Regional Studies, 2015
http://dx.doi.org/10.1080/00343404.2014.985644

Policy Debates

Edited by FIONA WISHLADE

A Post-Mortem of Regional Innovation Policy Failure: Scotland's Intermediate Technology Initiative (ITI)

ROSS BROWN*, GEOFF GREGSON† and COLIN MASON‡
*School of Management, University of St Andrews, The Gateway, North Haugh, St Andrews KY16 9RJ, UK. Email: ross.brown@st-andrews.ac.uk
†JR Shaw School of Business, Northern Alberta Institute of Technology (NAIT), 11762-106 Street NW, Edmonton, AB T5G 2R1, Canada. Email: geoffg@nait.ca
‡Adam Smith Business School, University of Glasgow, University Avenue, Glasgow G12 8QQ, UK. Email: colin.mason@glasgow.ac.uk

(Received January 2014; in revised form October 2014)

BROWN R., GREGSON G. and MASON C. A post-mortem of regional innovation policy failure: Scotland's Intermediate Technology Initiative (ITI), *Regional Studies*. The Intermediate Technology Initiative (ITI) was one of the most ambitious 'systemic' regional innovation policy instruments developed in the UK in recent years. However, little of the ITI's anticipated outputs materialized and the programme was prematurely terminated. This paper examines the reasons for its failure, which largely centred on the programme's inappropriate design. The findings suggest that greater recognition needs to be given to the specificities of local entrepreneurial ecosystems when designing, aligning and executing systemic innovation policy instruments. It is argued that paying greater attention to policy failures could potentially help innovation scholars better understand how innovation systems function.

Regional innovation system Commercialization Entrepreneurial ecosystem Public policy Peripheral region

BROWN R., GREGSON G. and MASON C. 区域创新政策失败后的事后检验：苏格兰的中间技术创新 (ITI)，*区域研究*。中间技术创新 (ITI)，是英国近年来所发展的最有野心的"系统性"区域创新政策工具之一。但ITI所预期的结果，却鲜少有所实践，而该计画亦过早遭到终止。本文检视该计画失败的原因，并主要聚焦该计画不合宜的设计。研究发现指出，当设计、连结与执行系统性的创新政策工具时，需要更进一步认识到在地企业生态的特殊性。本文主张，对政策失败有更多的关注，具有潜力协助研究创新的学者更佳理解创新系同如何运作。

区域创新系统 商业化 企业生态系统 公共政策 边陲区域

BROWN R., GREGSON G. et MASON C. Une analyse rétrospective de l'échec de la politique régionale en matière d'innovation: l'initiative écossaise en faveur de la technologie intermédiaire, *Regional Studies*. L'initiative en faveur de la technologie intermédiaire (Intermediate Technology Initiative; ITI) s'est avérée l'un des outils 'systémiques' les plus ambitieux de la politique régionale en matière d'innovation que l'on a développés au R-U au cours des dernières années. Néanmoins, les résultats réalisés par l'ITI étaient inférieurs aux attentes et on a mis fin prématurément au programme. Cet article cherche donc à examiner les causes de cet échec, lesquelles étaient centrées dans une large mesure sur la conception inadéquate du programme. Les résultats laissent supposer qu'il faut prêter plus d'attention aux particularismes des écosystèmes entrepreneuriaux locaux au moment de la conception, de l'alignement et de la mise en oeuvre des outils systémiques de la politique d'innovation. On affirme que prêter plus d'attention à l'échec de la politique pourrait, en principe, aider les chercheurs à mieux comprendre comment fonctionnent les systèmes d'innovation.

Système régional d'innovation Commercialisation Écosystème entrepreneurial Politique publique Zone périphérique

BROWN R., GREGSON G. und MASON C. Autopsie einer gescheiterten regionalen Innovationspolitik: die Intermediate Technology Initiative (ITI) in Schottland, *Regional Studies*. Die Intermediate Technology Initiative (ITI) war eines der ehrgeizigsten Instrumente der 'systemischen' regionalen Innovationspolitik, die in den letzten Jahren in Großbritannien entwickelt wurden. Allerdings stellten sich nur wenige der erwarteten Ergebnisse der ITI ein, weshalb das Programm vorzeitig beendet wurde. In diesem Beitrag werden die Gründe für ihr Scheitern untersucht und vor allem im ungeeigneten Aufbau des Programms gefunden. Aus den Ergebnissen geht hervor, dass beim Entwerfen, Ausrichten und Umsetzen von Instrumenten der systemischen Innovationspolitik die speziellen Gegebenheiten der lokalen unternehmerischen Ökosysteme stärker berücksichtigt werden müssen. Wir argumentieren, dass sich die Innovationsforschung durch eine stärkere Beachtung von politischen Fehlschlägen potenziell ein besseres Verständnis der Funktionsweise von Innovationssystemen erarbeiten könnte.

Regionales Innovationssystem Kommerzialisierung Unternehmerisches Ökosystem Öffentliche Politik Periphere Region

BROWN R., GREGSON G. y MASON C. Autopsia del fracaso de una política de innovación regional: la Iniciativa de Tecnologías Intermedias (ITI) en Escocia, *Regional Studies*. La Iniciativa de Tecnologías Intermedias (ITI) fue uno de los instrumentos más ambiciosos de la política de innovación regional 'sistémica' desarrollados en el Reino Unido en los últimos años. Sin embargo, pocos de los resultados anticipados de la ITI se materializaron y el programa finalizó antes de tiempo. En este artículo analizamos los motivos de este fracaso que en gran medida se debió al diseño inapropiado del programa. Los resultados indican que, a la hora de diseñar, alinear y ejecutar instrumentos políticos de innovación sistémica, debe otorgarse un mayor reconocimiento a las particularidades de los ecosistemas empresariales de ámbito local. Sostenemos que si en las investigaciones sobre innovación se prestara más atención a los fracasos políticos, posiblemente se podría entender mejor cómo funcionan los sistemas de innovación.

Sistema de innovación regional Comercialización Ecosistema empresarial Política pública Región periférica

JEL classifications: M13, O12, O31, O32, O33, O38

INTRODUCTION

Since the 1990s the focus of industrial and technology policies has shifted from science and technological development in favour of interventions that help build innovation systems, foster networks, develop institutions and align strategic priorities (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD), 2010; COX and RIGBY, 2013; WARWICK, 2013). A key manifestation of this trend is the increasing significance attached towards 'systems of innovation' (LUNDVALL, 1992, 2007; FREEMAN, 1995; EDQUIST, 2004; SHARIF, 2006; DODGSON *et al.*, 2011). Adopting this approach helps identify 'systemic problems' (EDQUIST, 2011) within innovation systems which 'systemic policy instruments' are designed to tackle (SMITS and KUHLMANN, 2004; WIECZOREK and HEKKERT, 2012). These policy instruments are 'integrated coherent sets of tools designed for a specific innovation system (or part of a system)' (WIECZOREK and HEKKERT, 2012, p. 86). The formulation of policies and programmes that attempt to enhance technology transfer and increase the commercialization of university research are frequently the focus of these instruments (EDQUIST, 2004; HEWITT-DUNDAS and ROPER, 2011).

In recent years, these policy trends have been evident in the UK, especially in the devolved regions of Northern Ireland, Scotland and Wales (KEATING, 2005; LYALL, 2005, 2007). In the case of Scotland, one of the most ambitious signs of this kind of policy experimentation was the establishment by Scottish Enterprise of the Intermediate Technology Initiative (ITI) (HUGGINS and KITAGAWA, 2012) as part of the Scottish Government's economic strategy 'Smart, Successful Scotland' (SCOTTISH EXECUTIVE, 2004). Established in 2003, it was intended to have a major transformational impact on the Scottish economy by tackling its low levels of university research commercialization, limited high-technology new venture formation and below UK average levels of business research and development (R&D) expenditure. The key focus of the programme was on promoting the formation of new technology-based firms (NTBFs).

Its projected budget of £450 million was a clear indication of the political importance attached to the programme. The Scottish First Minister at the time, Jack McConnell, claimed that the ITI would 'have a crucial role in making the giant leap to more world beating companies and high-quality jobs' (THE HERALD, 2013). Given this high level of expenditure and high expectations, the policy became highly visible within the Scottish policy landscape and was closely monitored by politicians, the Scottish media and international agencies (OECD, 2004). The ITI was meant to be a genuine attempt to affect change at the level of the Scottish innovation system as a whole (COOKE, 2004; ROPER *et al.*, 2006; EDGAR, 2009) and was closely aligned with existing science and technology policies in Scotland which were heavily focused on the strengths of Scotland's universities (LYALL, 2005).

Despite these high expectations and political 'buy-in', the ITI failed to achieve its objectives and was prematurely terminated (THE HERALD, 2010). To date, there has been no systematic and objective examination of this strategically important policy intervention. This

paper seeks to rectify this by asking the simple but multi-dimensional question: What did the ITI achieve in terms of its objectives and why did these fall so far below expectations? Policy failures are rarely acknowledged and even less likely to be the subject of analysis, preventing the opportunity for learning. MARKUSEN (2000) notes that despite the fact that technology policy failures are 'numerous and costly', remarkably little research examines such failures. She claims it is often implicitly deemed to be less promising than examining successful initiatives. Yet, without insights into the causal factors underlying policy failure: 'how can we fashion an effective program of government intervention?' (p. 136). By examining a high-profile case of systemic innovation 'policy failure', this paper aims to address this significant omission within the literature.

LITERATURE REVIEW: THE THEORY AND PRACTICE OF SYSTEMIC INNOVATION POLICY

The theory of innovation systems

One of the most important theoretical perspectives within the field of innovation policy over the past 20 years has been the concept of the national innovation systems (NIS) (LUNDVALL, 1992; FREEMAN, 1995; COOKE *et al.*, 1997; SHARIF, 2006). This perspective strongly embraces an evolutionary theory of economic change (NELSON and WINTER, 1982; METCALFE, 1997). Within this neo-Schumpeterian perspective, innovation is viewed as a non-linear, relationally 'embedded' and geographically bounded phenomena (LUNDVALL, 1992; MORGAN, 1997; GERTLER, 2010) where capitalism is driven 'by the pressures of creative destruction' (BEST, 1990, p. 119). Under these conditions, it is widely accepted that government policies often play a central coordinating role within the innovation process (BEST, 1990; FREEMAN, 1995; DODGSON *et al.*, 2011; COX and RIGBY, 2013). A key focus of the NIS concept is the strong emphasis it places on the relational aspects between different institutional actors and how this facilitates the innovation process in a 'crowded space' where firms and institutions all closely intermingle (ACS and VARGA, 2005, p. 323).

Much of the initial innovation systems literature is national or sectorally focused (CARLSSON *et al.*, 2002; MALERBA, 2002) and so ignores the importance of regional factors in shaping both the local entrepreneurial system and the policy context. This omission is important because policy frameworks within the sphere of innovation policy are often regionally constructed. However, since the late 1990s, scholars have begun examining the relevance of these systemic concepts for regions and sub-national actors (COOKE *et al.*, 1997; ASHEIM *et al.*, 2011). According to some, a regional innovation system (RIS) is not just a smaller scale or 'proto' NIS (HOWELLS, 1999) because knowledge transfer, agglomeration economies and external economies operate differently at the level of a region (OUGHTON *et al.*, 2002). At its most rudimentary level, a 'regional innovation system can be thought of as the institutional infrastructure supporting innovation within the production structure of a region' (ASHEIM and COENEN, 2005, p. 1177). Universities, public sector research organizations, skills development bodies, regulatory bodies and – increasingly – venture capitalists are key actors within an RIS (COOKE *et al.*, 1997).

An RIS has two main subsystems: a 'knowledge generation' subsystem and a 'knowledge exploitation' subsystem (COOKE, 2004). Despite this, policy-makers often promote and focus heavily upon 'knowledge generation' policies. This is because of the strong belief that the public returns to innovation outweigh the private returns which are often spatially localized (AUDRETSCH and FELDMAN, 1996). Therefore, to promote innovation within regions, policy-makers often look to create knowledge or infrastructure capacity-building at a regional level. Recent empirical research in Quebec's coastal region shows that regional policy-makers frequently generate new institutions but fail to recognize the importance of the demand for knowledge within their policy frameworks (MELANCON and DOLOREUX, 2013). According to MELANCON and DOLOREUX (2013), 'the creation of new organizations does not appear to be sufficient to guarantee that these organizations will be strongly engaged with other actors in the region' (p. 1570). New institutional arrangements are therefore no 'panacea' for the lack of dynamism within firms situated within an RIS (p. 1569).

Getting the right 'policy mix'

The recent literature on innovation policy now increasingly focuses on the importance of designing the correct 'policy mix' (FLANAGAN *et al.*, 2011) or 'instrument mix' (BORRAS and EDQUIST, 2013). This is defined as the 'specific combination of innovation-related policy instruments which interact explicitly or implicitly in influencing innovation intensities' (BORRAS and EDQUIST, 2013, p. 1520). Such a focus highlights the importance of interactions and interdependencies which coalesce to influence the effectiveness of public policies and to highlight the 'trade-offs' and 'tensions' embedded within any policy mix (FLANAGAN *et al.*, 2011). According to some, the problematic nature of the design of the 'instrument mix' is what makes innovation policy instruments 'systemic' (BORRAS and EDQUIST, 2013, p. 1513). This is because many innovation policies are constructed and mediated through a complex array of multi-actor, multi-scalar and multi-stakeholder relationships. Consequently, policy-making within this environment is often highly politicized and contested (UYARRA, 2010), with many

innovation instruments selected by a rather random or 'ad hoc' set of decisions and criteria (BORRAS and EDQUIST, 2013).

Yet, the complex interplay of institutional and political actors and how this shapes innovation policy has often been overlooked by innovation policy scholars. This has created certain shortcomings not only within the innovation literature but also within innovation policy itself. Given that 'innovation policy is what its instruments are' (BORRAS and EDQUIST, 2013, p. 1521), the innovation policy literature needs to go much deeper to assess the causal mechanisms shaping the institutional and operational effectiveness underpinning these policies. This is particularly important because of the highly risk-oriented nature of technology and policy which can fail just as easily as the innovation strategies deployed by individual firms (METCALFE, 1997; MAZZUCATO, 2013).

The effectiveness of policy instruments 'plays a crucial role as a way to open up new growth paths' (CRESPI and QUATRARO, 2013, p. 1447). Therefore, achieving the optimum innovation policy mix is the key to unlocking the puzzle of effective policy implementation. If innovation policy is to become more adaptive to the needs of key innovation actors, greater recognition needs to be given to the specificities of how policy operate and, importantly, what undermines the effectiveness of various 'policy combinations'. For this to happen, a key antidote is a deep evolutionary examination of the specificities and intricacies which shape the dynamics of the overall 'policy mix'.

Assessing policy effectiveness

Another key criticism that can be levelled at the innovation policy literature is a lack of detailed analysis of how public policies operate within innovation systems on a longer-term evolutionary basis (UYARRA, 2010; UYARRA and FLANAGAN, 2010). Research tends to focus on 'what policy makers ought to do' while being less concerned with 'what policy makers actually do' (UYARRA, 2010, p. 130). Most importantly, it portrays the process of innovation policy-making as a simple rational exercise which is constructed by optimal decision-making and perfect information. Just as there are a host of variegated actors within an RIS, most actors have quite distinct ideas and self-interests which in turn govern much of their behaviour. Some scholars rightly claim that much greater empirical attention needs to focus on 'actual' as opposed to 'idealized' processes of policy learning and to understand better the roles that experts, analysts and evaluators play in those processes vis-à-vis other actors' (FLANAGAN *et al.*, 2011, p. 711).

The relevance of the current literature may also be circumscribed by the fact that most empirical studies examining the effectiveness of innovation policies tend to be cross-sectional, providing a snapshot at one point in time (e.g., ROPER *et al.*, 2006) rather than demonstrating how the RIS evolves and upgrades over time (BERGEK *et al.*, 2008). These studies can be misleading (SALTER and MARTIN, 2001) because public policies often adapt according to market demands and incorporate changes suggested by stakeholders and recipients such as individuals and firms. Therefore, it is important to view the 'policy mix' within an RIS as a dynamic rather than a static phenomenon.

Standard forms of evaluative assessments of innovation policy instruments have also been strongly criticized for being too narrowly focused on performance measures (AUTIO, 1998; DIEZ, 2001; MOLINA and GREGSON, 2002). Although more nuanced qualitative-oriented evaluations are now being undertaken (YOUNG *et al.*, 2008), traditional approaches towards evaluating innovation policies strongly favour quantitative methods (FELDMAN and KELLEY, 2006), treating the process by which innovative inputs lead to outputs as something of a 'black box' (GREENE and STOREY, 2007; FLANAGAN *et al.*, 2011). Such approaches arguably hinder a proper understanding of the complex causal processes at work and indicate little about why interventions succeed or fail (TUROK, 1991). Indeed, evaluation approaches that have tended to rely on quantitative performance indicators tend to ignore the wider systemic factors affecting the success of policy interventions (ARNOLD, 2004).

Unravelling the complex interplay between the different combinative factors that mediate and shape the success of 'policy mixes' is methodologically difficult. In the context of this study, the authors believe that there is invaluable learning to be gained from assessing the causes and consequences (both intended and unintended) of systemic policy interventions. With its wide-ranging objectives of unlocking important 'blockages' in the Scottish RIS (COOKE, 2004, p. 94), the ITI provides an excellent case study of this new kind of systemic policy instrument. In line with others, the authors believe that much greater attention needs to be paid to the complex interrelated 'histories' of different 'policy mixes' (FLANAGAN *et al.*, 2011), especially in relation to policy failures (MARKUSEN, 2000). Therefore, the main aim of this paper is to provide learning that can inform one's understanding about how policy instruments interact (and indeed collide) with their economic and institutional environment.

METHODOLOGY AND DATA SOURCES

A longitudinal case study methodology was utilized to examine the ITI case during its seven-year (of a projected ten-year programme) lifespan (2003–10). The study sought to tease out the impact of the policy

intervention on a variety of levels. In order to maintain 'construct validity' (EASTERBY-SMITH *et al.*, 2002), the research used multiple sources of evidence built up over a period of time. The wide-ranging nature of the research process helped to mitigate the pitfalls of mainstream evaluative research which can be influenced and distorted by the project sponsors (BOZEMAN, 2000). Overall, this detailed qualitative research approach enabled the 'multifaceted, temporally unfolding situations and causal mechanisms' (GRAEBNER *et al.*, 2012, p. 279) to be unpacked.

The research drew upon a wide range of primary and secondary data sources. First, a wide range of unpublished background material was examined, notably internal reports by the ITI and Scottish Enterprise. This included analysis of the original approval papers that outlined the rationale for the ITI, feasibility studies and forecasted benefits. Numerous newspaper articles, company reports and websites were also examined as part of the background analysis for the research. Since the termination of the programme, obtaining evidence on the ITI's performance has been a challenge on account of its politically sensitive nature. Some of the evidence on the final impact of the programme is therefore drawn from information derived from a Freedom of Information request submitted by a Scottish newspaper (THE HERALD, 2013).

Second, the research included in-depth interviews with key stakeholders involved in the Scottish innovation system. These interviews were conducted at three points in time. Prior to the launch of the programme, 15 interviews were conducted in 2003 with senior figures representing three categories of actors central to the Scottish RIS: universities, government and the private sector, including university technology transfer managers (n = 9), Scottish Executive and Scottish Enterprise senior managers (n = 2), and with public–private-sector agencies (n = 4) supporting technology commercialization. Midway through the programme, in 2007, 19 interviews were undertaken with various actors' involved in the programme. These included contractors who received research contracts, recipients of licences from the commissioned research programmes, and staff within the ITI and Scottish Enterprise. It also included interviews with ten companies that were working with the ITI to undertake R&D programmes with a view to licensing the intellectual property (IP) produced. Following the termination of the programme in 2010, a final round of ten interviews was conducted with universities, technology entrepreneurs, policy-makers and small and medium-sized enterprises (SMEs) across Scotland. In summary, a total of 44 interviews were undertaken over the ten years in which the research was conducted.

Where possible, the interviews were taped and transcribed. However, a significant number of people declined to have their views recorded. The interview material was interpreted using a partial 'grounded' approach in which the data were systematically analysed to tease out themes, patterns and categories. When key categories emerged they were refined and re-evaluated. During the final phase of the interviews, some of these themes were then fed back to participants to assess the veracity of the earlier findings as others have done with policy-oriented research (FISCHER and REUBER, 2003).

THE INTERMEDIATE TECHNOLOGY INITIATIVE (ITI): AN OVERVIEW

The ITI was launched in 2003 with the objective of identifying emerging global market opportunities in the three key sectors of life sciences, techmedia (i.e. information and communication technology (ICT) and digital media) and energy. The ITI had three distinctive 'institutes': the Energy institute based in Aberdeen, Life Sciences based in Dundee and Digital Media based in Glasgow. It was designed to undertake four core functions: foresighting, programme development, programme management and value release/commercialization (Fig. 1). The model was heavily predicated on the ability of the programme to undertake advanced technological foresighting.

Thematic research areas were then developed into formal research programmes and evaluated on four core criteria:

- Forecasting new global market opportunities.
- Creation of novel and protectable intellectual property.
- Creation of new businesses with identifiable routes to market.
- Complementing the Scottish corporate and research base and Scotland's ability to exploit the technology.

Following this assessment, research programmes were then devised. Each R&D programme was managed by a programme manager whose role was to ensure that the knowledge and know-how from the programme was effectively identified, captured and (most importantly) protected. Typically, the range of technical development on any programme required multiple R&D providers from across the academic and business spectrum. The average size of expenditure per programme was £5.8 million, a figure much higher than originally anticipated by Scottish Enterprise. This was primarily because, in some cases, programmes had to commission further R&D to bring them 'closer to market'.

Intellectual property rights (IPRs) were fundamental to the ITI's operating model. Ownership of the IP by ITI Scotland was considered essential by Scottish Enterprise and programme directors to allow the platform potential of the technologies to be exploited in ways that created direct benefits to the Scottish

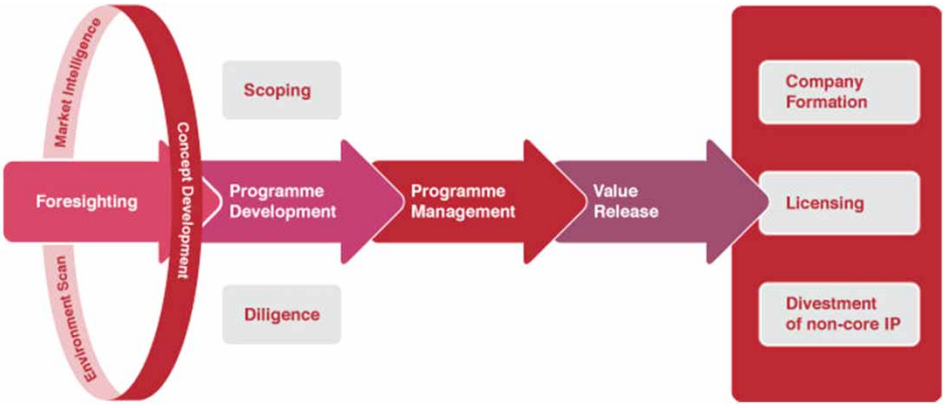

Fig. 1. *Operating model of the Intermediate Technology Initiative (ITI) programme*
Source: ITI SCOTLAND (2008)

economy. IP ownership was also needed to comply with stringent European Union state aid rules. Hence, in all the R&D programmes undertaken, the ITI sought to own the pre-competitive IP generated which it sought to license to commercial partners at market rates. It was anticipated that the main beneficiaries would be Scottish firms that license the technology but, failing that, firms outside Scotland were also eligible to license the IP.

The final and perhaps critical stage of the ITI model was the commercial exploitation of the intellectual assets developed. The economic impacts were expected to be derived in two main of ways. First, the key commercialization route was expected to be through the creation of NTBFs which were thought likely to emerge from research providers and commercialization partners. University spin-offs were initially expected to be the most important source of NTBFs. Second, the other expected strand of commercialization was via existing businesses licensing IP to enable new product or service development. Commercialization partners were expected to produce a plan showing their proposals for exploiting the technology. Licences for IP were negotiated on the content of detailed business plans submitted to the ITIs by commercial partners.

Assistance with the commercialization process was provided by the public sector in terms of business support for the NTBFs anticipated to emanate from the research programmes. The responsibility for this business support rested with Scottish Enterprise through existing support mechanisms such as the High Growth Start-Up Unit within Scottish Enterprise. In this respect, the model resembled the 'assisted linear' approach to innovation (ETZKOWITZ, 2006). The ambitious nature of ITI was reflected in the specific performance metrics adopted. Scottish Enterprise predicted that within the ITI's first ten years at least 75 NTBFs would be operating as a direct result of the programme. This figure was anticipated to rise to around 170 after 20 years.

THE PERFORMANCE OF THE ITI

By March 2013, the final budgetary outlay of the programme stood at £231 million, a figure just over half of the original anticipated ten-year budget for the programme (£450 million). To put this in context, in 2012 the total figure for business expenditure on research and development (BERD) in Scotland was £707 million, or 4.1% of the overall level of UK BERD (SCOTTISH GOVERNMENT, 2013). The ITI programme therefore constituted a sizeable sum equivalent to about one-third of annual Scottish BERD.

By March 2013, when the programme was effectively terminated, the programme had achieved the following outcomes:

- Twenty-two R&D programmes completed.
- Ninety-four patents registered.
- Five NTBFs currently trading.
- Twenty-four licensing deals, with £600 000 in licensing revenue having been paid to the ITI.

The 22 R&D programmes that have been completed across the three main sectoral divisions of the ITI (ranging in size from £30 million in the case of the Cardiac Biomarkers programme to just £1.8 million by the Games-based e-Learning R&D programme) resulted in 94 patents being registered; an average of around 13 per annum. To put this figure into perspective, there were 207 patents granted to Scottish firms in 2011 (INTELLECTUAL PROPERTY OFFICE, 2012). One of the most innovative technology-based firms in Scotland, Wolfson Microelectronics, a supplier of semiconductor devices to Apple and Samsung, registered over 60 patents in 2011 alone (INTELLECTUAL PROPERTY OFFICE, 2012). When seen in this context, the number of patents generated over a seven-year operating lifespan does not seem to constitute an exceptional output for the volume of expenditure committed.

However, the key failure of the ITI was not in terms of the research output it produced but rather the lack of commercial outputs generated. In this respect, the two

key 'output' indicators of the programme were the small numbers of NTBFs created and licences awarded. In terms of the former, just five NTBFs have resulted from the programme. By any yardstick, this figure seems low, but especially since the original aim was to generate 75 NTBFs on completion of the programme.[1] The second indicator, which further underlines the weak performance of the programme, is the very low level of licensing revenue generated by the programme. The ITI concluded 24 licensing deals producing revenue of £600 000, which implies that the vast majority of patents have not been commercially exploited. It is this low level of licensing revenues that has been the source of much of the criticism directed towards the programme (The Herald, 2013). There is no publicly available information on either the location of the licensees, so one cannot assess 'where' the IP produced is being commercially exploited, or how many full-time equivalent (FTE) jobs were created within the ITI's R&D research providers.

Following the internal review of the programme in 2008, a number of modifications were made. First, it was decided that the programme should be brought in-house within Scottish Enterprise (Edgar, 2009). This decision, which took effect in 2009, was taken to ensure that greater efforts were directed towards the commercialization of the R&D programmes. In 2010, with the programme's overall budget standing at £216 million, it was decided that no new R&D programmes would be commissioned. There was a further expenditure of £15 million on the remaining R&D programmes, but since March 2013 there has been no further expenditure committed to the ITI.

EXPLAINING POLICY FAILURE

This analysis identifies two main sets of factors that limited the effectiveness of the ITI. The first set comprises various internal institutional issues. These include the nature of the research programmes, the stance towards IPRs, the ITI commercialization procedures and internal ITI governance issues. The second set revolved around the systemic characteristics underpinning the Scottish entrepreneurial ecosystem. These two sets of factors coalesced to weaken critically the overall effectiveness of the programme. These are summarized in Table 1.

Table 1. Policy mismatch between the Intermediate Technology Initiative (ITI) and the Scottish entrepreneurial ecosystem

Nature of the ITI	Nature of the Scottish entrepreneurial ecosystem
Focus on creating new indigenous technology-based firms	Weak indigenous entrepreneurial capabilities, especially in areas of high-technology entrepreneurship
Produce leading-edge research and development (R&D) in high-technology areas for universities to commercialize	Most new technology-based firms (NTBFs) emerge from existing corporations through informal spin-offs or management buyouts (MBOs). Weak record of commercializing university research
Research was designed to develop novel intellectual property (IP) which would be commercially licensed to small and medium-sized enterprises (SMEs)	Main innovation sources for many Scottish SMEs are informal or 'open' innovation sources Limited history of SMEs formally licensing IP
Produce leading-edge IP in 'platform' areas of high-technology	Weak levels of 'absorptive capacity' within Scottish SMEs
Produce technology in three main high-technology areas to license to SMEs	Very low numbers of R&D-intensive firms or NTBFs within high-technology areas
Commercialization of leading-edge research could be undertaken in Scotland	Low levels of expansion capital to enable the commercialization of high-technologies in Scotland
Designed to generate 'risky' technologies with the expectation that these would be venture capital funded	Culture of premature sell-off within NTBFs Firms have limited access to venture capital; most risk finance is provided by business angel funding, often co-invested by the public sector, and tends to be small scale (i.e. below £500 000)

Institutional factors and policy underperformance

Nature of the research programmes. A key institutional factor impeding the successful operation of the ITI was the pre-competitive or 'blue sky' nature of the research programmes. The R&D programmes were heavily oriented to producing a novel IP which by its very nature was far from market. This had two negative

consequences. First, while many companies viewed the foresighting work to be of interest, the majority felt that the technology being developed was just too far advanced for their own requirements. The potential pitfalls of this approach were identified by one of the stakeholders prior to the launch of the programme:

> [I]f SMEs do not have the required technology/knowledge to exploit the market opportunity, then the pre-competitive research commissioned by the ITI may not find its way back to the Scottish economy and remain in the research environment.

Second, because of the formative nature of the technology, the programme did not generate applications that were immediately commercializable. In most cases, the programmes produced 'platform' technologies that many of the potential users considered not to be 'market ready'. Most of the programmes therefore required further work to be done to take the IP created to a stage which could be properly applied commercially. This was also a potential problem that some stakeholders had anticipated prior to the programme's launch. One remarked:

> [I]f the fore-sighting of the ITI involves global players, then the technologies commissioned will be even more advanced and harder to absorb by local SMEs, and most of this technology will be absorbed by multinationals.

Intellectual property rights (IPRs). The second key institutional issue was the approach adopted by the ITI's regarding IPRs. The ITI's stance on IP ownership – that all background and foreground IP developed through the research programmes was owned by the ITI – conflicted with the rigid stance of Scottish universities towards IP ownership, which emphasizes the need to protect the IP they produce in order to maximize the benefits of research in terms of future income generation from licence agreements and equity stakes in spin-off companies. As a consequence, some universities refused to engage in the ITI research programmes. When involvement between the universities and ITIs occurred, negotiations and transactions often became very protracted, and in some cases hostile, making them difficult to conclude. This rigid stance of universities has acted as a 'critical inhibitor', preventing many of the universities in Scotland participating in the ITI research programmes. However, it needs to be acknowledged that a more favourable outcome from a closer involvement of universities is questionable, in view of their poor track record in producing spin-offs of any scale (Targeting Technology, 2008; Harrison and Leitch, 2010). This issue of IP ownership was identified as a key concern by university technology transfer directors prior to the launch of the ITI.

The attitude of the ITI towards IPR also impinged on both commercial research providers and also the potential recipients of licences. The ambiguous and contested nature of IPR issues became apparent during the interviews with research providers (who were also potential licensees). Some companies – especially those that were venture capital (VC) backed – did not wish to license the technology from the ITIs because they did not feel that this would have provided them with sufficiently protected IP. One renewable energy firm stated that in order even to consider licensing IP, they would 'need exclusive IP' to allay any fears to their VC backers. Indeed, studies have shown that VC backing is strongly linked to IPR protection (Mann and Sager, 2007). Even the offer from the ITI of 'exclusive' licences was not sufficient for some early-stage companies that wanted the security of outright ownership of their IP. In summary, the decision on behalf of the ITIs to insist on outright ownership of the IP inadvertently prevented most Scottish universities and existing businesses from engaging in the programme, making the ITI-mediated RIS a rather 'closed' rather than an 'open' innovation system.

Research commercialization procedures. The ITI's approach towards commercialization of the research, particularly its licensing procedures, was also problematic. There was a requirement to pay up-front fees – often as much as £150 000 – to obtain an exclusive licence. This fee was often in addition to the payment of ongoing royalty fees to the ITI on sales from any new products developed as a consequence of the IP being exploited. Indeed, in nearly half of the licences examined during this research, an up-front licence fee was demanded in addition to on-going royalty payments.

The ITI was also criticized for being inflexible in the negotiation of licence agreements. One potential SME licensee interviewed enquired about the possibility of obtaining a 'demonstrator' licence so the firm could show the potential applications to a potential customer. This was strenuously opposed by the ITIs, so the company refused to license the IP. This lack of flexibility clearly inhibited the commercialization of the technology, especially by smaller companies with limited finances for such high-risk research expenditure. A number of firms felt that there was too much emphasis on producing IP and not enough emphasis on the need to 'create jobs'. Midway through the lifespan of the programme in 2007, one research provider presciently remarked, 'The ITI may end up just creating more IP in Scotland.'

Systemic factors mediating policy underperformance

The second set of factors focus upon the specific nature of the knowledge exploitation subsystem in the Scottish RIS. The nature of the Scottish 'entrepreneurial ecosystem' diverges from the manner in which the ITI was designed to operate in a number of important respects (Table 1). First, there was a lack of indigenous

entrepreneurs who wanted to take part in the ITI R&D programmes. The original intention was that the R&D programmes would mostly be undertaken by university researchers who would spin-out their research into new corporate ventures. This did not occur because, as noted above, most of the R&D programmes were undertaken by private sector research contractors to produce IP that would then be licensed to new start-ups, thereby breaking the link between the inventors and the adopters of the research.

From a demand perspective, very few potential entrepreneurs actively sought involvement with the ITI with a view to starting a NTBF. This is perhaps unsurprising, given the region's historical lack of new business start-ups, which has been an enduring part of the Scottish economic landscape over the post-war period despite considerable policy efforts directed towards raising the business birth rate (Van Stel and Storey, 2004; Brown and Mason, 2012). Another hallmark of Scotland's entrepreneurial ecosystem is the strong role of existing corporations as the main entrepreneurial incubator of new firms. A large number of 'new' firms emerge from existing corporate entities – as independent spin-outs, portfolio entrepreneurs (Rosa, 1999) or through ownership changes such as management buyouts (MBOs). Recent research has shown that the most important source of NTBFs in Scotland is the existing stock of high-tech firms (Brown and Mason, 2014). This situation is not unique to the Scottish economy (Oakey, 2012). Despite this, a strong feature of much of Scotland's innovation policies, such as the ITI, is a strong focus on commercializing research undertaken from Scottish universities (Lyall, 2005).

The focus of the ITIs on generating IP within universities therefore seems counter to entrepreneurial patterns within Scotland's entrepreneurial ecosystem where businesses, rather than universities, are the main incubators of NTBFs. One R&D provider interviewed suggested that a better model would have been for the ITI jointly to undertake the R&D programmes with existing SMEs, either to embed the IP within those firms or through the creation of new entrepreneurial spin outs.

A further constraint on high-tech entrepreneurship in Scotland, in common with many other peripheral regions, is the deficiency of large-scale 'patient' capital to aid the process of successful research commercialization (Mason and Pierrakis, 2013). While public sector organizations like Scottish Enterprise have created local venture funds and stimulated a number of small business angel syndicates within Scotland, none of these is capable of assisting firms with major levels of funding (between £2 million and £20 million) to help commercialize major disruptive technologies. Moreover, the investment approach of both VC funds and angel groups is to seek an exit, which results in a 'sell-off' mentality within Scotland's technology sector. Hence, for most entrepreneurs of technology-based firms, it is not a case of 'if' but 'when' to sell their company (Oakey, 2003). Indeed, one firm involved in one of the ITI R&D programmes was acquired shortly after the termination of the programme. The firm received close to £1.5 million in funding from the programme. While the firm found the funding 'very useful' in helping with its expansion, the ultimate benefit of this R&D funding went to the US multinational that acquired the firm. To our knowledge, at least one other firm funded through the ITI R&D programmes has also been acquired. In summary, the ITI approach was incompatible with a small local financial system biased towards short-termism, and lacking deep pockets (Mazzucato, 2013).

Another barrier to the commercialization of the research programmes concerns the nature of the existing business base in Scotland. The Scottish RIS is strongly characterized by an SME population with very low levels of BERD (Roper *et al.*, 2006) and very weak levels of 'absorptive capacity' (Cohen and Leveinthal, 1990; Harris *et al.*, 2013). The vast majority of Scottish SMEs do not conduct formal R&D and very few licence technologies from third parties such as universities or research providers (Brown and Mason, 2014). Hence, for the vast majority of Scottish SMEs, the research being undertaken was well beyond the reach of their technological capabilities. It was noted by one interviewee that

> SMEs many times do not have a strategic approach for technology transfer. They often do not know what they want and there is a lack of long-terms vision, awareness and resources.

Rather than formal R&D processes, the nature of the innovation processes deployed by local innovative SMEs is often through 'open' interactions with customers, end-users and suppliers (Luthje *et al.*, 2005; Von Hippel, 2009). These kinds of interactive open innovation processes are quite different to those used by larger enterprises with formal R&D procedures; by adopting these inbound innovation processes, SMEs can compensate for a lack of internal resources (Parida *et al.*, 2012). Indeed, the use of these open sources of innovation is often associated with superior economic performance by these smaller firms (Berchicci, 2013; Brown and Mason, 2014). This was completely overlooked by the ITI programme, which meant that the intended 'customer base' for the technology being produced was largely unfamiliar and unreceptive to the process of licensing IP from third-party organizations.

Another factor preventing local firms licensing IP is the dearth of technology-based firms in Scotland. Recent research shows that NTBFs constitute a very small overall proportion of the business base in Scotland (Brown *et al.*, 2012). Indeed, Scotland ranks the second lowest of all UK regions in terms of the proportion of its business base which are technology-

based firms (BROWN *et al.*, 2012). As a consequence, very few Scottish firms became research contractors for the R&D programmes. One respondent noted that the dearth of Scottish technology companies with the capabilities to license IP meant that

> there is no guarantee that the backward flow of economic benefits [to Scotland] is going to happen since it is possible that the Scottish companies wouldn't be able to deliver the expected development.

The ITI R&D research programmes were exclusively focused on technological foresighting undertaken in three main high-technology areas outlined above. These areas were selected on the basis of the global market opportunities that were forecast rather than activities where Scotland had pre-existing strengths. With the exception of the energy sector, which has a substantial presence in Scotland and contributes around one-third of Scotland's technology-based firms (MASON and BROWN, 2012), the life sciences and the digital media sectors are both small in size and have few research-oriented SMEs. Moreover, although the energy sector had potential to absorb some of the IP being developed, many of the research programmes undertaken by the energy division of the ITI focused on the renewable sector, a market that is still embryonic in Scotland and dependent on subsidies. Here again, this shows a lack of recognition of the specificities of the local entrepreneurial ecosystem, which was largely incapable of connecting to and 'absorbing' the outputs from the ITI.

CONCLUSIONS

This paper has made a novel contribution to the innovation policy literature by examining the failure of, arguably, the UK's most ambitious ever 'systemic' policy instrument. It has been shown that the ITI programme badly malfunctioned and was not the policy panacea envisaged by policy-makers. Based on the outdated linear model of innovation, it produced little of its anticipated commercial benefits. The design of the programme insufficiently connected the two sides of the RIS, leaving the knowledge production side and the knowledge exploitation elements isolated from one another. While reasonably effective at producing knowledge, the programme failed to harness properly the commercial benefits from the research, especially in terms of the numbers of NTBFs created.

The key problem with the ITI programme was its inability to diagnose properly the underlying structural problems within the RIS, which is heavily shaped by the nature of its local entrepreneurial ecosystem (MASON and BROWN, 2014). This confirms the view that more attention needs to be paid to the entrepreneurial propensity of innovation systems (RADOSEVIC and YORUK, 2013). The findings have a strong resonance for other peripheral regions with equally fragile entrepreneurial ecosystems (TOEDTLING and TRIPPL, 2005; MELANCON and DOLOREUX, 2013). They also suggest that the importance of entrepreneurial 'agency' within innovation systems needs to be better reflected within the systemic innovation literature (ACS *et al.*, 2014). Given the nature of the Scottish entrepreneurial ecosystem, possibly a better 'policy mix' in this context would have been attempting to improve the overall levels of 'systemic capabilities' within the RIS (IAMMARINO *et al.*, 2012) whilst fostering greater levels of open innovation within SMEs (BROWN *et al.*, 2014).

This kind of 'bottom up' demand-led approach towards innovation is in stark contrast to the dominant supply-side logic hardwired within innovation policy-making in the UK. Indeed, the empirical findings strongly echo recent claims by the House of Commons Science and Technology Committee that UK innovation policy 'retains an implicit discredited linear model in many places' (HOUSE OF COMMONS, 2013, p. 9). Hence, despite the opportunities presented to policy-makers from the process of political decentralization within the UK (COOKE, 2005), the Scottish Government has been unable to break away from the dominant, linear logic of UK technology and innovation policy as a whole. This demonstrates that, despite the adoption of an RIS approach in Scotland, strong path dependencies continue to shape and mediate regional innovation 'policy spaces' (UYARRA and FLANAGAN, 2010) within the UK's multi-scaler innovation system.

It is important to stress the ITI's lack of success is not a reason for policy-makers to curb their ambitions. Rather, the key issue is that policy failures need to be acknowledged and assessed so that policy-makers can learn and adapt in light of these experiences. Powerful insights can be gained from looking inside the policy 'black box'. To understand the full complexities of the policy-making process, however, innovation scholars need to scrutinize failure as well as successes.

Acknowledgements – The authors are very grateful to the substantial numbers of people who were interviewed during this study. In addition to stakeholders and participating companies, numerous people in Scottish Enterprise and the Intermediate Technology Initiative (ITI) kindly provided input into the research. The authors would also like to thank Phil Cooke, Alex Coad, Suzanne Mawson and Fiona Wishlade for their constructive suggestions made on earlier versions of this paper. They also wish to thank the referees for the very helpful comments received. The usual disclaimer applies.

NOTE

1. While this figure does seem very low, when the situation in Scotland is compared with elsewhere, the ITI's

performance may be less disheartening. The German technology organization Fraunhofer, which is often regarded as a best-practice example for public financing of applied research commercialization, provided support for 33 spin-off projects and produced ten spin-offs in 2012 (Fraunhofer-Gesellschaft, 2013). The Fraunhofer is a much larger research organization with 67 research institutes, 23 000 employees and an annual R&D budget of almost £2 billion. While the focus of this organization is directed towards technology transfer more generally, these relatively modest spin-off figures paint a more positive picture of the ITI's performance. The authors are very grateful to one of the anonymous referees for making the point about comparisons with other programmes.

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