a great challenge to be overcome such as the difficulty in translating scientific knowledge into economic development. By using an historical approach this study explores endogenous characteristics are those directly related to the innovation process, while exogenous characteristics address where the innovation processes occur and describe formal structures. The researchers had to compensate for the shortcomings of the institutional environment and that the researchers themselves were responsible for the successful application of the scientific knowledge they had generated. If entrepreneurial behaviour within public research institutions is not encouraged, the lack of integration within the innovation system makes the rise of innovation within the public research context excessively dependent on the entrepreneurial initiative of the researchers. However because of the environmental shortcomings, the main researchers became overloaded, roles should instead be disseminated among the innovation’s institutional agents. Not every Brazilian researcher who possesses viable economic and technical ideas is willing to take the initiative that these researchers took.

9 Lai and Tsai in their paper entitled 'Energising R&D accumulation and innovation diffusion: an intermediary model of integrating industry-university collaborations' re-examine the academic literature on 'Industry-University Collaborations (UIC)' and examines four countries' innovation systems. Although organisation (Japan), education (UK) and inducement (China) are four important influential bases of IUC (USA, Japan, UK and China), in order to speed the practice of IUC, it is necessary to have an intermediary model which provides opportunities to universities and industries for fulfilling the requirements of supply and demand. They suggest the concepts of Virtual R&D Organisation (VRO) and R&D Service Organisation (SO) as agents to enforce the collaborative magnetism of universities and industries. When an enterprise is interested in a university's science research or a university intends to diffuse its technological knowledge to the industry, the enterprise and university usually spend efforts on communication and negotiation in order to bridge requirements and capabilities from the both sides of supply and demand. Even if the enterprise and university finally consent to conduct the collaborative research or technology transfer, they will need much professional support to sufficiently implement the IUC for IPR, technology evaluation and financial investment. From the regional point of view, governments can assist and group the technological capacities from regional universities to support the VRO and fulfil regional enterprises' research demands.

10 Etzkowitz and Göktepe-Hultén in their paper entitled 'Maybe they can? University technology transfer offices as regional growth engines' discuss how an efficient TTO should act as a boundary organisation which balances the different expectations, objectives and demands of university-researchers and industry. They focus on the interdependence between regional specificities, design of university TTOs and regional development. At least three factors are needed in the vicinity of a TTO; active university and researchers, industrial absorptive capacity and investors. Although the expected role of TTO is to bridge these different factors and act as the glue of the process, it could only be true when TTOs are able to substitute or provide replacements for missing pieces in the technology transfer process. Otherwise TTOs are not the magical tools behind academic entrepreneurship. In this paper, they aim to understand how variation in regions and TTOs influence the technology transfer and where necessary we suggest to re-design the activities TTOs according to the surrounding circumstances reaching to a cooperative scientists or who is interested in patenting is not that difficulty.

3 Conclusion: an assisted linear model

Different approaches to university technology transfer may be identified, depending upon local academic traditions, the previous relationship of the university to industry and government and emerging regional development strategies. A university in a region with a highly developed innovation ecosystem can maintain strong boundaries and contribute to knowledge-based innovation through less intensive mechanisms. Conversely, a university in a region without significant innovation resources must then play a proactive role and intervene more extensively to create a framework in collaboration with other actors to achieve the preconditions for innovation. As a result, many governments and

universities have developed internal organisational capabilities to formally transfer technologies rather than relying solely on informal ties. Nevertheless, informal ties and inventor interest, as well as industrial absorptive capacity and government 'rules of the game' remain crucial to the transfer process which involves a balance between codified and tacit knowledge, public and private interests, economic and broader social goals.

An assisted linear model may be conceptualised based upon the different types of institutions and organisations that have been designed to facilitate commercialisation of research results. Based on the role model of US institutions and organisations, a number of policy tools (e.g., TTOs, University Industry Research Centres, patent legislations and clusters) which are all hyped around the success MIT and Stanford have been introduced. In most cases most tools are not yet in a position to play an active role in technology transfer and generate income. Therefore the broadly defined technology transfer infrastructure in the aspiring and developing regions need to play a much more extensive role by interacting different actors to create the conditions – fill the gap in the regions and universities. In the earlier stages they need to create the infrastructure for increasing university's research potential and technology transfer. They are trying to reach scientists and play an educational role.

This has actually a universal default role which has been achieved so far but not being recognised by the adapting universities, since they are expecting to become MIT's TTO instantly. This was however a role also played by precursor actors who were pioneering academic entrepreneurship, technology transfer and licensing at MIT and Stanford universities in the late 19th early 20th centuries. What actually world is copying is the early-stages or the visible parts of the institutions and organisations albeit with the expectation of their present achievements.

A flaw of the existing policy design lies in the fact that they have a narrow focus on commercial outcomes such as patenting, licensing and spin-offs and thus it misses the actual roles that institutions and organisations can play such as improving the preconditions. Very few countries, universities and regions have the preconditions for technology transfer. Sometimes they are not even aware that they lack the preconditions which cause underestimation of the role that institutions and organisations they may play. Today's policy emulations are based on a few successful cases of universities in their current stage without really considering the learning process that the faculty, university administration, TTOs and region had gone trough over the years.

It does not necessarily mean universities have to go decades of long process of learning and piece-meal development under conditions of stringent resources. Policy learning requires knowledge sharing, in-depth understanding and is not easy to follow. One also needs to consider the deficiencies in the looked-upon models. And the combination of culture, structure and norms that encourage conditions for technology transfer at some point in a specific context is not widely available. A more careful analysis of what has happened in the evolution of these successful cases and academic entrepreneurship.

We therefore need new metrics – indicators in the design as well as in the assessment of tools and initiatives for technology transfer. This may actually lead to a new definition and role like university-industry innovation development infrastructure. This redefinition can be derived from the analysis of the institutions and organisations designed either in peripheral regions or universities rather than the top level elite research universities. An analysis of such activities has two important implications. First, it typifies the mode of

the activities in the rest of the world, i.e., aspiring regions and universities. Second, it shows that the quantitative indicators to assess the activities of institutions and organisations might be counter-productive to their potential roles as such indicators hinder understanding the actual activities. The role of existing measurement tools should therefore be reconsidered for those new entrants with consideration given to developing new metrics to assess the academic and entrepreneurial development roles of TTOs in aspiring universities and regions.

This description of technology transfer infrastructure is not an idealistic one either. It is not easy to describe an idealistic or optimum model for per se. Institutions and organisations should in fact be temporary whose aims should be designed to fulfil the current needs and or solve the current problems. A TTO can actually handle with constant changes, as they are not bound by old traditions and rules, would be more responsive and adaptive to the needs of the so-called evolutionary economics. And they can hopefully assist the innovation process that take place among a large number of actors.