

THE TRANSFORMATION OF RESEARCH TECHNOLOGY
ORGANISATIONS (RTOs) IN ASIA AND EUROPE

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1. Key Issues

Research technology organisations (RTOs) (also frequently known as ‘research institutes’, ‘public research organisations’, and sometimes as ‘government research institutes’, etc.) exist in both industrialised and industrialising countries in various forms. However, their functions and development have not been subject to much academic research, since studies related to science and technology policy and technological innovation lately have tended to focus on organisations such as universities or business firms. Given the potential contribution of RTOs to innovation in important sectors of a national economy, this relative neglect is unfortunate. The papers presented in this issue seek to open up new research areas and debate related to RTOs in Asia and Europe.

Many RTOs were established by national governments to enhance the competitiveness of national economic sectors – agriculture, industry or services – during a period of inherent optimism about the efficacy of public organisations in conducting research and development and transferring the results to potential users. This rationale remains very important, but the environment for such activities have undergone significant changes in recent decades, and the RTOs often find themselves in transition to a new mode of operation. There are two key shifts in the environment that we believe have been particularly significant in shaping this transition: on the one hand, RTOs are increasingly compelled to commercialise research, both in order to generate new sources of income for their activities and to demonstrate their relevance to social and economic development; on the other hand, the process of globalisation

of R&D has opened up new opportunities for RTOs to extend their reach beyond national borders.

While these pressures for increased commercialisation and internationalisation have been felt most acutely by RTOs in industrialised economies, they represent similar challenges and opportunities in developing or newly industrialised economies. In Spain, for instance, RTOs were experiencing an environment of stagnating or declining funding from governments during the 1990s, and responded with more or less active search for external funding depending on the status of autonomy of the RTO and/or its researchers (Sanz-Menéndez and Cruz-Castro 2003). In many European countries, the effect of new funding and cooperation opportunities from the European Union appears to have been instrumental in a range of internationalisation initiatives, which have also reached beyond Europe to the US, Japan and Asian countries in recent years.

For Asian economies, the above two parallel processes have engendered a similar range of challenges to the role and functioning of RTOs. However, for these RTOs the emergence of such challenges has highlighted deep-seated dilemmas of the organisation of research and technology diffusion. The weak institutional frameworks for research and the lack of absorptive capacity of potential users remain endemic in developing and emergent economies, and RTOs have had to adjust their approaches to these conditions. Therefore it is worth re-examining the response of Asian RTOs and relevant policy making organisations at this juncture in time to better understand how the forces of change are resulting in a transformation of the mission and conduct of RTOs.

The papers selected for this journal issue reflect a few of the most important questions that RTOs in Europe and Asia face today, and also contribute to the development of a comparative perspective on the similarities and differences of RTO response. This includes such questions as what do increasingly open and global networks of R&D imply for the research portfolio of RTOs? Does a continued focus on the technological needs or policy decisions of national actors (SMEs and government agencies) run the risk that a national ‘lock-in’ will miss important opportunities for development of internationally competitive services? Another key question is whether RTOs in Asia and Europe have similar potential to enhance their services for local users through commercialisation of technologies and services. Can Asian RTOs reorient their traditional mode of operation (largely based on conducting advanced research) towards a strategy of providing integrated technological transfer services in cooperation with users?

2. Existing studies and theories on the role of RTOs in NISs

In some national innovation systems (NISs), the RTO plays an important role as a performer of research and development (R&D) alongside academia and industry. Either in collaboration with actors in an innovation system or on their own, it is now widely accepted that RTOs play a substantial role in the development of many high-technology regions around the world (Bresnahan and Gambardella 2004). RTOs can be publicly or privately owned and run. Public RTOs can be divided into national-level public RTOs financed by the central government and local-level public RTOs

financed by local governments. In addition to conducting R&D, public RTOs carry out other missions such as maintaining standards, providing consulting services, testing and measurement services, and playing a coordinating role. Similarly, private RTOs can also be divided into non-profit RTOs and for-profit RTOs. Many private RTOs are not-for-profit, and are largely financed by the public sector. In this case, their activities are similar to those of public RTOs insofar as the activities of both public and private RTOs are determined by the source and amount of the funding they receive (Crow and Bozeman 1987).

RTOs play an important role in a nation's innovation system—be it the innovation system of a developed nation or of a developing economy—and have been found to have played an especially important role in the early 'catch-up' phases of a nation's economic development (Nelson 1993; Crow and Bozeman 1998; Mazzoleni and Nelson 2007), particularly in the new industrialised East Asian economies. During the 'catch-up' phase of an economy's development, RTOs play an important role as facilitators and intermediaries in the learning required for firms and other actors in the innovation system to pursue technological innovation.

Over the last thirty years, science, including scientific activity conducted in RTOs, has been faced with increasing demands from society to realize the fruits of its efforts and contribute more concretely to a nation's economic growth and competitiveness. As observed by Ziman (1994), due to the limits of available resources, governments in many countries can no longer afford unconditional support for basic science. Scholars have attempted to capture this changing context, in which science, and by extension technology, as well as the actors who conduct these activities have had to

operate, with the use of new theories and concepts such as the ‘Mode I/Mode II knowledge production’ (Gibbons et al 1994), the ‘Triple-Helix’ (Etzkowitz and Leydesdorff 2000), and increasingly the ‘National Innovation System’ conceptual approach (Freeman 1995). Over roughly the same thirty year period, a second parallel trend has emerged in which innovation and technology more specifically, or knowledge more generally has become global and international in outlook. The trend towards exploiting knowledge more richly, and in general regarding knowledge as the most important factor of production (OECD 1996), has not been exclusive to large industrialised countries, but applies also to small, open, industrialising (and industrialised) economies. Across the board, countries have recognized the increasing global nature of scientific and technological activity as well as the globalisation of research and its outputs.

Increased internationalisation combined with commercialisation of science and scientific activity has been gaining traction in academia as well as in RTOs: In this vein, some universities have started to become more outward-looking and entrepreneurial in their stance (Leydesdorff and Meyer 2006), while RTOs too have demonstrated greater efforts to internationalise and commercialise the knowledge they produce.¹ RTOs have, therefore, concomitantly increased the flow of new knowledge, know-how, and trained personnel to industry and society at large (Lee 1996).² In response to these pressures, some RTOs have been privatised altogether (such as in the United Kingdom), yet others have introduced more stringent, performance-based criteria (such as in the United States with the National Institute of Health—NIH—where new regulation requires the NIH to report their performance to congress bi-annually) as a result of the magnification of these demands.

In this changing context, it is important to understand whether, and how, RTOs are coping with the challenges and adapting to the new set of circumstances imposed upon them by a rapidly changing society in general, and governments in particular. While some fret that increased commercialisation activities can have a detrimental effect on scientists' ability and willingness to fulfill their traditional, knowledge-led and creativity-driven, research agenda (Buenstorf 2009), there is a burgeoning body of literature which points to the stronger linkages between RTOs and other actors in the innovation system as a method to counteract the changing demands on the performance of RTOs. To be sure, such linkages are not limited to a nation's own innovation system. As Chesbrough (2003) and others have demonstrated, developing linkages beyond a country's innovation system, i.e. internationalisation, stands to offer a fruitful means of future growth for RTOs. Harding (2002), for example, describes how the Fraunhofer Society ensures the sustained technological competitiveness of the German economy by working together with a select number of universities locally and abroad. Lockett et al. (2005) studied the managerial and policy implications of the rising of spin-offs at (at or from?) public RTOs, based on a knowledge-based view of the firm. Hemphill (2006) discusses the legal and financial issues involved in the National Institutes of Health (NIH) in the technology transfer of research results, enabling Taxol (a cancer treatment drug) to be commercialised quickly by Bristol-Myers Squibb. Buenstorf (2009) studies the invention disclosure, licensing, and spin-off activities of Max Planck Institute directors from 1985 to 2004 by analysing their effects on the scientists' subsequent publication and citation records.

Despite this mushrooming literature, however, most prior studies have used evidence from research institutes in advanced industrialised countries to identify technology transfer activities, and few have used empirical studies of research institutes in developing countries or attempted a cross-country comparison of such activities. Studies that have sought to analyse the comparative performance of RTOs in industrialised as well as developing countries (Nath and Mrinalini 2000; Mrinalini and Nath 2006) have provided the criteria for the selection of indicators of best practices, and found that performance indicators should be benchmarked initially on the basis of qualitative analysis of the processes and practices of the RTOs, to be followed up with quantitative indicators. Another study of evaluation of projects to enhance the capacity of research organisations in developing countries (Horton 2003) indicated that involving stakeholders in evaluation and ensuring processes for the implementation of recommendations would enhance the performance of research organisations considerably.

The great majority of studies that have addressed the specific issues of research organisations in developing countries have focused on agricultural research and technology transfer. This is natural considering the importance of agriculture in developing countries and the fact that the 'green revolution' in the 1970s was spearheaded by public research and extension units. Although many RTOs serving agricultural development were geared to promotion of technological innovation and close contacts with users, the mission of these organisations appear to have been challenged by recent developments in public funding for R&D (Byerlee and Echeverría 2002).

The RTOs in developing and Asian countries that have been created to promote industrial development have received less attention in scholarly literature. Nevertheless, there is no doubt that public research institutes have been important for catching up in industrial development and economic growth for US, Japan, Korea and Taiwan (Mazzoleni and Nelson 2007). In the literature, those RTOs in Asia which have been analysed in more detail have mostly been successful examples in Taiwan (e.g., Hsu et al. 2003; Chu et al. 2006) or Korea (e.g., Ahn 1995; Kim and Leslie 1998). But our knowledge of the general challenges faced by these organisations and a theoretical interpretation of their functions and performance is hampered by the lack of a comparative perspective and an understanding of the ways that RTOs in Asian countries are embedded in the context of national innovation systems and culture.

3. Summary of papers

The papers published in this issue of *Science, Technology and Society* represent one of the first attempts to jointly put together a collection of manuscripts that seek to understand the role, functioning and trajectories of RTOs in both Europe and Asia. Given that the institutional context of both continents is markedly different, facile comparisons are avoided in order not to arrive at superficial conclusions. Rather, we hope that the reader of this issue will be able to better understand how the differing national contexts themselves affect the development and positioning of RTOs in the two different continents. To be sure, there are similarities in how RTOs operate in both continents, but there are just as many areas of contrast. The papers contained

herein serve to highlight/put the spotlight on/bring to the readers' attention this heterogeneity.

The original ideas contained in Intarakumnerd's paper were among the most hotly debated at the 6th 'Asialics' Conference in Hong Kong from where the papers for this special issue were sourced. Basing his results on Taiwan's Industrial Technology Research Institute (ITRI) and Thailand's National Science and Technology Development Agency (NSTDA)—among the two most prominent and well known RTOs in Asian innovation systems—Intarakumnerd's paper portrays two models, A and B, of RTOs in latecomer countries in the process of technological catching up. Model A stimulates accumulation of technological and innovative capabilities *within* firms whereas Model B attempts to create technological capabilities *on behalf of* firms. These two models are not intended to be generalisable (indeed they cannot be given that each is based only on single case study), nor are the two models meant to capture the rich heterogeneity of RTOs across Asian economies. Rather the two models are intended to highlight differences in characteristics of RTOs at the two ends of a spectrum. To be sure, these two ends of the spectrum are not 'extremes' as such, but rather point to noticeably differing functions of RTOs. The results of Intarakumnerd's investigation can be used to aid further detailed international comparative studies on the issue of categorizing various types of RTOs across the spectrum of Asian economies.

Gijsbers and van Tulder provide a study of agricultural-RTOs revolving around the cases of South and Southeast Asian countries. Their paper investigates the performance of RTOs as the agricultural sectors in four Asian countries—Indonesia,

Sri Lanka, Pakistan and Vietnam—become more knowledge-intensive and innovation-oriented. Their methodology of using field work conducted in each of the four countries from 2000-2004 to draw their insights offers the readers a unique look into the management practices in public agricultural-RTOs. They conclude that agricultural-RTOs are not adequately meeting the challenge of becoming more knowledge-intensive. In particular, the linkages between RTOs and the other actors within the four innovation systems studied by Gijsbers and van Tulder are either non-existent or weak leading to an inability to adapt and transfer new technologies and management practices to each of the agricultural sectors. The weaknesses of these linkages is especially profound in Sri Lanka and Pakistan, and less profound but equally problematic in Indonesia and Vietnam. If the agricultural sectors are to modernise and return to play the central role as they once did during the period of the ‘Green Revolution’, argue Gijsbers and van Tulder, the problem of weak or absent linkages needs to be addressed in each of the four countries examined.

Cho et al.’s paper examines, in a Korean context, the institutional legitimacy of public RTOs. This examination is conducted using an empirical, content-analysis methodology of columns, articles and interviews of RTOs in leading Korean newspapers. Cho et al. centre their arguments on the concept of institutional legitimacy—a critical determinant of the sustainability of public RTOs. Given the extent to which public RTOs are dependent on government resources, R&D activity in these RTOs is very sensitive to stakeholders’ demands and performance expectations which affect the availability of public funds. The lack of such institutional legitimacy leads to public funding cuts and a restricted role for public RTOs within the broader innovation system. The authors find that Korean RTOs have

not achieved sufficient institutional legitimacy to ensure their organisational sustainability. The reasons for this lack include frequent changes to the governance and management systems of RTOs, conflicting opinions of RTOs among relevant stakeholders, and occasional changes in policy directions of RTOs. The results of their study are, to varying degrees, applicable to a number of other East Asian developing economies, where RTOs are plagued with many similar issues.

Loikkanen et al. provide an in-depth examination of RTOs in Finland, pointing out that public research organisations (PROs) are in transition both internally—with respect to their organisational, managerial and funding structures and sources—and externally—insofar as the Finnish national system of innovation continues to internationalise. This transitioning climate calls into question the strategies undertaken by the PROs and even their very legitimacy. In their paper, Loikkanen et al. raise two particularly noteworthy issues: First, the pressures of internationalisation are not uniform in terms of their effect on PROs. Internationalisation has different effects on different PROs in Finland, depending on the historical background of the PROs, the differing focus areas of the PROs, as well as the PROs' financial and organisation structures (indeed some PROs even go so far as to actively resist internationalisation). Therefore, to assume that internationalisation has a standardized impact on all PROs in any given innovation system is an over-simplification of reality. Second, in their drive to become more outward-looking and international in nature, PROs are faced with an inherent tension in terms of focusing adequately on the innovation system at 'home', and balancing that view with global changes in the innovative and technological climate. Whereas funding for PROs originates from

‘home’, the markets which the PROs need to look towards serving are international. Such pressures can, and do, result in a conflict that is not necessarily easily resolved.

In their paper, Berger and Hofer provide further discussion of the issue of internationalisation among RTOs, using empirical evidence from qualitative interviews conducted with five European RTOs with representative offices in China. Interestingly, they conceptualize RTOs as hybrid organisations, encompassing business as well as academic elements, and making them potentially more engaging in internationalisation strategies. The authors find that the majority of these RTOs are still in their infancy when it comes to internationalisation. Although many RTOs have embraced a strategy for internationalisation, the focus remains on (academic) collaboration, publication and informal exchange. In contrast, the acquisition of foreign clients—especially industry clients—and the establishment of R&D facilities abroad is not a common strategy. The main reason for this is that the national governments that provide funding to, and take responsibility of the governance of, RTOs continue to exert a powerful indirect and direct influence on them. So strong is the influence (of the national governments) that governments are reluctant to buy-in to the perceived benefits of internationalisation. The safer route for governments is to continue to promote RTOs’ core function as they impact the domestic national (or even sometimes regional) system of innovation. Uniquely, in investigating the internationalisation of RTOs, however, Berger and Hofer are mindful of the changing relationship between RTOs and industry (and to a lesser extent universities), and their paper returns to address this point in the conclusions where the authors draw a tentative comparison of the different effects the internationalisation process has on enterprises and RTOs.

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¹ While commercialisation of knowledge has traditionally been at the heart of industry's efforts, industry too has undergone changes to cope with the increasing pace of innovation. By adopting an 'open innovation' mode (Chesbrough 2003), industry has been swept by a global trend of expanding the network of possible inputs to the production of successful, innovative outputs.

² It is worthwhile noting, however, that not all agree upon the perceived benefits, or indeed move in the direction of increasing commercialisation of scientific knowledge. Take, for instance, the case of the French National Center for Scientific Research (CNRS) which was forced to reform so as to reduce the number of laboratories, strengthen linkages with industry and help spin-offs promote their industrial innovation capability (Vavakova 2006). This led to considerable feelings of unease among the French scientific community and event protests, as scientists feared the high level of government interference in their activities and the use of market-based criteria to evaluate the efforts of CNRS (Vavakova 2006).