EARLY CAREER ARTICLE

The Strathclyde Technology and Innovation Centre (TIC) in Scotland’s innovation system

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Research and technology organizations (RTOs) have been the subject of recent interest because of the benefits they can bring to regional innovation systems. RTO functions must be tailored to their environments, but there has been little research into how these functions can be systematically deduced using the regional innovation system model as a normative reference. This paper examines the optimal functions of a new RTO in Scotland. An *ex ante* analysis based on three thematic areas (linkages, themes and services, and strategic capability) is used to consider how this RTO can optimally function in an innovation system with recognized structural weaknesses.

**Keywords:** innovation system; research and technology organization; Scotland

Introduction

Research and technology organizations (RTOs) – defined as public or semi-public organizations that ‘provide research and development, technology and innovation services to enterprises, governments and other clients’ (EARTO, 2007) – are of increasing interest to policy-makers and academics because they can enhance the performance of weak regional innovation systems (RISs). However, many RTOs do not succeed because they do not address regional innovation weaknesses in a demand-led manner, fail to integrate within the innovation system and become industrially dislocated (Rush, Hobday, Bessant, Arnold, & Murray, 1996). This challenge is exacerbated by the tendency for RTOs to be conceptualized as a single and unified organizational type, despite their delivery of a broad range of innovation support activities. How, then, can RTO functions be optimally designed for the benefit of regional innovation?

Tödtling & Trippl (2005) have demonstrated that identified weaknesses in RISs can be used as a stimulus for thinking about appropriately tailored innovation policy. However there has been much less focus on deducing the functions which RTOs might optimally undertake by applying the same demand-led logic. From a theoretical perspective the RIS model is a normative (and heuristic) hypothesis (Koschatzky, 2012) in which weak systems can be conceptualized as diverging from the ‘ideal type’, in that they perform certain processes imperfectly. This paper employs the RIS model as an analytical reference point. Specifically, by considering areas in which the case study system diverges from the ‘ideal type’, this paper aims to test the RIS framework as a conceptual vehicle for *ex ante* RTO evaluation.

A review of the management and innovation systems literature identifies three broad areas of divergence which form the basis for an examination of the case study

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institution – the Strathclyde Technology and Innovation Centre (TIC) in Scotland. The Strathclyde TIC, under construction as of mid-2014, will be a single-site building located in Glasgow. Its remit is to achieve an impact across Scotland (considered as a discrete region in this paper). Because the case study institution is not operational, this paper draws upon documentary analysis and information requested from the Scottish government. The abbreviation ‘RTO’ is used to refer to the general organization type, and ‘Strathclyde TIC’ is used to refer to the case study institution.

RTO functions in the regional innovation system (RIS)

Organizations that are referred to as RTOs have existed for a number of years. In the UK, research associations such as the Production Engineering Research Association (established in 1946) were the original intermediary institutions designed to advance research-based knowledge and pre-commercial technology (Rush et al., 1996). In Germany, the Fraunhofer-Gesellschaft was founded in 1949, but its success has placed it as the archetypal ‘model’ case in international comparisons today. The Strathclyde TIC was established by the University of Strathclyde, Glasgow, in 2011, with support from industry partners and the Scottish government. Its total budget was £89 million, with the majority (£57 million) sourced through the university (University of Strathclyde, 2012). The motivation for establishing the Strathclyde TIC originated in the University of Strathclyde’s research strategy; the TIC is primarily a facility for university-led collaborative research and development (R&D) (it is difficult to identify the exact rationale for the Strathclyde TIC as stated because detailed information is not publicly available). The introduction of an RTO of this type is novel in Scotland; although other intermediary organizations do exist, they are not of the same scale and operational model as the Strathclyde TIC. Whilst Scotland has an active economic policy agenda, its current innovation framework makes only limited reference to innovation intermediaries (Scottish Government, 2009) and focuses more on public sector agencies as key supporting agents.

The functions of RTOs have broadened over time. In addition to their traditional R&D ‘hard’ functions such as technology testing they are now promoted as service assets in regions, and provide ‘soft’ business services such as networking and consultancy (EARTO, 2007). Most, such as the Fraunhofer-Gesellschaft, have an applied research focus and receive public sector funding but rely on contract research for long-term sustainability. RTOs are distinct from private sector consultancies and operate for public benefit rather than primarily for profit. Previous studies have often adopted a management perspective in identifying how RTOs should operate (Arnold, Rush, Bessant, & Hobday, 1998; Rush et al., 1996). Research has highlighted that there is no single ‘ideal type’ RTO, and that each must be tailored to its innovation environment. The RIS perspective accommodates RTOs as a type of innovation intermediary; they are organizations that act as brokers in the innovation process and are situated between two or more other parties (Howells, 2006). Intermediaries are widely recognized as actors who perform essential enabling functions in the innovation process. More recently, conceptions of intermediaries have shifted away from narrow institutional categorizations, embracing functional descriptions to understand their roles better (Farina & Preissl, 2000). Based on the existing RIS and RTO literature, this paper distinguishes three areas in which RTO functions can enhance RIS performance.

First, a scarcity of network linkages is common in underperforming RISs (Tödtling & Trippl, 2005), whereas dense networks are characteristic of the normative RIS model.
Regional innovation depends on the exchange of knowledge and resources through inter-organizational interactions. Therefore, an essential function of RTOs is that they can enhance RIS connectivity by creating linkages between other actors; particularly between net knowledge creators (such as universities) and net knowledge users (primarily firms).

Second, the failure to realize innovative potential in an RIS is common where industry lacks commercialization capacity. Innovation can be understood as an incremental activity through which technologies, goods or processes are advanced from pre-commercial to commercial stages. Though this is not a linear process, and is characterized by iterative interactions between innovation actors (Kline, 1985), the central process is the accumulation of value-potential through transactions up to the point at which commercialization becomes feasible. Intermediaries can assist in this process by enhancing the knowledge they mediate—they are uniquely placed to construct new combinations of information (Hargadan & Sutton, 1997). In practice, this is achieved by providing complementary and demand-led RTO themes and services to innovation actors, which assist in moving from pre-commercial to commercial stages.

Third, weak RISs tend to lack dynamism and flexibility. For example, Tödtling & Trippl (2005) note that old industrial regions may find it difficult to adapt rigid innovation systems to accommodate new specialisms (‘lock-in’). Firms also tend to underinvest in R&D without ongoing support. RTOs can counter such limitations by positioning themselves within long lead-in technology development cycles to ensure that new technological opportunities and market changes are recognized and exploited (Rush et al., 1996). This function concerns long-term RIS sustainability and necessitates good strategic capability on behalf of RTOs (Farina & Preissl, 2000; Hales, 1997).

Linkages

The planned functions of the Strathclyde TIC will contribute to addressing network weaknesses in several ways. First, there is a general lack of interaction between net knowledge generators and net knowledge users (mainly firms) in Scotland, reflecting limited demand for collaboration and knowledge exchange from firms (particularly from indigenous small and medium-sized enterprises – SMEs). Scotland’s 15 universities generally do not collaborate intensively with Scottish firms (Roper, Love, Cooke, & Clifton, 2006). The Strathclyde TIC will aim to develop collaborative relationships with a large number of innovation actors. Network development for the wider benefit of the Scottish innovation system is not a stated organizational aim, but partnership building is heavily referenced in public sources (University of Strathclyde, 2014a). From an ex ante perspective, success in this area will facilitate the Strathclyde TIC’s position as an intermediary, and act to counter (partially) the lack of existing relationships between actors in the Scottish innovation system (Table 1).

Second, although it is usual for larger firms to lead private sector innovation activity, indigenous Scottish SMEs exhibit particularly low levels of innovation networking (Roper et al., 2006). Publicly identified Strathclyde TIC partners are limited to large firms, but the institution has committed to engaging with ‘a large grouping of innovative SMEs’ (University of Strathclyde, 2014a). Firms are the main agents of knowledge exploitation in the Scottish innovation system and include branch plants, foreign-owned R&D performing businesses and academic spin-outs. There is value in RTO mediation between a diverse range of types of innovation actors. This reflects the complementarity and interdependence stressed in contemporary RIS models.
Third, within Scotland there is a spatial concentration of population and industry in the Central Lowlands sub-region. The Strathclyde TIC consistently refers to achieving an impact across Scotland. In developing relations with innovation actors throughout the entire region, and particularly in the less populated Highlands and Islands sub-region, the Strathclyde TIC can function as a partial counter to ongoing peripheralization in the innovation system.

**Table 1. Scottish innovation system weaknesses and Strathclyde Technology and Innovation Centre (TIC) functions.**

| Thematic areas   | Scottish innovation system weakness                                                                 | Strathclyde TIC function                                                                 |
|------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Linkages         | Low density of network ties between innovation actors, particularly universities and firms           | Creating and maintaining numerous networked relationships to facilitate knowledge exchange |
|                  | Low independent private sector (notably SME) innovation activity                                     | Developing relationships with a variety of net knowledge users, particularly indigenous SMEs |
|                  | Spatially uneven engagement in innovation activity                                                   | Ensuring linkages with organizations across the whole of Scotland, including the Highlands and Islands peripheral sub-region |
| Themes and services | Low critical industrial mass and specialization in a limited number of industries                    | Focusing on technologies and industries that have current strength, or a potential for growth, to maximize innovation activity and competence |
|                  | Limited R&D experience of actors (particularly firms)                                               | Providing a range of services appropriate to user needs, including ‘soft’ services      |
| Strategic capability | Poor commercialization and licensing performance by firms and net knowledge users                   | Developing a long-term strategic orientation and focusing on emerging technologies, particularly in the energy and life sciences sectors |
|                  | Low private sector R&D activity; mismatch between university output and firm needs                   | Retaining and reintroducing IP and knowledge resources into ongoing technology development cycles |

Note: SME, small and medium-sized enterprise; R&D, research and development; IP, intellectual property. Source: Author.

Themes and services

Scotland’s industry base – made up of firms that represent net knowledge users in the RIS model – exhibits limited innovative activity. Low R&D expenditure, poor formalization of the innovation process and limited entrepreneurial activity are documented characteristics (Ashcroft, 1997). Public sector knowledge supply is perhaps the main strength within the system, and Scottish universities achieve good commercialization performance in terms of patents and spin-outs (Baumol, 2005).

Successful RTOs are complementary to the industrial specializations of their innovation systems, focusing on demand pull rather than science push. It is beneficial to make a unified, concentrated effort within a defined range of thematic fields which complement pre-existing industry sector strengths (Arnold et al., 1998). Of the 11 research themes within which the Strathclyde TIC will operate, most correlate with sectors in which Scotland has a competitive international advantage (notably energy) or in which
future market potential is likely to be strong (such as bio-nanotechnology). Its stated focus is on ‘sectors central to economic regeneration’ (University of Strathclyde, 2014a).

A demand-led orientation also necessitates an appropriate range of services to net knowledge users. The Strathclyde TIC will be industry-oriented and has a stated focus on hard technology services such as laboratory facilities. But because it will be dependent on contract research revenue for long-term sustainability – and is intending to form relationships with firms of limited R&D experience – providing ‘soft’ services such as consultancy, intellectual property management and training will be important complementary functions.

**Strategic capability**

Prior research has identified an ‘almost complete mismatch between the output of the research active [universities] and the absorptive capacity of SMEs’ in Scotland (Roper et al., 2006, p. 12). Scottish innovation strategy is largely science-based, with energy and life sciences amongst government growth sectors. Cooke (2005, p. 88) notes that, in the latter, ‘successes [are] slow in reaching fruition’, and that commercial innovation is restricted by a lack of critical mass. Because the main strengths of the Scottish innovation system lie in knowledge generation, support to commercialization stages within the innovation process would be a desirable function of the Strathclyde TIC. RTOs can play a central role in technology development cycles (Hales, 1997), focusing on emerging technologies in growth sectors with long lead-in times, which might otherwise not be pursued by industry actors. The Strathclyde TIC connections to research centres in fields such as power networks suggest that a longer-term contribution to technological innovation is being integrated into organizational planning (University of Strathclyde, 2014b).

Finally, though it is not unusual for RTOs to retain some ownership of intellectual property, the retention and reintroduction of knowledge into future technology cycles ensures long-term benefit to regional innovation actors. In Scotland, a locus of knowledge and expertise in the form of an RTO would further support long-term sustainability and would act to prevent the loss of competitive advantage to other regions. At present there is minimal publicly available Strathclyde TIC information that provides insight into its intellectual property strategy, making it difficult to assess in this regard.

**Conclusions**

This paper has examined a range of optimal functions that may be undertaken by a case study RTO: the Strathclyde TIC in Scotland. The methodological approach used draws upon Tödtling & Tripp (2005) in that an RIS with known weaknesses is taken as a starting point for ‘remedial’ prescription. RTOs, as a form of innovation intermediary, occupy an influential position within the system. There are two main conclusions.

First, by using the normative RIS model as a reference point, this paper demonstrates that the RIS framework can be employed as a means of *ex ante* RTO evaluation. As summarized in Table 1, RIS weaknesses and associated RTO functions can be conceptualized across three thematic areas: linkages, themes and services, and strategic capability. However, it is also important to highlight that the RIS model is not a concrete framework, and transferability would be limited by the absence of a standardized approach to measuring RIS characteristics (Koschatzky, 2012).
Second, contemporary RTOs are increasingly flexible and varied in their roles. This paper employs the functional description of an RTO, avoiding rigid institutional or organizational definitions (Farina & Preissl, 2000). This mix of functions is specific to the Strathclyde TIC, which will operate in an RIS with unique weaknesses. This reiterates the principle that the optimal functions of an individual RTO are bespoke, and that there is no single ‘ideal type’ which can be successfully introduced ‘as is’ into an underperforming RIS. Although academic research has previously highlighted this point clearly (Arnold et al., 1998; Rush et al., 1996), there has been a tendency for policy-makers to look to ‘best practice’ RTO models such as the Fraunhofer-Gesellschaft for inspiration (Reid et al., 2010). A conceptual shift towards a more pluralistic and flexible conception of RTOs by policy-makers would facilitate the more effective design of new RTOs. This could also help to avoid the pitfalls encountered by (failed) RTOs in previous years by helping to minimize redundant organizational functions and by addressing the needs of the RIS.

References
Arnold, E., Rush, H., Bessant, J., & Hobday, M. (1998). Strategic planning in research and technology institutes. R&D Management, 28, 89–100.
Ashcroft, B. (1997). Scotland’s economic problem: Too few entrepreneurs, too little enterprise? Glasgow: Fraser of Allander Institute.
Baumol, W. J. (2005). Innovation and enterprise: four sources of innovation and the stimulation of growth in the Scottish economy. In D. Coyle, W. Alexander, & B. Ashcroft (Eds.), New wealth for old nations: Scotland’s economic prospects (pp. 48–72). Princeton, NJ: Princeton University Press.
Cooke, P. (2005). Integrating global knowledge flows for generative growth in Scotland: Life sciences as a knowledge economy exemplar. Paris: Global Knowledge Flows and Economic Development, OECD Publ.
EARTO (2007). Research and technology organisations in the evolving European Research Area; A status report with policy recommendations. Brussels: EARTO.
Farina, C., & Preissl, B. (2000). Research and technology organisations in national systems of innovation (DIW-Diskussionspapiere No. 221). Berlin: DIW.
Hales, M. (1997). Producer services and manufacturing production (Report for the OECD STI Group). Brighton: CENTRIM, University of Brighton.
Hargadan, A., & Sutton, R. (1997). Technology brokering and innovation in a product development firm. Administrative Science Quarterly, 42, 716–749.
Howells, J. (2006). Intermediation and the role of intermediaries in innovation. Research Policy, 35, 715–728.
Kline, S. J. (1985). Innovation is not a linear process. Research Management, 28, 36–45.
Koschatzky, K. (2012). Fraunhofer ISI’s systemic research perspective in the context of innovation systems. In Innovation system revisited – Experiences from 40 years of Fraunhofer ISI research. Stuttgart: Fraunhofer Verlag/Fraunhofer ISI.
Reid, B., Sissons, A., Brinkley, I., Levy, C., Albert, A., & Holloway, C. (2010). Technology innovation centres: Applying the Fraunhofer model to create an effective innovation ecosystem in the UK (Submission to the Science and Technology Committee, December 2010). London: The Work Foundation.
Roper, S., Love, J., Cooke, P., & Clifton, N. (2006). The Scottish innovation system: Actors, roles and actions. Edinburgh: Scottish Executive.
Rush, H., Hobday, M., Bessant, J., Arnold, E., & Murray, R. (1996). Technology institutes: Strategies for best practice. Bury St Edmunds: International Thomson Business Press.
Scottish Government (2009). Innovation for Scotland: A strategic framework for innovation in Scotland. Edinburgh: Scottish Government.
Tödtling, F., & Tripl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. Research Policy, 34, 1203–1219.
University of Strathclyde (2012). £6.7 million European funding for Strathclyde research centre. Retrieved May 20, 2014, from http://www.strath.ac.uk/press/newsreleases/2012/headline_625848_en.html

University of Strathclyde (2014a). About TIC. Retrieved March 16, 2014, from http://www.strath.ac.uk/tic/about/

University of Strathclyde (2014b). Business and industry engagement. Retrieved March 16, 2014, from http://www.strath.ac.uk/tic/businessandindustryengagement/