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Review of International Knowledge Transfer Policy and Investment

A report to Knowledge Transfer Ireland

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Executive Summary

This study was commissioned by Knowledge Transfer Ireland (KTI) to review policies and investments in Knowledge Transfer in Ireland and six comparator countries.

The six countries – Denmark, Finland, Israel, New Zealand, Scotland and Singapore – are all small advanced economies, which provide suitable benchmarks for Ireland.

KTI was formed in 2013 as the central Knowledge Transfer office in Ireland and is continuously reviewing performance and looking at good practice abroad. The study seeks to support KTI in this effort by providing a deeper understanding of what Knowledge Transfer (KT) policies and measures have been put in place in six comparator countries, and the reasons for such decisions.

National approaches to knowledge transfer:

Approaches to KT reflect contextual factors as well as the maturity of a national innovation systems or the mix of specific KT instruments. We therefore looked at national approaches to KT, in order to try to disentangle the contextual from the instrumental.

Reviewing government policy statements and legislation we find:

- Across the seven countries, knowledge transfer is now a political priority in most cases, forming an integral part of national innovation policy. In five of the seven countries – the exceptions being Israel and Scotland (UK) – this is a relatively recent development, unfolding since the turn of the century
- In many cases, new legislation and policies have reformulated our social contract with public research organisations, and especially universities, with the introduction of the 'third mission' sitting alongside education and scholarship. The expanded mandate has been accompanied by a move to 'institutional ownership' of the intellectual property arising from publicly funded research, in order to incentivise entrepreneurship

The collection of data on knowledge transfer is rather uneven across the seven countries. Ireland, Scotland and Denmark perform annual surveys of knowledge transfer and commercialisation and as such are leading this in this area.

Examining the nature of investment and the measures taken to support knowledge transfer, we observe the following points of similarity:

- Denmark and Israel rely on general institutional funding to cover the costs of knowledge transfer activity within the university sector, whereas Scotland, New Zealand and Ireland provide specific KT funding to support the recurrent costs of running KT offices (KTOs) as well as project-related KT activities
- These three countries have also established national KT resources to complement the KT offices of the individual research organisations, to champion KT within policy circles and to facilitate peer-to-peer learning and professionalisation
- Other countries have established national coordination functions to service specific constituencies (e.g. the National Technology Transfer Company (NTTC) for teaching colleges in Israel and the Exploit Technologies Pte Ltd (ETPL) company in Singapore, which carries out TT activities for the government's public laboratories)
- In several of the comparator countries, individual institutions have come together to form member-based technology transfer networks to aggregate information about KT opportunities on the one hand and to support practitioners through peer-learning, training and information exchange (e.g. techtrans.dk in Denmark an open forum for researchers and businesses looking for innovative collaboration opportunities, 2000-2010)

- Across the seven countries, we find numerous variants of broadly similar KT support schemes from early stages (Ireland's TIDA and Israel's KAMIN) proof of concept (Singapore's Proof of Concept fund), schemes that involve business development or organisational aspects (Ireland's Commercialisation Fund, New Zealand's Pre-Seed Accelerator Fund, Scotland's High Growth Spinout Programme and Singapore's Gap Funding programme).
- Many of these schemes have evolved over time through experimentation and learning and also to reflect maturation in the underlying KT system, and are now in their second or third 'generation.' Performance based funding, for example, has been implemented in Scotland
- We also see some evidence of a broadening of types of support, as policy makers recognise the full spectrum of KT channels and the potential value added of providing some top down advice or financial support (e.g. innovation vouchers, industry fellowships, etc.)

Reflections

Knowledge transfer is a public good that warrants government investment

The seven countries reviewed all invest significant sums to improve knowledge transfer between Public Research Organisations (PROs) and business. With the exception of top Israeli universities, KT is a cost centre not a profit centre for the great majority of institutions, in all of our countries. Given the tight finances of individual PROs and the potentially very large social returns to improving access to public sector IP, most governments see a prima facie case for recurrent dedicated funding of KT, additional to general university funds.

One size does not fit all

The seven countries in our sample have chosen different approaches to supporting knowledge transfer and, to an extent, this reflects the underlying conditions in each country. Learning from best practice abroad is important but attempts to replicate systems elsewhere directly are unlikely to be successful. Israeli universities are among the top performers in the world in terms of commercialisation of research. However, this builds on a very specific set of circumstances including more than half a century of experience, and a unique economic and political environment. Similarly, Singapore has a strong and visible government support, cohesive policy, clear legislation and IP rules, and continuous investment in KT infrastructure and targeted financial schemes through the multiannual government framework for Research, Innovation and Enterprise (RIE).

There is clear value in a national KT function that provides additional expertise to individual institutions, is industry facing and actively champions knowledge transfer. In Ireland, Scotland and New Zealand where this approach has been taken in different forms, it addresses a clear need in the system. In Israel and Denmark, leaving the initiative largely to individual universities may well be viable decision given the different structure and history.

Monitoring and learning

Monitoring outcomes is a crucial part of the process of improving quality. Ireland is among only three countries of the seven reviewed to have systematic annual surveys of national knowledge transfer activity. It will be important to develop indicators further to track not only short-term outputs (LOAs etc.) but also long-term sustainability of knowledge transfer activities.

Our sources strongly suggest that a long learning process of trial, error and gradual adjustment is an unavoidable part of developing an effective knowledge transfer system. We have found evidence that this is the case for both government-led funding schemes and operation of individual knowledge transfer offices. Improving performance in national KT systems is the result of numerous incremental changes, rather than the apocryphal 'Eureka' moment.

Emerging trends

Government support for knowledge transfer has traditionally focused on the commercialisation of public research through patents and licences (and spinoff companies more recently), however here are many channels through which knowledge transfer can happen. This report has focused on existing government-led funding schemes but we have seen evidence of other areas of activity that may develop further in the future. For example, many universities actively engage in contract research and consultancy but none of the national policies or schemes in the countries we have reviewed address this specifically. Another area is mobility of researchers between academia and industry, which allows for a much richer transfer of tacit knowledge not easily captured in publications and patents. Some government schemes support staff exchange but some universities are developing more permanent measures in the form of tailored employment contracts, for example. Many of these activities are pioneered by universities and successful experiments may be taken up by the broader KT community.

1. Introduction

1.1 This report

This draft report presents the results of desk study to review knowledge transfer policies and investments in use in Ireland and six comparator countries: Denmark, Finland, Israel, New Zealand, Scotland and Singapore.

The study was commissioned by Knowledge Transfer Ireland (KTI) in order to deepen the organisation's knowledge about KT policies and instruments internationally. The study set out to provide KTI with new reference material and insights to ensure its own agenda and operations are focused in the right direction. The aim was to detail the types of KT policy interventions undertaken across the selected countries and to understand the drivers for and outcomes of those interventions.

The research comprised a series of country reviews, drawing on policy documents and programme descriptions, national and international KT statistics and published evaluations. The study team also interviewed 20 senior officials and experts in order to understand the particular policy choices and success factors within each of the comparator countries. The material was compiled in seven country profiles, which formed the background of this report. The largely descriptive country reports each:

- Profile the types of knowledge transfer policies and measures in use in the seven countries
- Discuss the drivers (rationale) for the choice of strategy and types of policy intervention
- Detail the outcomes of the different approaches and interventions

The main body of this analytical report draws selectively on information from those seven country case studies, highlighting the most interesting features of the technology and knowledge transfer system as it relates to publicly funded research.

1.2 Approach

The six comparator countries (Denmark, Finland, Israel, New Zealand, Scotland and Singapore) were selected based on their size and similarity to Ireland, as well as their performance in knowledge transfer. The unit of analysis is the country rather than individual programmes in order to reach an understanding of the national systems and policy mix in place. Comparative cross-country analysis examines initiatives and policies implemented at the national scale, except in the Scottish case (as a devolved region of the UK) and as such does not take into account sub-national initiatives or those undertaken by individual research or higher education institutions. The analysis examines features of the different national systems, without going into activities that are 'non-systematic' (e.g. ad-hoc workshops or seminars). Finally, the study attempts to draw lines between support for policy for knowledge transfer, and the broader innovation ecosystem.

We rely only on the data collected via desk research and our interviews with key figures in each country. We have strived to gain insight from both the 'user' and 'government/policy actor' sides of the system, and reflect in the case studies the key developments, policies and investments (i.e. programmes and supports) discussed in those interviews.

1.3 Scope

This report is about government investments in knowledge transfer between public research organisations (PROs) and industry and wider society. 'Knowledge transfer is a rather fluid concept and can include a wide variety of KT 'mechanisms' or 'channels' (Figure 1) that go beyond the activities formally considered KT such as IP exploitation, spin-off creation and contract research. In this report, we look at the subset of these mechanisms found to be subject to government policy and investment in KT across the seven countries. This mainly concerns traditional 'technology transfer' with patents and licencing (1a), more or less formal networking (2) as well as academic consulting and contract research (1b and 1c). In addition, we acknowledge the importance of collaborative research (1d) as a mode of KT.

Figure 1 KT activities / potential services provided by KTOs

KT Mechanism	KTO Role / Activity
1. Exploiting research outputs	Facilitating research exploitation
1a Exploiting IP ('Technology Transfer')	Developing university IP policy IP advice for academics Patenting and managing IP Making/ supporting licensing deals, Establishing university spin-outs
1b Academic consulting	Supporting /managing academic consulting, contract research, Collaborative R&D: Identifying opportunities Brokering teams Supporting/writing bids Agreeing contracts Project management Customer relationship management
1c Contract research	
1d Collaborative R&D (and other publicly funded KT activities)	
Other KT activities that support all of the above Business liaison/ business development Marketing and communications Point of contact for businesses Business liaison /relationship management Changing university culture Internal communications Raising awareness among academics of importance of KT 'Selling' the KTO internally Disseminating KT best practice KT training Entrepreneurship education/training: for staff & students / for external organisations	
2. Knowledge diffusion / networking (informal interactions)	Facilitating networking and knowledge diffusion Events Newsletters / websites Alumni networks Networking with professional organisation / trade associations Academic networking
3. Developing skills	Enabling access to recent graduates/ career services Providing access to CPD / lifelong learning Short training courses for businesses Business funded PhDs / Masters Work placements for students Joint curriculum development Temporary staff exchanges
4. Community development/ public engagement	Public lectures/events /open days Newsletters Supporting local regeneration
5. Exploiting the physical assets of universities	Science parks/ incubators Enabling access to equipment and facilities Exchange/sharing of research materials

Source: HEIF studies (PACEC) and Technopolis

The public research organisations considered in this study are mainly Higher Education Institutions (HEIs). The majority of the seven countries reviewed in this report are 'university-centred' systems where HEIs account for most public research. Public research institutes in New Zealand (the so-called Crown Research Institutes) and Singapore (public labs under the agency A*Star) are integral parts of the research systems and subject to investment in knowledge transfer.

1.4 Report structure

The remainder of this report is structured as follows:

Chapter 2 profiles the national level policies and rationales in the six comparator countries and Ireland, and the levels of public investment in R&D

Chapter 3 presents government-led schemes in knowledge transfer, including the objectives and inputs, and the outputs, outcomes and impacts of those schemes, plus a discussion of the drivers and rationales for those schemes.

Chapter 4 presents a brief discussion and conclusions

2. Government policy and knowledge transfer

The issue of knowledge transfer has become an established part of innovation policy across the seven countries. A major objective of knowledge transfer for the benchmark countries is to generate economic and social returns on investment in the form of economic growth and jobs. Knowledge transfer is also seen as important to creating a positive business environment for both indigenous and foreign firms, boosting the competitiveness of existing industries, growing new industries, and increasing export revenue. In the following section, we summarise the observable national policy trends and what and how much is invested nationally in public R&D in the seven countries.[1]

2.1 Policy and legislation

Reviewing government policy statements and legislation we find a rather consistent picture. In six of the seven countries in our analysis, knowledge transfer forms an integral part of the government's research and innovation policy (Denmark, Finland, Ireland, New Zealand, and Singapore) or Economic strategy (Scotland). Israel does not have a centrally defined policy for knowledge transfer, or indeed a research policy, but reportedly policy-makers have started to show interest in the field. In five of the seven countries – the exceptions being Israel and Scotland (UK) – this high-level commitment is a relatively recent development, with KT being added to national research and innovation policies within the past 15 years. Ireland is the only country among the comparators that has a separate statement on government policy for knowledge transfer, which is contained within the National IP Protocol.

This ascent of KT within national research and innovation priorities is also evident in the reformulation of our social contract with public research organisations, and especially universities, with the introduction of the 'third mission', sitting alongside education and scholarship. The 'third mission' may be defined as "…all activities concerned with the generation, use, application and exploitation of knowledge and other university capabilities outside academic environments"[2] and has been introduced legislatively in Denmark (1999) and Finland (2007) via the reforms of the University Acts. Not all countries have taken this approach. In New Zealand, no specific legislative action has been taken, but the Tertiary University Strategies since 2002 have emphasised the importance of knowledge transfer and universities are aware of the government's expectation to them. In Israel, the practice of knowledge transfer from universities predates government intervention by several decades and still today relies mainly on university bylaws.

Other milestones include new legislation granting universities the ownership rights over the IP created by their faculty within the context of publicly funded grants. In many European countries (including Denmark and Finland), this replaced the principle of inventor ownership (so-called 'professor's privilege') whereby the researcher personally retained the IP rights over inventions made[3]. A similar legislative change was made in Israel (2004) although only for the government sector. This move was intended to give universities the incentive to pursue commercialisation more actively at the institutional level, although it is disputed whether it has, in fact, lead to higher rates of commercialisation.

In addition to legislative initiatives, several countries have developed guidelines and model contracts for the management of IP at public research organisations. Examples include the UK Lambert Toolkit[4], the Danish 'Schlüter' model contracts[5] and the

[1] This is based on national policy documents and interviews with senior national figures.

[2] Galas-Mollart, J. et al. (2002): "Measuring Third Stream Activities. Final Report to the Russell Group of Universities", SPRU Science and Technology Policy Research.

[3] Geuna, A., & Rossi, F. (2011). Changes to university IPR regulations in Europe and the impact on academic patenting. *Research Policy*, *40*(8), 1068–1076.

[4] https://www.gov.uk/lambert-toolkit

framework set out in the Irish 'IP protocol' and subsequent documents. Among other things, such model contracts are intended to help RPOs manage research-industry collaboration and to provide a consistent set of conditions for the benefit of businesses. In Israel, no such coordinated effort to codify university-industry interaction exists but conventions have grown from practice. In particular, other institutions have imitated the by-laws of successful institutions such as the Weizmann institute of Science (WIS). Reportedly, new public research hospitals have found it difficult to deviate from this practice in the face of protests from employees. Though not a policy initiative, Scottish universities have signed up to the Easy Access IP project.

Data collection is another powerful tool for governments to monitor progress and inform future policy and interventions. This is an area that several countries are looking to improve but, so far, Scotland, Ireland and Denmark are the only countries in our sample to produce comprehensive annual statistics. The rest of the countries collect national-level data less systematically: In Singapore, A*Star publishes a limited selection of annual data, and Israel has carried out two surveys or university knowledge transfer (2008/9 and 2012/13). The University Commercialisation Offices of New Zealand (UCONZ) ran a one-off survey covering the years between 2003 and 2008 but attempts to organise systematic data collection have so far been unsuccessful.[6] Finally, the Finnish government plans to establish national statistics and has requested universities to report on knowledge transfer activities but so far, the Ministry only has incomplete estimates.

2.2 National investment in R&D

Examining the nature of investment and the measures taken to support knowledge transfer, we observe more variation. Among the seven countries, we see different levels of investment. In Denmark, Finland and Singapore we see a high level of investment in R&D at universities and other PROs, whereas Ireland accounts for the lowest absolute number out of the selected countries. The level of investment is the basis on which the national 'return' should be judged.

Figure 2 Expenditure on R&D performed by the HEI and Government sectors

	HERD 2013 (current USD m)	**As % of GERD**	**GovERD 2013 (current USD m)**	**As % of GERD**	**HERD + GOVERD 2013 (current USD m)**	**HERD + GOVERD As % of GERD**
Denmark	2,387.18	31.8	179.79	2.4	**2,566.97**	**34.2**
Finland	1,543.85	21.5	640.25	8.9	**2,184.10**	**30.9**
Ireland*	764.23	23.1	155.01	4.9	**919.24**	**28.0**
Israel	1,552.82	14.1	235.37	2.1	**1,788.19**	**16.2**
New Zealand**	562.62	31.9	401.10	22.7	**963.72**	**54.6**
Scotland[7]	1,628.92	50.3	348.94	10.8	**1,977.87**	**61.1**
Singapore*	2,367.35	29.1	815.48	10.0	**3,182.83**	**39.1**

Source: OECD Main Science and Technology Indicators, and UK Office of National Statistics. *2012 **2011

It is clear that there are also structural differences between the ways the investment is made. In Denmark, Ireland, Israel and Scotland[8], the higher education sector R&D investment (HERD) takes up the bulk of publicly performed R&D (more than 4 times

[5] http://ufm.dk/en/research-and-innovation/cooperation-between-research-and-innovation/collaboration-between-research-and-industry/model-agreement?searchterm=schl%C3%BCter

[6] Interview insight.

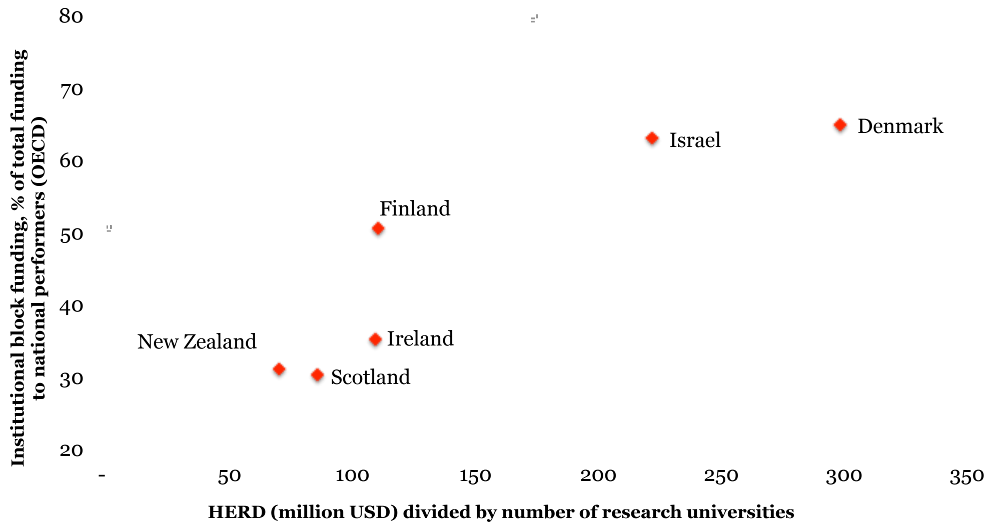
[7] Converted from GBP at 1.56 USD per GBP (2013 exchange rate) and

[8] In Scotland, the GovERD is relatively high as a share of national expenditure, but this is largely a result of a very low level of business R&D. GovERD is still substantially lower than HERD.

greater than the government sector (GovERD)). In the remaining countries, particularly New Zealand, the investment in public research is more evenly distributed between the two.

Within the higher education sector, the majority of HERD is allocated to research universities (as opposed to colleges, polytechnics and Institutes of Technology). Relating the overall level of HERD to the number of research universities, it becomes apparent that in some countries, public R&D funding is concentrated within a few large institutions (Denmark and Israel), whereas other countries' (Ireland, New Zealand and Scotland) systems are made up of smaller units on average. As illustrated in Figure 3[9] universities in Denmark and Israel receive a larger proportion of their funding as block grants compared to the rest of the group. Unfortunately, comparable data for Singapore are not available. In Denmark, the government has specifically pursued an aim to create larger universities through a series of mergers (2007), and some observers believe that the same might be on the cards for Finland. The question of scale has implications for the institutional and political approach to knowledge transfer, as discussed in chapter 3.

Figure 3 Research universities' funding base: six countries compared



Source: Technopolis, compiled from data in OECD Main Science and Technology Indicators. Comparable figures were not available for Singapore.

[9] Comparable figures were not available for Singapore.

3. Government-led knowledge transfer funding schemes

Government investment and support for knowledge transfer in the seven countries examined here is observed broadly across three categories, depending on the needs of the system in question. These are: support for building and maintaining capacity in the knowledge transfer system, initiatives to co-ordinate providing central co-ordination and/or resourcing for KTOs, and specific commercialisation support in the form of competitive programmes to help research ideas reach markets. The section will conclude with a brief overview of examples government initiatives aimed support contract research and academic consultancy, as well as schemes to encourage the mobility of people between research and business.

Through desk research and interviews with key stakeholders, we have identified the funding schemes considered to be central to knowledge transfer in each country as relates to publicly funded research. We have accessed various sources of information, including published evaluations where available. There is no standard type or uniform reporting, and so we have extracted data on outputs (activities undertaken as part of the scheme and short-term results), outcomes (short to medium-term results relating to specific programme objectives) and impacts (longer-term effects relating to overall programme aims) from these sources that are broadly comparable for each 'type' of investment. The below tables summarise the data, along with information about the inputs (i.e. the cost of the measures to government) in order to highlight the return on these investments. Alongside each table we add discussion points and reflections of particular interest learned through the evaluations and consultations. There are no English language evaluations available for the Israeli schemes, though we were able to gain insight via our interviews.

3.1 Institutional knowledge transfer capacity

Many of the benchmark countries have made investment in building capacity for knowledge transfer. This is often done through the higher education budget, either through specific grants or by using block grants for universities.

3.1.1 Capacity and capability building in Higher Education Institutions

In 3 of our 7 countries – Denmark, Ireland and Scotland – dedicated funding streams have been in place specifically to support building and maintaining capacity at public research organisations. These are detailed in Figure 4. These schemes cover activities such as staff salaries, patent operations, training and professional development. In addition, commercialisation support schemes such as Tutkimuksesta Liiketoimintaa, "Creating Business from Research" (TULI) in Finland and the Pre-Seed Accelerator Fund (PSAF) in New Zealand also aim to strengthen the general knowledge transfer capacity at public research organisations. With the exception of Scotland, these are countries where knowledge transfer was a relatively new activity. In Ireland, the first Technology Transfer Strengthening Initiative (TTSI1) "started from a baseline of very little infrastructure"[10] and in Finland, "very little (if anything) existed in terms of internal support structures/measures for commercialisation services"[11]. In this situation, there was a need to build capacity within higher education institutions in order for them to be able to play their part in a more effective knowledge transfer process. By contrast, Israeli universities had decades of experience and already had significant capacity.

[10] 'A Review of the performance of the Irish Technology Transfer System 2007-2012', p. 4.

[11] 'Path to creating business from research: Evaluation of the TULI programme', Tekes, 2013, p. 34.

Figure 4 Objectives and inputs, outputs, outcomes and impacts of capacity-building supports by country

Country and measure	Objectives / aims	Input	Outputs, Outcomes and Impacts
Denmark Support for institutional patent costs (2000-2003) and best practice projects (2004-2007). *Not evaluated*	• Build capacity in KTOs	EUR 7.1m (over period)	• *When the Act on Inventions at Public Research Organisations was first adopted in 1999 it was accompanied by a national budget grant to support practical implementation. This grant was available until 2012. During the 12 years the national budget grant was available its focus developed in order to accommodate changing needs. From 2000-2003 institutional patent costs were supported. From 2004-2007 developments of new research and technology transfer concepts were supported b y funding best practice projects. From 2007 onwards a Proof-of-Concept scheme provided early stage gap funding for universities*
Ireland Technology Transfer Strengthening Initiative (TTSI1) 2007-2012 *Evaluated 2014*	• Build capacity in KTOs • Operational costs, patent support and access to Enterprise Ireland's Commercialisati on Specialists were for further 14 Institutes of Technology and Colleges.	€30m (over period)	*Outputs* • Supported 32 commercialisation executive posts in 10 HEIs • Increased volume of KT activity (annual): – Invention disclosures increased: 435 from 265 – Filed patents increased 119 from 115 – LOAs increased 119 from 12 – Spinouts increased 34 from 5 *Outcomes* • Substantive change in how state capitalises on HE research investment • Experienced, resourced, teams of professionals led to enterprise friendly interface • Good business sentiment on approachability, ease of engagement, expertise and negotiating IP (TTO performance) • Led to next iteration continuing to build via consortia *Impacts* • Economic impact: €100m attributable turnover and 1,844 attributable jobs (60 companies surveyed): • "The level and quality of intellectual property (IP) captured by the HEIs and transferred to industry has increased" • National IP Protocol and formation of KTI
Technology Transfer Strengthening Initiative (TTSI2) 2013-2016	• Build capacity • Formation of consortia of KTOs to share and scale expertise	€22m (over period)	• Collaborations of TTOs through TTSI2 'already bearing fruit': "working closely, sharing experiences and identifying best practices".
Scotland Knowledge Transfer Grants (KTG) 2001+ *Evaluated 2008*	• Promote KT • Fund increased capacity and capability • Incentivise KT	€27.5[12] (one year 2008) €23m (one year 2014)	*Outcomes* • Supported additional KT professionals in all HEIs • Increased volume of KT activity (non-numerated) *Outcomes* • Enhanced underlying capacity • Engagement on cultural change - internal resources dedicated were very low compared to KT with commercial organisations *Impacts* • Used as match funding to contribute to other public sector KT initiatives • Enabled development of risky/experimental KT initiatives by HEIs

Source: Technopolis, from published evaluations and reviews.

[12] GBP 21.5m at 1.28 EUR per GBP (2008 exchange rate)

In addition to dedicated funding for knowledge transfer, several countries fund knowledge transfer capacity and activities through the general allocation of funding for HEIs. In Denmark, development contracts between the universities and the Ministry of Education were introduced in 2003.[13] The contracts run for periods of three years and consist of a set of government-defined aims applicable to all universities and supplemented by a set of aims defined by the universities individually. In the 2012-2014 contracts, the Ministry had included 'increased innovation capacity' among the mandatory targets but in the current period (2015-2017), it is only included where universities have decided to do so themselves. The aims are not binding and do not have any direct bearing on funding decisions. Some see this as an effective method of 'soft steering'[14] whereas others recommend more direct financial incentives.[15]

One way to achieve the latter is by making university funding directly dependent on indicators of knowledge transfer activity. In Israel, knowledge transfer indicators have recently been made part of the funding formula used to calculate government block funding for universities. Although at a 'symbolic' scale, this is seen as an important political signal.[16] The same is true in New Zealand where the 'Performance-Based Research Fund' (PBRF) aims, in part, to strengthen knowledge transfer. In the PBRF formula (as revised in 2013), 20% of the allocation is made on the basis of universities' performance in attracting 'External Research Income' (ERI).[17] In Finland as well, the government foresees that knowledge transfer will be included in the funding criteria for universities.[18]

In countries where data are available – such as Ireland and Denmark – the start of the investment (in conjunction with the policy changes discussed) was followed by an initial surge in performance on 'out-the-door' indicators (patents, licences etc.) From here, the countries have made different choices: In Ireland and Scotland specific support for knowledge transfer staff and operations is on-going. The evaluators of the Irish TTSI1 programme stated that "ring-fenced funding is critical to sustainable and successful knowledge transfer."[19] In Denmark, by contrast, specific support for knowledge transfer at universities was seen as a temporary measure to build capacity up to a point where universities could take care of themselves. This choice to discontinue funding (2010) was made in the context of a period with increased general university funding which, it was argued, was sufficient to cover knowledge transfer operations as well.[20] In Israel, such funding was seen as unnecessary since universities were able to finance their KT operations through commercialisation revenue supplemented by philanthropic contributions.[21] However, in Denmark, stakeholders have identified this absence of specific funding as a barrier to knowledge transfer[22] and in Israel, the financial crisis is reported to have put a strain on resources as income from philanthropy and business have decreased.[23]

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[13] Wright and Ørberg (2008): 'Autonomy and control: Danish university reform in the context of modern governance', *Learning and Teaching*, 1 (1).

[14] Interview insight.

[15] ''Vidensamarbejde under lup', op. cit., p. 114.

[16] Interview insight. Details about indicators and amounts are not available.

[17] 'What we get for what we spend: Inputs, outputs and outcomes of the Government's tertiary education expenditure 2004-2013', New Zealand Government, Ministry of Education, April 2015.

[18] "Reformative Finland: Research and innovation policy review 2015-2020", Research and Innovation Policy Council, 2014, p. 18.

[19] 'A Review of the performance of the Irish Technology Transfer System 2007-2012', p. 10.

[20] Interview insight.

[21] Interview insight

[22] 'Vidensamarbejde under lup', op. cit., pp. 113-114.

[23] Interview insight.

3.1.2 The role of research institutes

In Finland and Denmark, research institutes were reported by key stakeholders to play a specific role for knowledge transfer, complementing the universities. The Technical Research Centre of Finland (VTT) is the largest of the Finnish institutes and plays an important intermediary role linking business and industry.[24] Following a recent reform, it is now a state-owned company with 2,375 employees and a turnover of €251m (2014).[25] VTT's most important routes for knowledge transfer are contract research (EUR 80m in 2012), sale of patenting and licencing (EUR 2.1m) and spinouts supported by VTTs own venture funds.[26]

In Denmark, the Advanced Technology Group (usually referred to as the GTS institutes) is a network of government accredited research institutes. They are independent, non-profit organisations providing technological services to clients in the public and private sector. Their core function is to provide technological know-how to Danish companies, especially SMEs with limited internal research capacity. They have been described as 'consulting technology organisations' but are also involved in R&D.[27] An international review (2012)[28] suggested that the existence of the GTS institutes could have the effect of insulating universities from business contact but recently, there has been closer collaboration between the GTS institutes and universities.[29]

In New Zealand and Singapore, the public research institutes make up a larger share of total public research than in the other countries reviewed. The New Zealand Crown Research Institutes are covered by the same government-funding scheme for commercialisation, the Pre-Seed Accelerator Fund (PSAF), as the universities. In Singapore, a separate organisation ETPL (Exploit Technologies Pte Ltd), functions as the 'technology transfer arm' for research institutes under the A*Star system.[30]

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[24] Interview insight.

[25] VTT website: http://www.vttresearch.com/about-us (accessed 19 May 2015)

[26] 'Roles, effectiveness, and impact of VTT: Towards a broad-based impact monitoring of a research and technology organisation' VTT, June 2013, pp. 6-7.
Available at: http://www.vtt.fi/files/news/2013/vimpact/VTT_IMPACTS.pdf (accessed 20 May 2015).

[27] Interview insight

[28] ERAC (2012): 'Peer review of the Danish Research and Innovation System', European Commission, p. 28.

[29] 'Videnskab under lup', op. cit., chapter 6.

[30] https://www.etpl.sg/introduction/about-etpl (accessed 19 May 2015).

3.2 Central co-ordination and resourcing

In addition to building and sustaining capacity at the individual institutions, support is also given to networks ('Technology Transfer Alliances'[31]), or centralised coordination functions complementing the work of individual KTOs.

These networks are not always directly related to government intervention. In some countries, KTOs of individual institutions have formed networks to work together on strategic issues or pool resources. For example, the Israeli Technology Transfer Organisation (ITTN) is entirely independent of the government and has, among other things, shared good practice and represented KTOs collectively on policy issues.[32] Denmark's 'techtrans.dk' also works on an independent basis but is reported to have lost importance because of a lack of funding (since 2010) and because universities have become bigger and more self-reliant as a result of mergers.[33] Professional membership associations of knowledge transfer professionals are another example. In Finland research managers are brought together in FINN-ARMA, which organises training and networking, but a distinct group, 'Finnovation Champions', has formed specifically for knowledge transfer mangers as a consequence of knowledge transfer becoming a specialised function within university management.[34]

In other cases, government initiatives have encouraged or directly set up collaboration between public research institutes. Funding schemes in several countries have required 'consortia' of KTOs to implement programme activities, pooling resources and supporting mutual learning. For example, the Danish Proof of Concept scheme (2007-2012) was implemented through two consortia of public research institutes (East and West), each with investment boards deciding which project applications to forward for funding. New Zealand's Pre Seed Accelerator Fund (PSAF) is, in large part, 'devolved' and implemented through networks of institutions such as KiwiNet and Return on Science. Other examples include the second Technology Transfer Strengthening Initiative (TTSI2, 2013-) in Ireland and the second phase of the Finnish Tutkimuksesta Liiketoimintaa "Creating Business from Research" scheme (TULI, 2008-2012). Such structures have tended to emerge to implement a specific programme and dissolve when this task is completed.

Finally, several countries have elected to create coordination structures or central resources for KTOs, as a means by which to improve the coherence of national policy, facilitate learning / professional development and otherwise help to aggregate issues of interest. It is important to note that these are not knowledge transfer offices in their own right,[35] but provide a range of services and resources to enhance the effectiveness of individual KTOs. Figure 5 summarises the role of and investments in such central structures set up in three of the seven sample countries. Most of these offices combine a role of intermediary or 'one-stop-shop' between businesses and public research with the allocation of funding for knowledge transfer. In Scotland, Ireland and New Zealand, the central offices serve the entire national system, whereas the ETPL in Singapore and the National Technology Transfer Company in Israel serve a subset of public research organisations: public sector research and teaching colleges respectively.

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[31] OECD (2013) 'Commercialising Public Research: New Trends and Strategies, op. cit., p. 68.

[32] Interview insight.

[33] Interview insight.

[34] Interview insight, see also: https://www.linkedin.com/grp/post/4481279-272380944.

[35] The exception to this rule is the newly formed National Technology Transfer Company in Israel, which serves colleges without their own KTO.

Figure 5 Objectives and inputs, outcomes and impacts of central co-ordination or resourcing supports by country

Country and measure	Objectives / aims	Input	Outputs Outcomes and Impacts
Ireland Knowledge Transfer Ireland (KTI) 2013 -	• Supporting, developing and building capacity and capability in the KT system • Increase visibility of opportunities for business • Increase transparency of KT • Provide practical KT resources • Ease access for business	Current FTE = 4.5	Delivers a single national offering for industry: • Signposting to HEI and research system and TTOs • Conveying information about the State funded research capabilities across the Irish landscape • Providing practical resource enclosing 6 Guides to different contracting with RPOs and 10 Model template contracts to date • Maintaining national policy document • Delivering best practice events • Delivering national KT metrics reports • Hosting KT Impact awards • Presenting searchable databases of: – 150 licensing opportunities – >7,000 research experts *Outputs* Management of the €22M Technology Transfers Strengthening Initiative (TTSI2) programme which to its 2 year mid-point has delivered: • Approx. 300 LOAs • Over 60 spin-outs • Over 1,300 collaboration agreements with industry
New Zealand Commercialisation Partner Network (CPN) 2010+ *Evaluated 2015*	• Build relationships, capacity and collaboration • Improve capabilities (upskilling) in new structures • Aggregate KT activities of PROs • Increase KT rates • Increase spinouts (investible entities) • Increase visibility and transparency of KT *Funds network organisations such as KiwiNet (headcount = 7)*	€2m per year[36] *(Resource for running costs)*	*Outputs* • 400 projects presented for investment decisions (cumulative) • 140 commercial deals (cumulative) • 300 people attended training programmes on professionalization (2012) – 200 researchers, 100 KT staff • National database of publicly funded research looking for commercialisation opportunities (780 entries - judged to be relatively current) *Outcomes* • Self-reinforcing cycle through exemplary integration with Pre-Seed Accelerator Fund *Impacts* • "Successfully established the activities required to increase scale, capability and improve collaboration which the sector believes will improve commercialisation outcomes" • "Increase in collaboration on commercialisation between research organisations, particularly between Auckland University and the rest of the system and between Universities and CRIs" • Culture change - Improved attitudes of researchers to commercialisation • International connections growing to Australia, US and Asia
Scotland Interface 2005+ *Evaluated 2010 Annual Report*	• Brokering connections between business base and academia (focused on business need) • Overcome points of	*Current headcount = 22* *Running*	*Outputs* • 98 collaborative projects (2010) – 14 new patents, 13 new licensing deals, 4 new companies • 214 collaborative projects (2014 – 19% annual rise) *Outcomes*

[36] NZD 3.2m per year at 0.65 Euro per NZD (current exchange rate)

from 2014	friction (timescales, expectations, costs and IP arrangements) *Interface has grown over the years since its inception, taking a more sectoral approach and being given additional resources for regional presence and rural areas.*	*costs =* €1.8m (2005-2010) €0.4m (2010) €0.6m (2014)[37]	• Jobs created 360 (2014) • SMEs in Highlands and Islands stated they will hire more staff next year because of collaborative projects (2014) • 99% businesses satisfied • 88%needed interface for project to happen *Impacts* • Economic impact: £17m annual GVA contribution (2014) • £5.4m value of Interface projects to the HE sector (2010) • Raising business' awareness of benefits of innovation and collaboration w/HEIs • 2/3 of surveyed intermediaries and stakeholders state KT activity would be lower without Interface • 98% of businesses would collaborate with academia again

Source: Technopolis, from published evaluations and reviews.

[37] GBP 1.55m over five years and GBP0.36m in 2010 at 1.15 EUR per GBP (2010 exchange rate). GBP 0.48m in 2014 at 1.24 EUR per GBP (2014 exchange rate).

3.3 Commercialisation support

In recent years, government investments in early stage commercialisation have increased[38]. They aim to 'bridge the gap' between research funded through traditional funding grants and the stage where they are ready to be picked up by private investors, either through a process of patenting and licencing, or through the establishment of new companies based on university research (spin-outs). The overall aim is to bring public research to market and create value for business and society. In the countries studied in this report, funding schemes for Proof of Concept or pre-seed funding emerged in the 1990s or 2000s alongside legislative initiatives described above. Even in Israel, the first government schemes did not emerge until the 1990s, decades after the practice of knowledge transfer had been pioneered by the universities.

The schemes detailed here cover a very diverse range of activities, often in combination.[39] Figure 6 summarises the schemes in each country. At the earliest stage of the spectrum, we find Israel's KAMIN programme, which provides funding exclusively for academic researchers without any requirements of business involvement. The National Research Foundation of Singapore's Proof of Concept scheme also focuses on technological development. The majority of the schemes identified span both technological development and organisational aspects. For example, New Zealand's Pre-Seed Accelerator Fund (PSAF) provides funding for both "prototype development to the point where it is investor-ready" as well as "market research, IP strategy development, and commercialisation partner engagement".[40] Equally, the new Finnish New knowledge and business from research ideas (TUTL) scheme provides funding for Proof of Concept development as well as market research and commercialisation. In several cases (e.g. the now ceased Finnish Creating Business from Research (TULI) scheme and the Scottish Proof of Concept schemes), elements of training and external advice from entrepreneurs have been included in the support.

In most countries here, investments in early commercialisation are separate from seed funding in spinout companies. The 'High Growth Spinout' (HGSP) scheme from the Scottish government integrates three stages defined as 'Proof of Concept', 'Proof of Company' and 'Proof of Investment'. Uniquely in our sample, this scheme integrates support after the formation of a spinout company, in the form of a convertible loan. It is structured in a 3-stage structure whereby each stage is subject to review and only promising projects allowed to progress to the next round of funding.

Many of these schemes have evolved over time through experimentation and learning and are now in their second or third 'generation'. For example, Finland has re-designed its national support measure, increasing the focus on commercialisation as it moved from the original TULI programme to the current TUTL. We learned that while Finland's TULI had a positive impact in relation to laying the foundations for a professionalised KT system, it did not impact cultural change in academia. The evaluation of TULI concludes that it was poorly resourced and insufficiently structured to incite collaboration. Similarly, the new Scottish scheme HGSP was based on lessons from the preceding Proof of Concept Programme (PoCP), which was said to be said to have been less effective due to how funding was used by academics. Compared to PoCP, HGSP takes away training for academics and brings in instead experienced entrepreneurs as project lead (and eventual CEO of the spinout).

[38] OECD (2013): 'Commercialising Public Research: New Trends and Strategies

[39] There is no commonly agreed typology for commercialisation funding schemes. In a study about spinouts, Rasmussen and Sørheim (2013) distinguish between three types of activities: technological development of an idea (Proof of Concept), organisational preparation for commercialisation (Pre-Seed), and support for new companies (Seed funding for spinout companies). Most of the programmes investigated here contain elements of both PoC and pre-seed and some also provide seed funding.

[40] 'Non-Devolved Pre-Seed Accelerator Fund (PSAF): Request for Proposals', MBIE, October 2014.

Figure 6 Objectives and inputs, outputs, outcomes and impacts of commercialisation (project) supports by country

Country and measure	Objectives / aims	Input	Outputs, Outcomes and Impacts
Denmark Proof of Concept Funding 2006-2012 *Evaluated 2006-2009*	• Support the commercialisation of inventions • Bridge the gap between grant-funded research and initial product development	€3.3m per year [43]	• 66 PoC projects (cumulative) – 22 finalised: 3 continued with external funding; 13 in negotiation; 6 terminated
Finland Tutkimuksesta Liiketoimintaa, "Creating Business from Research" (TULI) 2002-2006 2008-2012 *Evaluated 2013*	• Develop a professional commercialisation system. (i.e. "fundamental capacities and structures within the universities and research institutes") • Make commercialisation a strategic topic for HEI/RTO management • Promote active co-operation between actors • Integrate commercialisation into the academic world, creating networks of researchers and business development advisors • Raise licensing and technology sales to quantifiable international level • Lay foundations for a start-up ecosystem	€35m over period 1: €10m 2: €25m €4.4m per year (average)	*Outputs* • 3,400 projects over 2 phases – 512 patent applications filed 2008-2011 • 254 new companies founded over 2 phases *Outcomes* • €5.4m licensing revenue • 294 jobs over 2 phases *Impacts* • "TULI played an important role towards a professionalised commercialisation system [and] establishing processes and structures" at universities and research institutes. • Increasing the level of interest and awareness of commercialisation were the largest effects
Finland Tutkimuksesta uutta tietoa ja liiketoimintaa, "New knowledge and business from research ideas" (TUTL) 2013 – *Not evaluated*	• Preparing commercialisation ideas • Finding the best route to take forward • Developing into new businesses or transferring to existing businesses	€15m per year	*Replaced TULI in 2013* • *Addressing lower commercialisation achievements of TULI* • *Addressing issue of projects not being taken forward* • *From interview: Funding is given directly to the researcher to develop their idea, with the strict condition that they do the work themselves (rather than subcontracting as happened under TULI) to analyse the market. Policy makers hope that this will make researchers more likely to take projects forward. However, it is not possible to spend the money on actually starting a company.*

43 DKK 25m per year at 0.13 Euro per DKK (2009 exchange rate)

Ireland Commercialisation Fund 2003 - *Evaluated 2003-2009*	• Transform research output form HEIs into new products and spinouts • Effect change in approach to research by academics • Realise potential of HEIs in developing new products and processes for commercialization • Fund projects at different stages – from concept to de-risking to attracting investment • Support academic researchers	€144.2m over period €21m per year (2013)	*Outputs* • 895 projects – 73 patents, 35 licences, 21 spinouts *Outcomes* • Competency: improvements in internationally recognised commercialisation and knowledge transfer skills • Maintain relationships with commercial partners, but not carrying through to internal relationships • Publication and reputational benefits to HEIs • Mobility of staff: 76 research staff moved to private sector *Impacts* • Economic impact €137.9m export sales 2005-2009 (companies surveyed) • The GVA impact accruing over the period 2003- 2009, amounts to €34.099 million • Estimated to reach €400m 2003-2015
Ireland SFI Technology Innovation Development Award (TIDA) 2009 - *Not evaluated*	• Demonstrate commercialization feasibility • Develop awareness of commercialisation process • Encourage movement, academia-enterprise activities • Prototype development / demonstrators • Improve industrial processes • Encourage multi-disciplinarity	€6.5m per year (2011)	
Israel MAGNET (all strands) 1994 – *Evaluations not available in English*	• Support pre-competitive R&D • Encourage collaboration among companies and HEI researchers	€57m per year	Includes sub-strands: • NOFAR: 52% of projects secured at least USD 100,000 private investment within 12 months • MAGNETON: nothing quantifiable, but success is judged by continuous collaboration or work on the technologies.

Israel KAMIN 2011 – *Evaluation not available in English*	• Address gap in applied research between end basic research grants and business readiness (no business involvement)	€8m per year	• *Introduced in 2011 to overcome issues related to early stage funding gaps*
New Zealand PreSeed Accelerator Fund (PSAF) 2004 - *Evaluated 2014*	• Improve the commercial capability and skills of public research organisations • Promote linkages between public research organisations and potential private sector partners, including industry players and capital providers in New Zealand and offshore	€24m[42] over period €2.4m per year (average)	*Outputs* • 386 commercial deals to date (cumulative) *Outcomes* • 460 jobs (temporary and permanent) • €124.8m43 of actual revenue back to the research organisations (4x higher than government investment) *Impacts* • Economic impact: $3.0 billion NZ estimated potential export revenues
Scotland Proof of Concept Programme (PoCP) 1999-2010 *Evaluated 2006* **Updated via Forfás 2013*	• Support academic PoC • Improve level and quality of commercialisation • Raise profile of capabilities • Encourage academics to take forward commercial opportunities • Contribute to development of Scottish clusters	€39.2m[44] over period €3.6m per year (average)	*Outputs* • 227 projects* – 42 new companies* – 45 licences* *Outcomes* • Uplifts in commercialisation activity; • Uplift in patents, licensing and spinouts • 500 knowledge-intensive jobs in HEIs and 300 in private companies* *Impacts* • Economic impact: £125m estimated GVA (2006) • £238m wider leverage*
Scotland High Growth Spinout Programme (HGSP) 2013 – *Not evaluated*	• Funds commercialisation from concept through to resulting spinouts securing private investment	No fixed budget	*Replaced PoCP to address the perceived shortcomings of the funding approach* • *Changes were made to the funding approach, no longer training the researcher, but installing experienced entrepreneurs as project leads and eventual CEOs of resultant spinouts.* • *The programme is more focused on high-potential (setting a very high bar for funding at the appraisal stage)* • *The programme now funds across three phases (proof of concept, proof of project and proof of investment) rather than its predecessor's lone proof of concept stage* • *Management of projects is now more 'hands-on' than under the 'light touch' approach of the PoCP. Programmes are aggressively terminated if not performing*

[42] NZD 40m over ten years at 0.65 EUR per NZD

[43] NZD 188.2m at 0.66 NZD per EUR

[44] GBP 28m at 1.43 EUR per GBP (2003 exchange rate)

Scotland Strategic Priority Investment in Research and Innovation Translation (SPIRIT) 2008-2013 *Evaluated 2013*	• Alongside Knowledge Transfer Grants to fund KT projects of strategic national priority	€9.5m over 2009/10[45]	The evaluation covered the programme process, but details some spillover benefits of the ten funded projects: • Improved networks of industrial contacts, including cementing links with industry and overseas partners • More aware of the research needs and skills of industry • Improved relationships with other universities working in complementary areas • Improved the way academics think about structuring projects around deliverables *However, it was also found that the projects did not result in the expected innovative KT approaches, choosing instead to fund traditional routes such as PhD studentships* *Learning reportedly informed the new Innovation Centres approach*
Singapore Research Innovation Enterprise (RIE) 2015 (Exploit Technologies Pte Ltd - ETPL) 2011-2015 *Reviewed 2013*	• Support Singapore's aim to be one of the most research-intensive, innovative and entrepreneurial economies in the world • Fund structures and programmes across a broad spectrum of basic research, KT and business-focused capability building	€8.9bn[46] over lifetime of whole RIE2015 to 2015 €1.8bn per year for whole RIE2015 (average)	*Outputs* • Increased volume of KT activity (annual): – 210 licenses 2013 (compared to 73 2010), 559 technical disclosures received 2013 (compared to 623 2010), 254 priority patents filed 2013 (compared to 252 2010), 14 spinoffs involving A*Star staff in 2013 compared to 7 2010 *Outcomes* • Many events to raise awareness • Delivery of TT Summit Asia in Singapore in 2013 • Business friendly licencing terms • Much stakeholder engagement - and positive views about role, approach and knowledge • Laying the foundations to become a 'technology developer' rather than a 'technology transactor'
Singapore ETPL Gap funding 2002 – Current tranche 2011-2015 *Reviewed 2013*	• Technology Development and Business Incubation processes, typically up to Technology Readiness Level 7	€18m[47] per year (2013)	*Outputs* • 154 licenses or spinoffs from GF (154% of target) 2013
Singapore NRF Proof of Concept Funding 2008 – Current tranche 2011-2015 *Not evaluated*	• Funding to public researchers to conduct further work on ideas to a resulting product for licensing, sale or marketing to companies	€3.7-€4.9m over five years [48]	

Source: Technopolis, from published evaluations and reviews.

45 GBP 8.1m at 1.17 EUR per GBP (2010 exchange rate)

46 SGD 16.1bn at 0.55 EUR per SGD (2010 exchange rate)

47 SGD 30m (SGD 150m over five years) at 0.61 EUR per SGD (2013 exchange rate)

48 SGD 6-8m over per year at 0.61 EUR per SGD (2013 exchange rate)

3.4 Collaborative research, contract research and academic consultancy – research based knowledge services

The main focus of this report is government support schemes, but knowledge transfer also takes place in the context of research activities partly or wholly financed by industry. There are a number of different types of such interactions but overall, we can distinguish between collaborative research, contract research and consultancy.[49]

3.4.1 Collaborative Research

Collaborative research involves contributions from both public and private partners, that is, from PROs and industry. This can take the form of stand-alone collaborative research projects, or larger, longer-term collaborative research centres. Collaborative research can have a complex set of aims but among the rationales for investing in collaborative research is that it can create linkages between research providers and end-users, promote the transfer of skills and knowledge and help translate ideas into products and services.[50]

Large firms are more likely than SMEs to engage in collaborative research with public research organisations, not least in Finland where some 90% of all large firms do so.[51] In Finland, the Strategic Centres for Science, Technology and Innovation (SHOK) were reported as a key measure in their national approach to knowledge transfer. The first SHOK centre was set up in 2007 and by 2012, €813m had been invested in the SHOKs (cumulative), 53% funded by Tekes, 37% by companies, and 10% by universities and research organisations.[52] Other examples of such centres within our sample include the MAGNET consortia in Israel and the Scottish Innovation Centres, though a study of these centres was not a topic for this review.

3.4.2 Contract research and consultancy

Contract research and consultancy are services provided by public research organisations to an external costumer to address a specific need or problem. Whereas contract research involves the creation of new knowledge, consultancy relies largely on existing knowledge mobilised by the research organisation. Contract research and academic consultancy is an important mechanism for knowledge transfer,[53] with the available statistics suggesting that this demand-led, commercial work can produce direct financial benefits (income to RPOs) an order of magnitude higher than income

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49 National governments classify such activities slightly differently: The Irish Annual Knowledge Transfer Survey (AKTS) includes the three categories. The Danish 'Commercialisation survey' uses the term 'Research agreements' to cover all three whereas the 2014 evaluation distinguishes between collaborative research and knowledge services (including contract research and consultancy). HEB-CI provides a more comprehensive list with collaborative research, contract research and 'business services

50 Cunningham and Gok (2012): 'The Impact and Effectiveness of Policies to Support Collaboration for R&D and Innovation', in *Compendium of Evidence on the Effectiveness of Innovation Policy Intervention*, Manchester Institute of Innovation Research, available at http://www.innovation-policy.org.uk/share/06_The%20Impact%20and%20Effectiveness%20of%20Policies%20to%20Support%20Collaboration%20for%20R&D%20and%20Innovation.pdf.

51 OECD (2013) *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, pp. 126-127.

52 'Licence to SHOK?', op. cit., p. 64

53 Perkmann et al. (2013): 'Academic engagement and commercialisation: A review of the literature on university–industry relations', *Research Policy*, 42, p. 426. Ponomariov, Branco. *Organizational Behavior and Human Resources Management for Public to Private Knowledge Transfer: An Analytic Review of the Literature*. Paris, OECD, 2012.

deriving from formal IP management activities.[54] This kind of activity concerns the public sector at least as much as private businesses: the Canadian survey (The Impact Group, 2010) found that around 50% of the contract research income derived from government departments and in particular the health service.

Contract research and consultancy is probably even more important within the institute sector; it is almost part of their DNA, as they provide access to deep specialists and large-facilities that few businesses – large and small – can justify (or afford) maintaining on a proprietary basis. The big labs have capabilities that go far beyond the typical industry research association, with their large rigs, modelling facilities, and so on, and as such research collaboration and consultancy is a central part of their role and a critical function within the national innovation ecosystem. The Technical Research Centre of Finland (VTT) and the Danish GTS institutes exemplify this role.

None of the benchmark countries considered here has developed national policies around this particular aspect of knowledge transfer, preferring to leave questions about the mode of KT open to research performing organisations and their partners. National support for KT has however focused on classic IP management and research commercialisation activities, as noted previously. We found no examples of national support measures that explicitly target contract research, although one could argue that innovation vouchers are a national response to improving direct business engagement with academic research groups, and that these small credits will allow many hundreds of smaller businesses to get their first experience of universities' commercial offering and lead some fraction of those first timers to return as paying clients. Government schemes, which try to create contact and build relationships between universities and potential business 'customers', include 'Innovation Vouchers' in Scotland and Ireland and the 'Inno-booster' scheme of the Danish Innovation Fund. In New Zealand, Callahan Innovation provides subsidies.

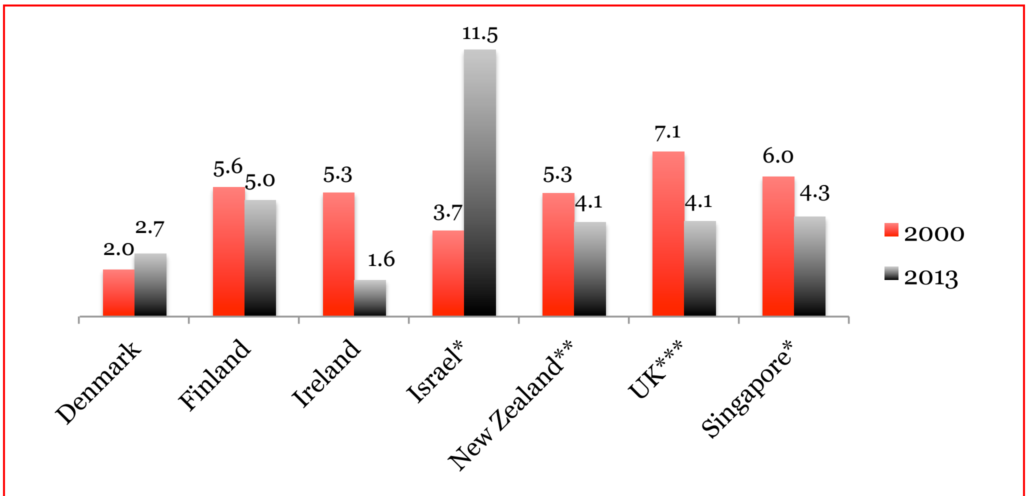
3.4.3 Development and discussion

There are no good international statistics specifically describing these issues, so it has not been possible to look at the relative importance of this KT function across each of our comparator countries. We do however have ready access to one indicator that is widely used as a measure of public-private research cooperation, which is the share of research (in financial terms) carried out in higher education that is financed by industry. This is a standard metric within the OECD's Main Science and Technology Indicators, and it a useful means by which to gauge the level of interaction between the public and private sectors in different countries. It is not perfect for collaborative research, contract research and consultancy, however, as it omits third party funding that originates in the public sector and also excludes substantial technical interaction that falls outside the Frascati definitions of 'research'. Figure 7 presents the figures for our seven countries for each of two years, which together suggests that industry is typically funding around 3-5% of the R&D activities by the higher education sector, but with a high degree of variance even within this limited number of otherwise quite similar comparator countries. This perhaps reflects differences in the balance of public and private sector R&D investment more generally and also the importance of the research institute sector within the overall innovation landscape. The reduction in

[54] The UK Higher Education – Business and Community Interaction Survey 2012/13 (HEFCE 2014/10) presents a breakdown of income by broad class of knowledge transfer. The data for 2012/13 show that UK universities together earned around £1.7 billion in contract research (£1.16 billion), consultancy (£0.4 billion) and facilities rental (£0.14 billion) as compared with £86M for IP related income. This is not a UK phenomenon: the situation is very similar in other countries, and relatively recent work in Canada shows a ratio of around 20:1 for commercial research versus IP related income (Knowledge Transfer Through Research Contracting, June 2010, The Impact Group).

share for five of the seven countries, between 2000 and 2012 or 2013, may reflect the more general weakening of private investment in R&D, driven by the global recession and the movement of increasing amounts of MNCs' R&D investment to emerging economies. Israel and Denmark stand apart on this measure, which is interesting and not immediately explainable. Ireland appears to have experienced a particularly difficult reversal, however, cross-checking the OECD statistics on the sources of R&D expenditure (which are only available in percentages) with expenditure by broad sector of performance in €M and Ireland's official statistics, show that there has been a substantial and long-run expansion in Ireland's gross expenditure on R&D (GERD) driven by strong growth in business expenditure in R&D (BERD) and even stronger growth in HERD, following the increase in State investment in research through the creation of Science Foundation Ireland. The increase in government support for HERD, from a low base, has had the effect of reducing the proportion of HE research funded by industry. Whilst business investment has increased over the period, much of this has been outside of the higher education sector.

Figure 7 Percentage of HERD financed by industry in 2000 and 2013



Source: OECD, Main Science and Technology Indicators. * Data from 2000 and 2012; ** data from 2001 and 2011; *** data for Scotland not available.

There is clearly activity at the level of individual research organisations. We understand that employers are increasingly issuing employment contracts that allow academic staff to work on consultancy for some fraction of their contracted time, as a means by which to encourage individuals to engage in this kind of external activity. It is unclear from our work on this project as to whether the income earned would be paid in full to the contracted academics – boosting their personal income – or paid in part to either the staff or their research group, for funding additional post-docs or new equipment. No doubt there will be a mixture of scenarios, and different outcomes. In some of the most entrepreneurial universities, we understand this kind of consultancy forms part of the annual appraisal process, with staff being set targets for income.

The activity appears to occur largely through bilateral relationships between individual academics or research groups and their 'clients,' with very little active support by institutions beyond basic contracting and assurance of terms and conditions. In some of the world's most entrepreneurial hotspots, like Boston, one can see that this kind of commercial consultancy is actively encouraged and that there are mentors and angel investors available to provide encouragement or advice on how to develop a single promising transaction into something more substantial and maybe scalable.

From a policy perspective, two things stand out:

- Contract research is something of a Cinderella topic for national policy makers, and yet it aligns closely with the political ambition to improve university-industry interaction in general and to intensify and research commercialisation specifically
- Individual researchers have tended to be the focal point for much of this work and individual universities provide little direct support for such work beyond basic contracting. University knowledge transfer offices tend not to have a lot to do with this form of cooperation, perhaps because they don't have the scale or skills in most cases to add much value and might easily do the opposite. We understand that research institutes will manage such interactions very much more explicitly

In summary, contract research and consultancy may be an aspect of knowledge transfer where a national conversation could be helpful for Ireland, as the size of the underlying activity means that even a small relative improvement in performance at the system level could deliver substantial additional benefits in absolute terms.

3.5 Movement of people

The movement of people is arguably the single most important mechanism for knowledge transfer between universities and companies, as new graduates take up their positions in the labour market. There is also a recognition that industry and academia can both benefit through the movement of experienced people between the two sectors. Individuals carry knowledge and know-how that often cannot be codified in patents or publications. This is also part of a wider discussion about the incentives for individual researchers (as opposed to institutions) as such schemes can contribute to improving the financial prospects for researchers who wish to build a career around knowledge transfer and industry-interaction as opposed to more traditional academic aims.[55]

Increasing inter-sectoral mobility and permeability is an explicit aim of the European Research Area (ERA), and the Commission has been collecting statistics on activity levels for two or three years now. The figures show that this kind of cross-fertilisation operates at a relatively low level in most countries, with around 10% of post-doctoral researchers at universities reporting that they have spent 3 months or more working in industry in the previous five years. The figure for Ireland is 16%, which places it joint fourth within the wider EU. The figure for doctoral students work placements is understandably higher, but is still only 23% for the EU overall.[56]

This understanding however tends to be acknowledged only briefly within national knowledge transfer policies, as a truism, and is not a primary focus for most.

The situation may be changing, however, possibly through the encouragement and interest of the Commission and ERA. And there appears to be an emerging trend of schemes funding individual mobility between public research organisations and the private sector. The two main forms of support identified through our research are:

- Work placements and internships of doctoral students
- Fellowships and exchange programmes of experienced researchers

These schemes allow researchers to work part time in industry and universities, in some cases working on the same project in both institutions. Examples of such schemes have been found in five of the seven countries:

[55] 'Vidensamarbejde under lup' op. cit.

[56] MORE2 study "Support for continued data collection and analysis concerning mobility patterns and career paths of researchers", IDEA Consult (2013)

- Denmark: Industrial Researcher (PhD and Postdoc) working on the same project in industry and academia in parallel[57]
- Finland: Proposed industrial doctorates and shared professorships[58]
- Ireland: SFI Industry Fellowship Programme (€1.7m) which aims to "facilitate the bi-directional movement of academic and industry researchers"[59]
- New Zealand: Higher Education strategy calls for more movement of people between HEIs and business
- Scotland (UK): Business Scotland's Industry Fellowship scheme, which funds the basic salary (for up to 2 years) of an academic scientist to work on a collaborative project with industry or an industry scientist to work on a joint project with a university or research institute. Some nominal research expenses may be claimed too (up to £2K a year)
- Scotland (UK): Knowledge Transfer Partnerships, which part fund the cost of employing a recent graduate on a business-development project for the host organisation (business or public sector) and which is supervised by an academic

57 http://innovationsfonden.dk/en/investment/industrial-researcher (Accessed 14 April 2015)

58 'Transformative Finland', op. cit., p. 18

59 http://www.sfi.ie/funding/funding-calls/open-calls/sfi-industry-fellowship-programme-2015.html (Accessed 19 May 2015)

4. Conclusion and reflections

4.1 Summary of knowledge transfer policy and investment in seven countries

In this report, we have looked at support for building and maintaining knowledge transfer capacity at PROs, initiatives to coordinate and support knowledge transfer at the national level and commercialisation schemes to help research ideas reach markets. Figure 8, below, summarises the approaches taken in each of the seven countries.

Figure 8 Summary of government-led investments in knowledge transfer directed to or with PROs.

	Support for capacity	Coordination mechanism	Support for commercialisation	Other programmes referenced
Denmark	General support through block funds only.	Bottom-up networking only (since 2010).	No specific government schemes to support commercialisation at universities.	Innovation Fund Denmark supports business-led collaborative research.
Finland	General support through block funds only.	Bottom-up networking and encouragement through government funding.	Support to develop ideas to business (TUTL)	SHOK centres
Ireland	Dedicated government support through TTSI	Centralised resource for the KT system provided by Knowledge Transfer Ireland	Early Proof of Concept through SFI TIDA and commercialisation support through the Commercialisation Fund (Feasibility, project funding and '+' fund)	
Israel	General support through block funds only (supplemented by private sources).	Bottom-up networking through ITTN	KAMIN proof of concept fund (since 2011) Industry-driven schemes (MAGNET).	
New Zealand	Dedicated support for profession-alisation through CPN.	Government-led coordination through the Commercialisation Partner Network (CPN) funding network organisations	Pre-seed accelerator Fund (PSAF)	
Scotland	Dedicated government support through KTG	Centralised knowledge transfer resources and brokering provided through Interface.	From Proof of Concept to seed funding through the High Growth Spinout Programme (HGSP)	Innovation Centres
Singapore	*[Limited information but university TTOs are reportedly well resourced]*	Central knowledge transfer office for government sector through ETPL. Close links between universities and PRIs.	Proof of Concept (from NRF) and Gap funding (from ETPL)	

Source: Technopolis

Examining the nature of investment and the measures taken to support knowledge transfer, we see some similarities and differences between groups of countries: Denmark and Israel have a relatively small number of large universities[60] with a large proportion of block funding. Both have made the policy choice to rely on universities to carry out knowledge transfer activities, with little dedicated support for institutional capacity, coordination or commercialisation. We may label this the distributed model of knowledge transfer.

With a relatively larger number of small universities[61], the governments of Ireland, New Zealand and Scotland have put different types of national resources and services in place to support the efforts of university KTOs. Similarly, Ireland and Scotland provide dedicated support for knowledge transfer capacity through the TTSI and KTG schemes. Thus, these countries are characterised by a higher degree of government-led coordination and support than Denmark and Israel. Finland is somewhere in between with a relatively large number of smaller universities but without national support in the same way as these other countries. Some correspondents have described the current Finnish system as somewhat fragmented, and reforms are expected.

For Singapore, we were not able to obtain the same level of information as for the other countries, which makes it difficult to compare directly. We learned through interview that the approach taken in Singapore – strong and visible government support, cohesive policy, clear legislation and IP rules, and continuous investment in KT infrastructure and targeted financial schemes through RIE – has produced positive outcomes at the macro and meso levels, working well with HEIs and government labs. We were told, however, that this is not replicated at the micro level, where linkages between the public and private sectors are still difficult to foster and maintain. There was some positive feedback that RIE2015 has to a degree taught people to work together, but it is clear that this will be an iterative process that requires more time and investment through RIE2020.

4.2 Reflections

Knowledge Transfer is a public good and needs government investment

Legislating that universities should pursue knowledge transfer has been an important milestone but needs complementary measures to be effective. Mechanisms to incentivise institutions to prioritise knowledge transfer are now in use in several countries. These include 'hard' financial incentives through formula funding based (partly) on knowledge transfer in Israel and New Zealand, and 'soft' steering through performance contracts in Denmark.

KT is a cost centre not a profit centre for the great majority of institutions, in all of our countries. Given the tight finances of individual PROs and the potentially very large social returns to improving access to public sector IP, most governments see a prima facie case for recurrent dedicated funding of KT, additional to general university funds. Denmark provides an interesting counterpoint. It argues it provides enough institutional funding to allow universities to cover the costs of this additional 'social' responsibility, and the government has therefore switched to an indirect approach to funding KT. Recent evidence from Denmark suggests this may have resulted in a fall in resources available to support KT and while administratively efficient, it may not be sustainable; apparently there are already calls to revisit the question of hypothecated funding. Similar, in Israel where knowledge transfer activities developed historically on the universities' own initiative, government funding has been introduced to support early stage commercialisation.

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[60] HERD per research university above 200m USD/year, see Figure 3 above.

[61] HERD per research university approximately 100m USD/year, see Figure 3 above.

Other countries (e.g. Scotland and Ireland) have determined to continue to fund KT separately, however, there are important conditions, with the award of funds linked (in a non-linear fashion) to measured performance: in essence, the Scottish government is making incremental payments for incremental increases in the flow of social benefits. This highlights a growing interest in the effectiveness of KT operations in general as well as specific types of KT programmes.

One size does not necessarily fit all

There seems to be a view across our comparator countries that most if not all public research organisations should have an in-house KT function of some sort, even if it is part of the research management function and not a full-service office. It means institutions have the internal capacity and expertise to make use of external KT functions (and contribute to national policy discussions about KT support). There is also a general sense that it is easier to do KT where there is a larger body of research generating lots of IP that is of possible interest to business and the wider community, and that the portfolio will grow in extent and value over time (i.e. decades).

There is value in a national KT function that provides additional expertise to individual institutions, is industry facing and actively champion knowledge transfer. Ireland, Scotland and New Zealand have developed some centralised functions. They are similar roles in some respects, acting as an intermediary between business and university research ('shop window') but the Irish model seems the most general. The Finnish case illustrates the risks of a 'fragmented' system where no one 'owns' the issue of knowledge transfer, even for a country that is an 'innovation leader' in many respects. In contrast, Israel and Denmark made the decision has been made to rely on the institutions themselves to develop knowledge transfer activities. We have shown that universities have a different resource base in these two groups of countries which and that this is part of the context in which policy choices are taken. In Denmark and Israel, the argument put forward is that they able to resource their own KT operations. Even so, we see even in these two cases that there are difficulties arising from a lack of government Proof of Concept funding.

Knowledge transfer requires learning and time

The first stage of development of a knowledge transfer system is often associated with an increase in the *quantity* of activities. The next step is to focus more strongly on *quality*. Monitoring outcomes is a crucial part of the process of improving quality. Ireland is among only three countries of the seven reviewed to have systemic annual surveys of national knowledge transfer activity. It will be important to develop indicators further to track not only short-term outputs (LOAs etc.) but also long-term sustainability of knowledge transfer activities. For example, the Scottish (via the HE Business and Community Interaction Survey) and Israeli knowledge transfer surveys include data on the long-term economic performance of spinouts.

Our research suggests that the improving performance in national KT systems is the result of numerous incremental changes, rather than the apocryphal 'Eureka' moment, where a country or university realised a radical and totally new type of KT programme would fix everything. So, we see a keen interest in the experience / expertise of the TT team, the scale of their IP portfolios, the terms on which they strike deals with investors and the financial strategies of the various national support measures, which strive to increase the number of high quality outcomes, rather than just net volumes.

Israel is the most successful country in terms of generating income from commercialisation but this builds on decades of experience. Our interview partners emphasised this point and described a process of trial and error, which had allowed them to refine and improve their approach to knowledge transfer. Even now, almost 70 years after the first TTO was formed at the Weizmann Institute of Science, improvements are still made, most recently by changing the composition of knowledge transfer staff to combine expertise about science, business and law. Israeli universities operate under particular circumstances that cannot easily be replicated in other countries: in addition to decades of experience, our corresponds explained the success of Israeli knowledge transfer by the high level of business R&D performed in the country, international links (e.g. with the United States) and a particular entrepreneurial culture.

New approaches to knowledge transfer

Beyond the government-funded schemes, which have been the main focus in this report, various other initiatives are undertaken to promote knowledge transfer. Scottish universities have benefited from the UK Design Council's scheme to help TTOs become more productive by (i) improving the understanding / appraisal of their portfolios, (ii) being tougher in the prioritisation of projects and (iii) getting their supported projects to go through a process of mentoring to develop awareness of users / markets, develop better prototypes and presentations and generally improve their business proposition.

We saw plenty of activity around the development of new tools to broaden interest and support for KT within institutions, whether that is CPD accredited e-learning tools for researchers or competitions that provide grants to students for innovative projects carried out in collaboration with local businesses or third sector organisations. The Scottish universities signed up in 2011 to an interesting new scheme, Easy Access IP, which brings together some 30 or so universities at present and allows companies to get access to (some parts of) university IP rapidly and free of charge, based on a one-page agreement, so that they can quickly evaluate it and determine whether to invest in its development. We understand that this is an initiative that Ireland has been considering too, with the encouragement of KTI. The University of Nanyang (Singapore) and several New Zealand organisations (via a KiwiNet community) also share innovations via the iBridge network, which supports technology searches for Easy Access IP.

The professionalisation of KT is also supported by the activities of a growing number of national and international representative bodies and private consultancies, from the European Association of Research Managers and Administrators (EARMA) through to the consulting arm of AUTM and Praxis Unico. The recent creation of 'Finnovation Champions', a network of KT professionals in Finland (currently) separate from FINN-ARMA, illustrates how KT management is becoming a distinct profession. Individual KT organisations, such as ISIS Innovation in Oxford, have diversified beyond their in-house operations and are now running KT for other universities and even consulting internationally, providing training and strategic advice to individual institutions.

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