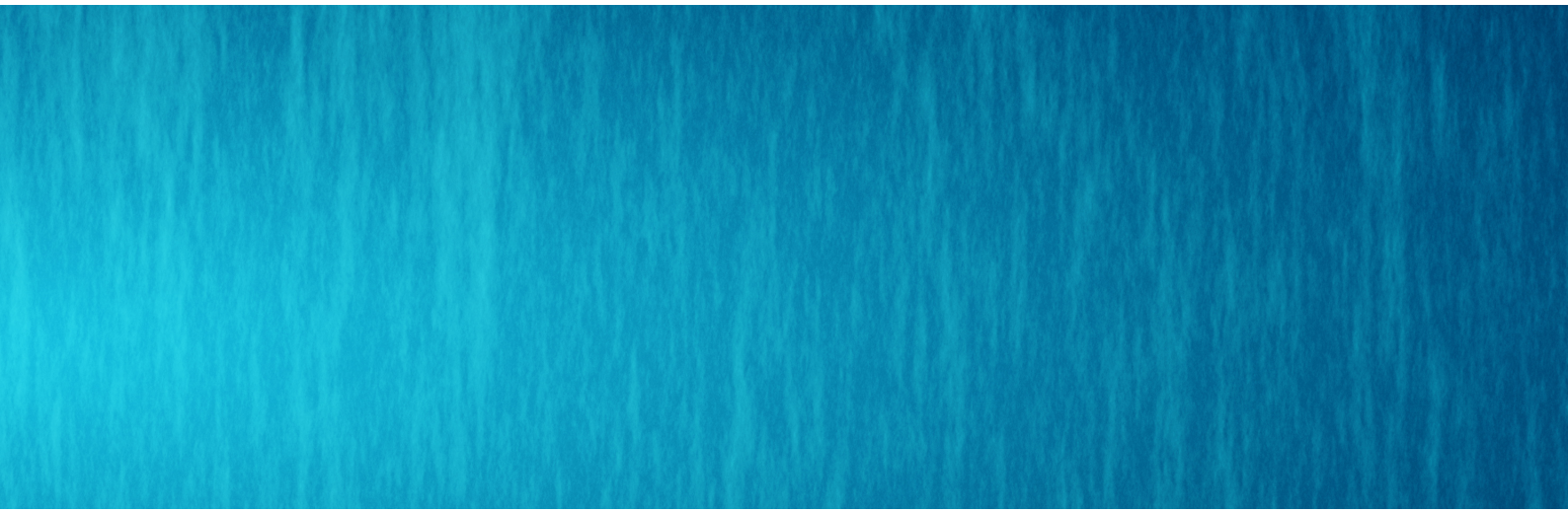

Danish Council for Research Policy

International Perspectives on Framework Conditions for Research and Technology Transfer

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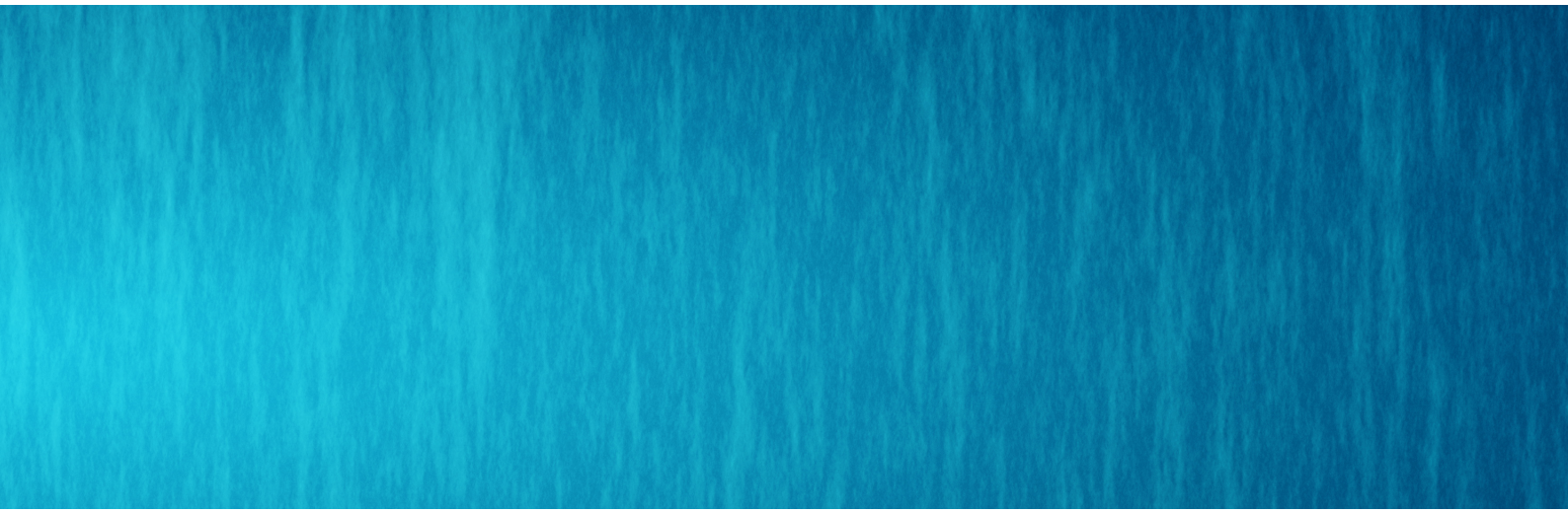

Danish Council for Research Policy

International Perspectives on Framework Conditions for Research and Technology Transfer

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International Perspectives on Framework Conditions for Research and Technology Transfer

Executive Summary

In this report, the Danish Council for Research Policy summarises a review of framework conditions for research and technology transfer in a number of selected countries. The aim of the review has been to establish 1) whether differences in the design of legal, organisational, and financial framework conditions and 2) whether the application of explicit success criteria and consistent impact assessment might feasibly explain the perceived low success rate of technology transfer from public research organisations in Denmark compared to a number of similar countries/regions.

On the basis of the comparison of the countries/regions reviewed, the Danish Council for Research Policy concludes that it has not been possible to detect any differences in the framework conditions of a nature and magnitude that can explain the perceived differences between Denmark and other similar countries.

However, the council does find that the financial framework conditions for research and technology transfer in Denmark should be studied further in connection with the ongoing (2014) evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions in Denmark. It should e.g. be clarified whether sufficient funds are made available for the very early stages of commercialisation; the council firmly believes that this factor makes a pronounced difference as regards the success rate of research and technology transfer.

Furthermore, the Danish Council for Research Policy finds that defining explicit success criteria and following up on these is crucial to supporting successful research and technology transfer. Finally, the council firmly believes that it is necessary to look further into how to foster a more entrepreneurial culture in Danish public research organisations, and into which incentive structures would most effectively engage a broader segment of researchers in research and technology transfer.

For the purpose of this report, the Danish Council for Research Policy applies a narrow definition of research and technology transfer focusing on commercial utilisation. The council fully acknowledges that knowledge transfer encompasses a wide variety of activities where research-based knowledge and technology is transferred to different parts of society, including the transfer of research and technology to the public sector.

Introduction

In the autumn of 2013, all the political parties in the Danish parliament agreed to launch an evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions in Denmark.[1] This decision should be understood as part of an overall debate on Denmark's ability to translate substantial public investment in education and research into innovation, growth and job creation in private enterprises. There is a general perception in Denmark that we are not doing particularly well in this respect compared to similar countries, and that this barrier must be overcome if we are to safeguard the Danish economy and build long-term social prosperity.

1 Agreement on Denmark's Innovation Foundation of 3 October 2013 entered into by the Danish government and political parties, Venstre (the Danish Liberal Party), Dansk Folkeparti (the Danish People's Party), Enhedslisten (the Red-Green Alliance), Liberal Alliance and Det Konservative Folkeparti (the Conservative People's Party); http://fivu.dk/en/newsroom/press-releases/2013/large-new-innovation-foundation-to-solve-societal-challenges-and-create-jobs. The responsibility for this evaluation lies with the Danish Agency for Science, Technology and Innovation, and it is expected to be conducted in the course of 2014.

Over the past three years, the Danish Council for Research Policy has worked to put the broad societal value generated through research, education and knowledge transfer on the political agenda in Denmark through the focus on "The Value-Generating University". In this context, technology transfer, commercialisation, and knowledge collaboration between universities and businesses have been an important element.

Against this backdrop, the Danish Council for Research Policy has decided to conduct a review of framework conditions for research and technology transfer between public research organisations[2] and the business community in a number of selected countries/regions[3]. On the basis of descriptions of the legal, organisational and financial framework conditions and focusing on success criteria for research and technology transfer, the objective of the report is to assess the degree to which these framework conditions are similar. Furthermore, the aim is to assess whether any elements of the individual framework conditions may partly explain differences in prevalence of research and technology transfer in Denmark compared to the other countries/regions. It should be noted that given the timeframe of the review, the ambition is to provide a general picture of the systems in the selected countries/regions and whether any aspects should be studied further. It has not been possible to study the different countries/regions in great detail nor has it been possible to clarify aspects of research and technology transfer that may be contingent on historical and cultural conditions.

The report by the Danish Council for Research Policy constitutes a separate and independent contribution to the ongoing (2014) evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions in Denmark

A definition of research and technology transfer

For the purpose of this report, the Danish Council for Research Policy applies a narrow definition of research and technology transfer. The Danish Council for Research Policy considers the exchange and transfer of research-based knowledge with society to be one of the core missions of universities and other public research institutions. Moreover, the Council fully acknowledges that knowledge transfer may encompass a number of different activities where research-based knowledge, know-how and technology is shared, developed and exchanged with external stakeholders - including but not limited to - industry, NGOs and public institutions.

For the purpose of this report, the Danish Council for Research Policy has chosen to focus on one element of these activities in particular, namely research and technology transfer. In this context, the Danish Council for Research Policy defines research and technology transfer as the identification, valuation, protection, sharing and assignment of intellectual property rights (IPR) with the purpose of commercial utilisation. The review does not, therefore, focus on research and technology transfer taking place between public research organisations and the public sector. Moreover, whilst the report recognises that the role of universities in society is manifold, the general value generated through university research and transferred to society will not be touched upon.

2 Public research organisations encompass research universities and other public research institutions.

3 Baden-Württemberg (Germany), Denmark, Finland, Ireland, Israel, The Netherlands, New Zealand, Singapore and Switzerland.

Comparison of framework conditions for research and technology transfer

The description of framework conditions for research and technology transfer in the selected countries focuses on four main elements: 1) The legislative framework; 2) The organisational set-up for research and technology transfer, i.e. the division of labour between different administrative levels (national, regional, institutional); 3) The financial framework, i.e. the availability of gap funding and pre-seed funding to support the development and testing of research-based ideas and inventions; and 4) The existence and use of success criteria for research and technology transfer.

The countries/regions in the review (Baden-Württemberg, Finland, Ireland, Israel, The Netherlands, New Zealand, Singapore and Switzerland) have been selected on the basis of resemblance to Denmark in the sense of being small advanced economies committed to R&D and to the notion of the knowledge economy. Furthermore, the Danish Council for Research policy has aimed to include countries/regions that do well in terms of research quality and innovation. For an overview of the selected countries/regions based on a few relevant indicators please consult annex 1. Below an overview of the findings in the different countries/regions is provided. For a full description of the framework conditions in the individual countries/regions please see annexes 2-10.

1. Legal framework conditions

It generally applies to all the countries/regions reviewed that public research organisations can claim ownership of the inventions made by researchers employed at the given organisation/institution, and that each invention must be disclosed to the organisation/institution. In Finland, however, there is some variation from this norm since inventions are divided into three categories: open research (rights to the researcher), contract research (rights to the institution), and intellectual property (IP) resulting from other situations (rights to the researcher). Most IP belongs to the contract research category, which has a broad definition in the relevant legislation. The researcher must disclose the potential IP to the institution in all cases after which the institution has six months to consider further action. There is also some variation with respect to the length of time nationally regulated institutional ownership has been in place. Switzerland's general IP legislation, for instance, established institutional ownership already at the beginning of the 20th century; Israel did so in the 1960s, the Netherlands in the 1990s and Germany and Finland in the 2000s. Institutional ownership is likely to positively influence public research organisations' propensity to engage in research and technology transfer.

In many countries/regions, knowledge transfer is legally incorporated into the mission statements of universities and/or public research institutions, making institutions legally obligated - or at least legally permitted - to support the use of public research results, particularly through commercialisation. Generally, however, public research organisations, and particularly universities, have a high degree of autonomy to determine how to organise and implement research and technology transfer at the institution. Nor does national legislation usually specify details as to the organisation, rules and procedures related to research and technology transfer. Often universities can even override national IPR regulations through university bylaws that allow them, for example, to negotiate different IP arrangements with third parties. The role of university bylaws is especially important in countries such as Ireland and Switzerland where the legislative framework regulating academic patenting is not strong[4], but in all countries/regions studied universities have a great degree of flexibility to define internal rule.

4 "Changes to university IPR regulations in Europe and the impact on academic patenting", A. Genua and F. Rossi, in Research Policy 40 (2011), 1068-1076.

Thus, the different institutions establish their own procedures and practice in this area to a very high extent.

Furthermore, in several of the countries/regions reviewed, the public sector research landscape is decentralised and divided into different funding institutions and R&D performing institutions. This implies that there are often different legal frameworks regulating the different public research organisations. For example, in Switzerland, federal legislation regulates the two federal institutes of technology (FIT) and the four public research institutions within the FIT domain. The universities and universities of applied science, on the other hand, are mainly regulated by cantonal legislation. As a result, research and technology transfer may be governed by several regulatory regimes within the same country/region.

Most countries/regions have introduced legislation and public policies during the 1990s and the 2000s that specifically influence the autonomy and obligations of public research organisations in the area of research and technology transfer. There are, however, notable exceptions like Israel, which implemented IP policies already in the 1960s and established technology transfer companies during the 1960s and 70s. It might also be noted that several institutions in the different countries/regions have worked actively with research and technology transfer without national legislation requiring them to do so. It may reasonably be assumed that the length of time legislation and public policies in this area have been in force partly influences the culture surrounding research and technology transfer and the degree of professionalisation in procedures and practices within the public research organisations themselves.

Based on the review of the legislative framework conditions for research and technology transfer, the Danish Council for Research Policy finds no differences of a nature and magnitude that may explain why several of these countries/regions appear to be particularly successful at research and technology transfer. The Danish Council for Research Policy, however, notes that the length of time legislation, practices and procedures have been in place is likely to be significant as this may affect the culture and professionalisation surrounding research and technology transfer in public research organisations.

2. Organisational framework conditions

It is the general norm that each public research organisation in the countries/regions studied has its own technology transfer office (TTO) or unit, although the relative size of these varies. Usually, organisations providing research and technology transfer services are not established at national level. The OECD confirms the perception that research and technology transfer is primarily developed and takes place at the TTOs of the public research organisations, citing in a recent publication that: *"Today, TTOs are seen by most policy makers as the centre and primary driver of commercialisation efforts, and their size in terms of the number of full-time employees has steadily increased over the past two decades."*[5] Furthermore, TTOs are usually independent divisions of public research organisations or an integrated part of the general administration. Exceptions to this general rule are Israel, where the TTOs are run like private companies independently of the universities, and to some extent the Netherlands, where the universities and medical centres can also chose to place research and technology transfer activities in private holding companies with more room for manoeuvre.

5 Commercialising public research: New trends and strategies", OECD, 2013, p.65.

Marketing of research-based IP is usually carried out directly by the individual TTO, either on the basis of the network of individual researchers or the network of the TTO. TTOs also perform market research, marketing IP directly to known companies. Finally, IP may also be marketed through (individual or central) websites, through network organisations of the TTOs and through attending events.

Several countries/regions have publicly funded national organisations and programmes that provide services such as professional coaching, platforms for networking, etc., to support R&D collaboration between the business community and public research organisations in general and research and technology transfer and research-based spinouts and start-ups in particular. Support for early-stage commercialisation activities in the form of professional consulting services and coaching, housing, laboratory facilities, etc., are usually also available through incubators and science parks that are part of or closely associated with public research organisations. Sometimes such services are publicly funded.

In Baden-Württemberg, the organisational framework surrounding research and technology transfer is quite comprehensive. Institutional TTOs are supplemented and supported in the area of invention and patent management at the regional level through the *Technologie-Lizens-Büro*, an organisation that provides support for inventions by universities, enterprises and inventors from the initial idea stage right up to the finished commercial product. Furthermore, with the abandonment of the "professor's privilege", the German federal government established 21 patent exploitation institutions (*Patentverwertungsagenturen*/ PVA) across the country. In addition, regional organisations cooperate at national level within the *TechnologieAllianz*, a network providing private enterprises with access to research results as well as market-oriented and patented-protected inventions from universities and public research institutions across Germany. The *TechnologieAllianz* likewise provides a platform for its members to cooperate with one another. Last but not least, the so-called *Steinbeis* enterprises supplement the research and technology transfer activities of primarily supply-driven organisations. *Steinbeis* enterprises thus supply on-demand research-based services and solutions to mostly small and medium-sized companies, drawing on a network of individual professors from universities and universities of applied sciences.

Similarly, in New Zealand there are a number of transverse organisational structures that supplement the work of the TTOs at the individual institutions. In 2010, the New Zealand government established the Commercialisation Partner Network with the aim of developing centres of excellence in research and technology transfer to boost scale, enhance capability and improve collaboration across New Zealand. In addition, a number of other networks and organisations aim to empower and enable the research and technology transfer effort taking place locally with the objective of boosting the overall economic outcomes for New Zealand. Other interesting examples include Ireland, where a central TTO (KTI – Knowledge Transfer Ireland) has just been set up. KTI appears to be an umbrella-type body that will provide services complementary to already existing TTO structures and act as a central point of contact for companies looking for specific IP opportunities and/or research expertise at individual institutions.

The widespread practice of establishing TTOs at institutional level implies that there is usually no single model or policy governing research and technology transfer practices within one country/region. Indeed, evidence collected by the OECD suggests that variations in the missions and nature of the individual institutions naturally create variations in the missions, models and practice of their TTOs.

However, there are indications of a convergence across countries towards a common set of organisational and financial models for TTOs at public research organisations.[6]

It should also be noted that several countries/regions in this review emphasise the strength inherent in the decentralised nature and relative autonomy of their public research organisations and hence of the TTOs. Such decentralisation allows for flexibility and for institutions to establish procedures and practices that suit their particular context. Conversely, the same characteristics and different standards may complicate coordination and create barriers for companies wanting to collaborate with public research organisations as they encounter an (unnecessary) variety of practices and procedures. The national and cross-cutting structures of Baden-Württemberg, New Zealand and Ireland can be seen as attempts to offset the negative consequences of this decentralised organisation while preserving the advantages of individual approaches and practices. Other measures may be national guidelines (e.g. Ireland, and Singapore) and/or agreements on model contracts, joint codes of practice, etc., among institutions (e.g. Finland).

The Danish Council for Research Policy notes that there is a very high degree of similarity in the organisational framework conditions in the selected countries/regions. As in Denmark, most of the countries/regions reviewed place the primary responsibility for research and technology transfer with the individual institution. The Danish Council for Research Policy finds it interesting, however, that some countries/regions have chosen to supplement this decentralised structure with other organisational structures at the regional and/or national level. Fragmentation and lack of coordination of TTOs keep search costs high for businesses, especially the smallest ones. Therefore, the Danish Council for Research Policy finds that it is important to make it easier for companies of all sizes to access the expertise and relevant research results of public research organisations and to strengthen the scope and capability of the individual TTOs.

3. Financial framework conditions

The majority of countries/regions have public funding schemes available for the support of early-stage commercialisation of research results. These funding schemes vary in size and objective, some specifically supporting start-up companies or proof-of-concept, while others support both. Some countries/regions support this early stage of commercialisation also "in kind", providing consulting services, coaching, laboratory facilities, etc. Furthermore, proof-of-concept and/or start-up companies are sometimes also supported through funds available at the individual institutions although the amounts available here are often smaller than what is obtainable through public programmes.

Israel is an interesting example that stands out in terms of its financial framework conditions. Most Israeli research universities have traditionally had an internal "bridging the gap" fund to accelerate commercialisation of potential technologies by demonstrating feasibility. Such funds have previously been based on philanthropy or semi-philanthropy resources, yet many of these funds have vanished with the 2008 financial crisis. Based on the existing internal model, the Israeli Ministry of Finance has established a national "bridging the gap" fund, called KAMIN, managed by the Office of the Chief Scientist. In addition, the Israeli government supports research and technology transfer through a

6 Commercialising public research: New trends and strategies", OECD, 2013, p.67; "Changes to university IPR regulations in Europe and the impact on academic patenting", A. Genua and F. Rossi, in Research Policy 40 (2011), 1068-1076.

number of other programmes covering early stages of commercialisation, including pre-seed as well as later stages.

Private risk capital is less generally available in the early stages of commercialisation due to the high risk involved. A recent OECD publication supports the findings of this review, stating, that the scale of financing for early-stage commercialisation remains limited in most cases, but that national policy instruments are now shifting from the seed funding stage to proof-of-concept and prototype funding. The OECD moreover points to the existence of a funding gap which limits the possibility of turning research results into commercially viable products and services, hence making it difficult to attract private investors. This funding gap has led governments and, increasingly also individual institutions, to provide financing to public research spinouts. Some public research organisation administrations are thus taking further steps to complement national programmes by setting up their own proof-of-concept and seed funds either fully funded or co-funded with institutional sources.[7]

As concerns financial framework conditions, the Danish Council for Research Policy finds that there seems to be some difference in the design of support schemes and size of funds available for the early-stage commercialisation of public research results in Denmark compared to a number of the other countries/regions. Since the time frame of the present study has not allowed for deep analysis of the financial framework conditions, the Danish Council for Research policy recommends that this aspect be studied further. The Danish Council for Research Policy firmly believes that having substantial funds available specifically for proof-of-concept, prototyping and research-based start-ups does make a pronounced difference when it comes to the success rate of research and technology transfer, particularly as regards spinouts. The OECD confirms this perception, listing the availability of risk capital as one of the important determinants of spinout formation.[8]

Consequently, the Danish Council for Research Policy suggests that the financial framework conditions for research and technology transfer in Denmark be considered specifically in connection with the ongoing (2014) evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions in Denmark. It may be expedient in this context to consider whether there is a need for new schemes and additional funds specifically aimed at supporting the (very) early stages of commercialisation of public research results, such as proof-of-concept, prototyping, etc.

4. Success criteria for research and technology transfer

Even though knowledge transfer is formally and legally a part of the mission of many public research organisations, there is a general absence of established success criteria for research and technology transfer at national/regional level that can serve as guidelines at institutional and TTO-level. Singapore does conduct impact assessment on the IP outcomes of publicly funded R&D projects as well as a number of other indicators related to the translation of IP. Ireland also has national metrics and data collection in relation to research and technology transfer in order to monitor the development in outcomes. However, it seems that only Finland and the Netherlands are working on defining indicators that capture the knowledge transfer activities of public research organisations. Such indicators may be used in institutional performance agreements and are likely to influence funding models at some point.

7 Commercialising public research: New trends and strategies", OECD, 2013, p. 95-106.
8 Commercialising public research: New trends and strategies", OECD, 2013, p. 40.

Success criteria are often established at the level of the individual institution as a natural consequence of public research organisations being required by law to support research and technology transfer. In many cases, however, success criteria for research and technology transfer are only defined at the level of the TTO, by the TTO itself; in effect making research and technology transfer very much a bottom-up driven process. In many public research organisations, research and technology transfer is not a strategic objective and, thus, does not have the attention of management. Technology transfer is considered a service to the faculty at universities, but the general perception is that the real value is in the research itself, which is then transferred to society primarily through research-based education. A notable exception to this rule isIsrael, which stands out with its highly professionalised TTOs run like private companies with clear mission statements, clear incentive structures, and professional staff.

If explicit success criteria are defined at the institutional level, there is a general tendency towards using easily measurable indicators for output, such as the number of patent applications, number of patents granted, number of licensing deals, number of spinout companies, etc., which is also the case in Denmark. Impact assessment studies outlining e.g. how many spinout companies survive after a certain number of years, are less common. Some organisations dealing with research and technology transfer, like *Fraunhofer Venture* in Germany and Leiden University in the Netherlands, systematically benchmark their research and technology transfer performance against leading US research institutions. Performance, as measured against success criteria set at institutional level, is usually reported on in the annual report of the institution. And even if performance on research and technology transfer is not reported publically, TTOs are often required to report to the board of the institution on progress made against a set of given measures.

The Danish Council for Research Policy finds that there is a general lack of nationally established, explicit success criteria for research and technology transfer in the countries/regions reviewed. Success criteria may be defined at the institutional level or, alternatively, at the level of the TTO. However, the high degree of variation when it comes to the use of explicit success criteria within each country/region leads the Danish Council for Research Policy to conclude that this element *per se* cannot explain the perceived differences between Denmark and the other countries/regions as regards the volume of research and technology transfer. It is nevertheless worth noticing that the TTO model applied in Israel is different from those applied by the other countries/regions reviewed. The Danish Council for Research Policy firmly believes that the importance of applying clear mission statements and incentive structures is an area that should be explored further (see the following section).

A need for more knowledge

Based on the review of framework conditions for research and technology transfer in a number of selected countries, the Danish Council for Research Policy concludes that there is a very high degree of similarity in the reviewed framework conditions, especially regarding legal and organisational aspects. The same observation applies to the relative prevalence or absence of explicit success criteria for research and technology transfer. Thus, by and large, the Danish Council for Research Policy has not identified any differences in the framework conditions for research and technology transfer in the selected countries/regions of a nature and magnitude that might fully explain the perceived differences between Denmark and other countries/regions in terms of volume of successful research and technology transfer. That being said, the Danish Council for Research Policy would like to emphasise a number of key aspects of the above observations:

Key messages of the Danish Council for Research Policy

- The length of time that research and technology transfer legislation, practices and procedures have been in place is likely to play a role and affect the culture and professionalisation surrounding research and technology transfer in public research organisations.
- It is interesting that some countries/regions have chosen to supplement the decentralised TTO structure with cross-cutting organisational structures at the regional and/or national level. Fragmentation and lack of coordination of TTOs keep search costs high for businesses. It is important to make it easier for companies of all sizes to access the expertise and relevant research results of public research organisations and to strengthen the scope and capability of the individual TTOs.
- Having substantial funds available specifically for proof-of-concept, prototyping and research-based start-ups makes a pronounced difference when it comes to the success rate of research and technology transfer. The financial framework conditions for research and technology transfer in Denmark should be considered specifically in connection with the ongoing (2014) evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions in Denmark.
- The TTO model applied in Israel is different from the other countries/regions reviewed. It is important to explore further the correlation between the success rate of research and technology transfer and the presence of clear missions, explicit success criteria and consistent incentive structures in public research organisations.

Apart from the points accentuated above, the Danish Council for Research Policy would like to elaborate on a few other aspects, which it finds relevant to consider and explore further in the quest to improve the success rate of research and technology transfer between public research organisations and private enterprises in Denmark. The council believes that there are most likely several explanations as to the current volume of research and technology transfer and, therefore, more than one solution should be sought.

The presence of explicit success criteria accompanied by a stringent follow-up on the progress towards these is one aspect likely to play a crucial role. This aspect has already been touched upon in the comparison of framework conditions above. The data collected for the purpose of this report suggests that there is often no consistency between national (if they exist) and institutional definitions of how to assess the impact and success of research and technology transfer between public research organisations and private enterprises. The Danish Council for Research Policy recognises that differences in missions and profiles of public research organisations make it difficult to establish agreement when it comes to success criteria for research and technology transfer. Nevertheless, the presence of relevant, explicit and consistent success criteria at national, institutional and TTO level is crucial in order to ensure a common focus and clear incentives on all levels.

It is equally essential that success is measured in areas of strategic importance, which generate real value and impact. A survey of European TTOs found that generating licensing revenues is the most important criterion by which TTOs measure their success, closely followed by enhancing industry-scien-

ce relationships and the diffusion of science and technology results.[9] The Danish Council for Research Policy finds licensing revenue to be an insufficient measure for successful research and technology transfer, not least due to the long time lapse between invention disclosure and revenue return and, what is more; only a small number of TTOs generate substantial revenue.[10] Furthermore, the societal benefit and economic value of research and technology transfer is potentially much broader. Therefore, and for the reasons touched upon previously in this report, the Danish Council for Research Policy recommends that the importance of success criteria and adequate impact assessment procedures be explored further.

In this connection, it should be emphasised that the quality of the research-based ideas and technology generated in public research organisations is significantly more important than the sheer number. A number of studies indicate that the increasingly commercial orientation of universities induced by changes in regulation and policy interventions, encourage academics to patent discoveries regardless of their importance, leading to a lower quality of patents.[11]

Another aspect which the Danish Council for Research Policy finds eligible for further exploration is the question of culture and the importance of incentives at institutional level. Anecdotal evidence collected in connection with this report suggests that it is largely the same pool of researchers in public research organisations that engage in research and technology transfer. This indicates that in spite of the efforts of the TTOs, the culture and mind-set of researchers act as a significant barrier. This perception is supported by studies of academic entrepreneurship which show that the researchers engaged in research and technology transfer are typically serial entrepreneurs (who essentially do not need the skills and services of the TTOs) or one-time entrepreneurs, although variations of these two prototypes also exist.[12]

It might be difficult to replicate the large ecosystems of universities such as MIT and Stanford that have extremely good track records when it comes to entrepreneurship and research and technology transfer. Nevertheless, the Danish Council for Research Policy firmly believes that it is necessary to look further into how Denmark might foster a more entrepreneurial culture in its knowledge institutions, and into which incentive structures would effectively engage a broader segment of researchers in research and technology transfer. Studies of academic entrepreneurship and motivation for involvement in research and technology transfer show that if researchers are to engage in such activities, especially when having attained the title of professor, it requires peer recognition of this effort.[13] As long as there is little or no official recognition by institutions or peers of research and technology transfer activities, it is likely to prove difficult to set a cultural change in motion. This perception is supported by the literature on spinouts, one of the robust findings being that institutional policies and rules have a marked effect on the rate of spinout formation. All other things being equal, cultural

9 "Commercialising public research: New trends and strategies", OECD, 2013, p.65-67.
10 "Commercialising public research: New trends and strategies", OECD, 2013, p.65-67.
11 "Changes to university IPR regulations in Europe and the impact on academic patenting", A. Genua and F. Rossi, in Research Policy 40 (2011), 1068-1076.
12 "Academic Entrepreneurship: University Spinoffs and Wealth Creation", Scott Andrew Shane, Edward Elgar Publishing Ltd., 2004.
13 "Academic Entrepreneurship: University Spinoffs and Wealth Creation", Scott Andrew Shane, Edward Elgar Publishing Ltd., 2004.

norms that support research and technology transfer activity will produce higher levels of research and technology transfer and higher rates of spinout activity.[14]

The question of incentive structures underpinning research and technology transfer is thus closely related to a general debate of how knowledge transfer activities can and should be acknowledged in the academic career path. In the opinion of the Danish Council for Research Policy, significant change is needed if Denmark is to improve its success rate of research and technology transfer. This might be achieved by establishing a stronger basis for generating more research-based start-up companies as well as by establishing even closer links to existing (research-based) companies.

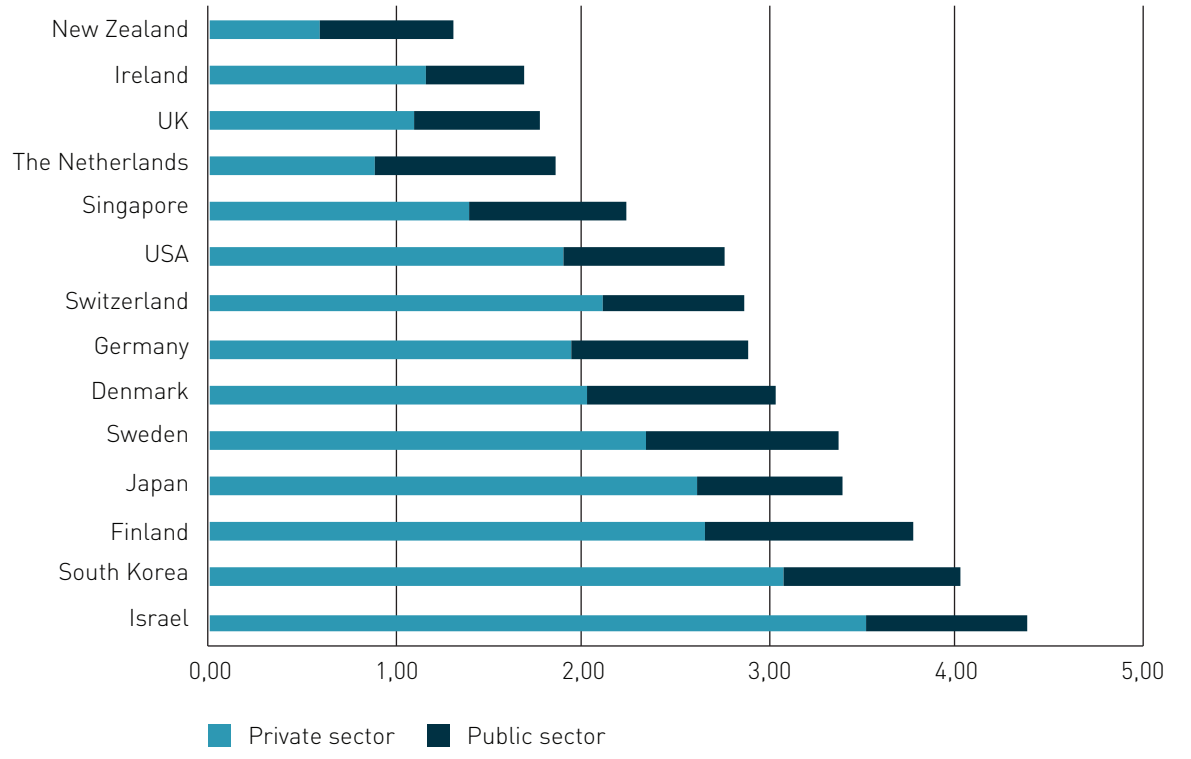
14 Commercialising public research: New trends and strategies", OECD, 2013, p.40.

ANNEXES
Annex 1:
The selected countries at a glance

The following pages provide some pertinent data on the selected countries/regions (Baden-Württemberg, Denmark, Finland, Ireland, Israel, the Netherlands, New Zealand, Singapore, and Switzerland). The intention is to provide a picture of the different countries/regions based on different research and innovation parameters. For the sake of comparability and availability of data, the following figure includes data for Germany as a whole and not Baden-Württemberg in particular. For descriptions of the individual countries/regions, please see the individual annexes.

Figure 1 shows the total expenditure on R&D as a percentage of GDP as well as the distribution between private and public R&D respectively. A few extra countries have been included for the sake of comparison.

Figure 1:
R&D expenditure as percentage of GDP, according to performing sector, selected countries, 2011 or most recent year*[15]



* CHE: 2008; NZL: 2009

As exemplified in the figure, significant differences exist between the countries, with New Zealand, Ireland and the Netherlands investing less than two per cent of GDP in R&D while Finland and Denmark invest above three per cent and Israel above four. Looking at Baden-Württemberg in particular, it should be noted that this region invests considerably more in R&D than Germany as a whole, namely

15 Source: OECD and Statistics Denmark (final figures for the private sector, preliminary figures for the public sector); Figure 1.1 in "Forskningsbarometer 2013", Danish Agency for Science and Innovation, Ministry for Science, Innovation and Higher Education, 21 January 2014.

4.8 per cent (2010). Differences among countries are generally explained by the volume of R&D carried out by the private sector, which reflects both the R&D level in individual sectors and the share of R&D-intensive firms (e.g. the pharmaceutical industry) in the private sector as a whole.

The following table provides an overview of the comparative share of research carried out by public research organisations according to scientific field. These figures provide an indication of the scientific basis present in the different countries from which research and technology transfer must originate.[16]

Table 1:
R&D carried out by public research organisations according to scientific field, as a percentage of total R&D carried out by public research organisations, 2011 or most recent year*[17]

Natural science		Technical science		Medical and health Sciences	
Germany	37 %	Singapore	41 %	Denmark	34 %
Ireland	32 %	Finland	27 %	Singapore	32 %
Finland	21 %	Germany	23 %	The Netherlands	27 %
Denmark	21 %	The Netherlands	21 %	Ireland	22 %
The Netherlands	21 %	Ireland	20 %	Finland	19 %
Singapore	13 %	Denmark	14 %	Germany	18 %
Agricultural and veterinary sciences		**Social science**		**Humanities**	
Ireland	10 %	Ireland	19 %	Germany	10 %
Finland	8 %	Finland	19 %	Ireland	8 %
Denmark	8 %	The Netherlands	18 %	Denmark	7 %
The Netherlands	7 %	Denmark	17 %	The Netherlands	6 %
Germany	4 %	Germany	8 %	Finland	6 %
Singapore	1 %	Singapore	**	Singapore	**

* Data not available for Israel, New Zealand and Switzerland.
** Singapore does not calculate expenditure for social sciences and humanities separately; the total percentage for social sciences and the humanities is 13 per cent.

16 Public expenditure on R&D is an indicator of the amount of R&D carried out by public research organisations, including hospitals, and does not imply that all funding originates from public sources. Thus, funding originating in the private sector may also be a contributing factor in the share of public expenditure on R&D within a particular scientific field. It should also be noted that opinions vary concerning which areas fall under which particular scientific fields. For example, in Denmark the 34 per cent of public expenditure on R&D within the scientific field of medical and health sciences cover areas such as public health, health services and public health medicine, which may be grouped under the social sciences, as well as areas such as pharmacy, pharmacology and medical biotechnology, which may be classified as drug discovery.

17 FIN: 2010, GER: 2010, IRE: 2010, NLD: 2009, SGP: 2010. Source: OECD and Statistics Denmark; table 1.1 in "Forskningsbarometer 2013", Danish Agency for Science and Innovation, Ministry for Science, Innovation and Higher Education, 21 January 2014.

Table 2 gives an overview of the citation impact of research originating in the selected countries/regions; a few additional countries are included for the sake of comparison. Citation impact is a generally accepted proxy indicator for research quality. Switzerland, Denmark and the Netherlands are ranked number two, three and four, respectively, if we include all OECD and BRIC-countries.

Table 2:
Citations of scientific publications, selected countries, 2008-2012[18]

Total number of citations		Citations per publication	
USA	13,434,826	Switzerland	9.25
UK	3,682,386	Denmark	8.49
Germany	3,374,761	The Netherlands	8.40
Japan	2,070,597	Sweden	7.76
The Netherlands	1,343,801	USA	7.63
Switzerland	1,072,102	UK	7.61
South Korea	897,073	Germany	7.35
Sweden	802,835	Finland	7.34
Denmark	528,845	Ireland	7.02
Israel	410,502	Singapore	6.94
Finland	378,706	Israel	6.69
Singapore	320,137	New Zealand	5.93
Ireland	236,787	Japan	5.39
New Zealand	224,193	South Korea	4.31

In order to estimate national ability to innovate and put research and technology to use in the economy, the following table shows the ranking of the selected countries as well as a few other countries according to The Global Competitiveness Index 2013-2014's Innovation-pillar and The Global Innovation Index 2013's Knowledge-and-technology-output-pillar. Looking exclusively at the countries/regions that are part of this review, Denmark along with New Zealand ranges in the bottom-three in both rankings.

18 Source: InCitesTM, Thomson Reuters (2012).

Table 3:
Ranking of selected countries according to different innovation indicators, 2013[19]

Global Competitiveness Index 2013-2014 12th pillar: Innovation, 1-7 (best)*		Global Innovation Index 2013 Knowledge and technology outputs, score and percentage rank*		
Finland	5.79 (1)	Switzerland	61,5 (1)	100
Switzerland	5.70 (2)	Israel	56.0 (3)	98.5
Israel	5.58 (3)	Ireland	55.6 (4)	97.8
Germany	5.50 (4)	Sweden	54.1 (5)	97.7
Japan	5.49 (5)	The Netherlands	53.9 (6)	96.4
Sweden	5.43 (6)	USA	53.6 (7)	95.7
USA	5.37 (7)	UK	51.1 (8)	95.0
Singapore	5.19 (9)	Finland	50.8 (9)	94.3
The Netherlands	5.16 (10)	Germany	49.1 (10)	93.6
Denmark	4.99 (11)	Singapore	48.5 (11)	92.9
UK	4.90 (12)	South Korea	47.8 (12)	92.1
South Korea	4.78 (17)	Japan	44.6 (16)	89.3
Ireland	4.58 (20)	Denmark	41.9 (19)	87.2
New Zealand	4.34 (26)	New Zealand	37.2 (29)	80.1

*Number in bracket shows ranking among all countries in the index.

19 Source: The Global Competitiveness Index 2013-2014, 12th pillar: Innovation, 1-7 (best), indicators included: Capacity for innovation, quality of scientific institutions, company spending on R&D, university-industry collaboration, government procurement of advanced tech products, availability of scientists and engineers, PCT patents, applications/million population; The Global Innovation Index 2013, Innovation Output Sub-Index, pillar: Knowledge and technology outputs, indicators included: Knowledge creation (national office resident patent applications, PCT resident applications, National office resident utility model applications, scientific and technical publications, citable documents H-index), Knowledge Impact (growth rate of GDP per person engaged, new business density, total computer software spending, ISO 9001 quality certificates, high-tech and medium-high-tech output), Knowledge Diffusion (royalties and license fees receipts (% service exports), high-tech exports, communications, computer and information services exports %, foreign direct investment net outflows).

Annex 2:
Baden-Württemberg – Framework conditions for research and technology transfer

General information

Population: 10,569,111 (2012)	GDP annual growth rate: 0.6 % (2012)
GDP: USD 541.7 billion (2012)	R&D as percentage of GDP: 4,8 (2010)
GDP per capita: USD 50,092 (2012)	R&D personnel: 88,600 FTE[20] (2010)

The public sector research landscape in Germany is decentralised and divided into many different funding and R&D performing institutions. In Germany, the universities (research universities and polytechnics) account for roughly half of the public sector R&D. A large part of the other half of public sector R&D is performed by four non-university organisations (*Max Planck, Fraunhofer, the Helmholtz Association* and the *Leibniz Association*).

There are nine research universities, 41 polytechnics, eight cooperative education universities and 21 private universities in Baden-Württemberg. Besides the institutions of higher education, there are 12 *Max Planck* institutes, 14 *Fraunhofer* institutes, two *Helmholtz Association* research centres as well as seven Contract Research Institutes located on university premises (not including *Steinbeis* transfer centres).

The private sector is the predominant investor into R&D in Baden-Württemberg. In 2009, this sector alone accounted for almost 80 per cent of total R&D investments. The most R&D intensive sectors are the automotive, electrical, and mechanical engineering sectors which jointly were responsible for 76 per cent of all in-house R&D in 2009. Nearly 17 per cent of all employees in Baden-Württemberg (2011) were working within high or medium-high-tech industries.

Legal framework conditions for research and technology transfer

Research and technology transfer between public research organisations and private enterprises is regulated by legislation at both federal and Länder level. The core legislation is the Employee Invention Act, which was modernised in 2009 as part of the *Patentmoderniserungsgezetz*. The so called "professor's privilege" was abandoned in 2002, and the new Employee Invention Act now assigns patent rights to the public research organisation. Each invention must be disclosed to the university which then decides whether or not to proceed with commercial exploitation; otherwise the rights can be given back to the inventor. Data suggests that there are no clear, identifiable effects of the legislative framework introduced in 2002 on volume of research and technology activities.

The Constitution and State Higher Education Act (LHG) states that institutions of higher education must actively support the use and application of knowledge through research and technology transfer. However, the institution is only allowed to establish, overtake, expand or engage in private companies under the following conditions:

1. In order to support research and technology transfer which is in the public interest.
2. The nature and character of the company is reasonably related to the mission of the higher education institution.
3. The higher education institution is granted reasonable influence in the deciding bodies of the company.

20 FTE: Full-time equivalent.

4. The obligation to contribute and the liability of the higher education institution can be limited in accordance with its mission.

Legislation does not specify conditions concerning the negotiation of IP-related to research and technology transfer. The *Innovationsrates Baden-Württemberg* argued in a 2010 report that, due to the general character of the legislative framework for research and technology transfer, in effect a variety of practices and procedures are implemented at the different institutions. As a consequence, contractual negotiations are very time-consuming (i.e. no standard model is applied). Various guidelines concerning research and technology transfer can be found on the websites of each of the four large non-university research institutions.

Organisational framework conditions for research and technology transfer

Individual universities and research institutions have technology transfer offices (TTO) or units of various sizes. At *Länder* level, these units are in many cases supplemented and supported by large (network) institutions like the *Technologie-Lizenz-Büro* (TLB) in Baden-Württemberg. Thirdly, the regional organisations cooperate at national level within the *TechnologieAllianz*, which consists of 28 German patent marketing agencies and technology transfer agencies working in a joint network representing more than 200 universities and non-university research institutions. The *TechnologieAllianz* focuses on market-oriented and patent-protected inventions making these inventions available to industry partners as well as providing a platform for its members to cooperate with one another.

Accompanying the shift from an inventor-ownership system to an institutional ownership system in 2002, a number of regional patent agencies (*Patentverwertungsagenturen*/ PVAs) were established in Germany to support patent activities. The government aimed for one PVA for each of the 16 *Länder*. In the end, 21 PVAs were established to cover the patenting activities of nearly 240 universities and public research institutions. Eight of the PVAs were newly established institutions while 13 existed before as patent consultancies or technology transfer service institutions of some kind.

Finally, the Baden-Württemberg based *Steinbeis* Foundation has developed and spred its activities from the South-eastern corner of Germany to the entire country and beyond. The *Steinbeis* transfer centres (today *Steinbeis* enterprises) were established during the early years of the foundation in the 1980s. These units are organised as "companies within companies", the core idea being to formalise of the part-time jobs conducted by professors at universities or universities of applied sciences in addition to their formal teaching commitments and research activities. The *Steinbeis* concept is thus based on bottom-up interest among researchers. The professors become part of a network that helps mainly small companies solve problems on a demand-driven basis.

Some professors are an entity in themselves (a "one-man company") with only few jobs a year while others have set up entire systems with many additional employees and an annual EUR million turnover. When companies approach *Steinbeis*, the network of participating researchers identifies the researchers who can provide the best solution in the particular case. The stand-alone *Steinbeis* enterprises operate beyond the auspices of universities and public research institutions, and their portfolio of services include: consulting, R&D, training and employee development as well as analyses and expert reports. Critics argue that the solutions provided by this decentralised and loosely organised network can be of a somewhat more erratic quality than what is provided, for example, by the *Fraunhofer* institutes.

Intellectual property (IP) is typically marketed through the institutional TTOs, *Steinbeis* or TLB, who actively scout for talent, potential patents and innovative research. In addition, during 2012 and 2013, the four large non-university research institutions have jointly launched one-day innovation days, where their TTOs present inventions and technology to the companies that sign up for participation (entrance fee between EUR 100 and 500 depending on company type/size). *Fraunhofer*, which is the most patent-active of the four non-university research institutions, is also active at another fair.

Financial framework conditions for research and technology transfer
As the *Länder* are responsible for universities (funding, governance, etc.), the role of the federal government is primarily to provide funding in the form of programmes targeting entrepreneurship in a broad sense at universities and research institutions.

EXIST (University-Based Business Start-ups) is a support programme of the Federal Ministry of Economics and Technology (BMWi) aimed at improving the entrepreneurial environment in universities and research institutions and at increasing the number of research and technology based business start-ups. The EXIST programme is part of the German government's "High-tech Strategy for Germany" and is co-financed by funding from the European Social Fund (ESF). The EXIST programme includes three sub-programmes:

EXIST – Culture of Entrepreneurship supports projects at universities that focus on building infrastructure and skills to support research and technology based innovative ventures. To support such activities universities may receive a grant over a three-year period. Projects can include the following activities: a) establishing a lasting culture of entrepreneurship in universities and research institutions; b) supporting consistent transfer of scientific knowledge into commercial output; c) promoting potential business ideas and entrepreneurs from universities and research institutions in a targeted manner; and d) increasing the number and the chances of success of innovative start-ups.

EXIST – Business Start-up Grant supports the preparation of innovative start-up projects at universities and research institutions. The grant aims to help scientists, university graduates and students develop their business ideas into business plans and to advance their ideas for products and services. Entrepreneurs receive a grant to cover living expenses for a maximum of 12 months. In addition, they receive materials and equipment, funding for coaching and, if relevant, a child supplement. The university or non-university research institution provides the infrastructure during the pre-start-up phase and provides technical and start-up-related assistance.

EXIST – Transfer of Research promotes research and technology based start-up projects in the pre-start-up and the start-up-phase. This programme has an excellence-oriented focus on high-tech start-ups which complements the more broadly targeted EXIST Business Start-up Grants. The purpose of the first funding phase is to support research teams at universities or research institutes so as to enable them to provide proof for the technological feasibility of their product idea and to prepare the start-up. The maximum funding period is 18 months in the pre-start-up phase. During the second funding phase, the newly founded research and technology-oriented companies can be supported to continue the product design, for instance, up to prototype realisation where they are able to solicit external funding for their company.

At *Länder* level, the Baden-Württemberg programme *Junge Innovatoren* plays an important role in supporting younger scientists who engage in entrepreneurial activities.

A 2008 study of 262 spinout companies in Bavaria going back to the 1990s indicates that the funding programmes that have typically played an important role are a mixture of federal and *Länder* programmes. Many of the spinout companies have made use of two or in some cases three programmes. It is unknown to what degree these results are transferable to Baden-Württemberg, but it does seem to indicate that the presence of several funding opportunities plays a role in the establishment and survival rate of spinout companies.

Success criteria for research and technology transfer

There are no explicit success criteria defined either at federal or at Länder level. The federal state is active in monitoring and analysing the German science and innovation system, including the area of entrepreneurship and technology transfer. The lack of annual, national statistics on public-sector patent applications and patents granted, spinout companies, license fees, etc., however, makes it challenging to assess a core part of the research and technology transfer system. Several German studies and reports try to gather data on research expenditures (input) and patent/spinouts and in some cases publications (output). Some of these studies contain data allowing for comparisons over time, between different scientific fields, and/or between different institutions.

At institutional level there is a tendency towards focusing on data that is easy to measure, such as the number of patent applications, the number of patents granted and the number of spinout companies. Studies of impact, e.g. how many spinout companies survive a certain number of years, employment effects etc., are much less common. There are examples of institutions, e.g. *Fraunhofer* Venture, using other German and leading US research institutions to benchmark performance.

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Annex 3:
Denmark – Framework conditions for research and technology transfer

General information

Population: 5,548,000 (2010)	GDP annual growth rate: 1.1 % (2011)
GDP: USD 233.0 billion (2011)	R&D as percentage of GDP: 2.98 (2011)
GDP per capita: USD 40.929 (2011)	R&D personnel: 56.126 FTE (2011)

In Denmark, there are eight public universities (no private universities); four of these have medical faculties with university hospitals affiliated. There are five government research institutions.

In 2011, two thirds of R&D investment came from the private sector (approx. DKK 36.3 billion) and one third from the public sector (approx. DKK 18.2 billion). The strongholds within private R&D are biotechnology and life sciences, food and agriculture, information and communication. In 2009, 3,800 Danish companies were involved in R&D. Of these, the 10 most R&D-intensive companies were responsible for approximately 40 per cent of the total private R&D investment.

Legal framework conditions for research and technology transfer

The Danish system of transferring IPR between public research institutions and private enterprises is governed by national and international regulations. The core legislation is the Act on Inventions at Public Research Organisations, which was originally adopted in 1999. This act covers universities, government research institutions and the hospitals owned by regional authorities, and serves aspoint of departure for all university patenting and licensing in Denmark. With the introduction of this act, the previous "professor's privilege" ownership ceased to exist.

The basic principles of the act are: 1) Institutions can claim ownership to inventions made by their employees; 2) Researchers are obliged to notify institutions of inventions and postpone publications if required; 3) Institutions are required to evaluate inventions within specific time limits; 4) Institutions must establish adequate structures for technology transfer; 5) Contracts with industry involving IP must be negotiated by the institution; 6) Institutions can utilise funds to cover costs for patenting and commercialisation activities; 7) Mandatory profit sharing of commercial revenues between institutions and inventor; and 8) Institutions can receive equity in return for IPR in spinout companies.

The Act on Inventions at Public Research Institutions does *not* regulate the terms of collaboration, assignment or licensing contracts, e.g. with regard to transfer of ownership, exclusivity, sub-licensing and pricing, etc.. Indirectly, the negotiation of such contracts is affected by other national and international regulations such as the University Act, budgetary guidelines, state aid and competition law.

Apart from the Act on Inventions at Public Research Organisations, national guidelines have been established to facilitate public-private research collaboration. Hence, a best practices manual on university-industry collaboration agreements was published in 2000, followed by Government guidelines for university research collaboration with private enterprise" in 2005. In 2011, the Government published an additional "Guidelines on private funding of public research". Moreover, in 2008, a model contract toolkit on IP issues between universities and industry was published, namely the Johan Schlüter Committee model contracts. The inspiration for this toolkit came from the UK Lambert Agreements, and a selection of model contracts for different types of research collaboration.

Initially, when the Act on Inventions at Public Research Institutions was passed, the balancing of interests and matching of expectations was a source of conflicts. In the meantime, the situation has improved and the level of conflict is lower today. One notable observation related to the legal framework, however, is that the incentives from royalty sharing have proved somewhat weaker than expected. One explanation for this fact may be that royalties often only materialise several years after the time of invention.

Organisational framework conditions for research and technology transfer
The Act on Inventions at Public Research Organisations requires the institutions to establish adequate procedures and structures to deal with invention disclosures, patenting and licensing, but does not specify a specific design of this organisation. According to the Danish University Act, Danish universities are independent and autonomous entities and hence determine their organisational structure on an individual basis. In practice, major institutions with substantial patenting activities have established independent technology transfer offices (TTO) while minor institutions tend to integrate this function in the general administration. Some university hospitals are serviced by the corresponding universities' TTOs. Moreover, some regional authorities run their own TTOs. Against a background of major institutional and regional reforms in 2007, a number of institutions were merged. This led to fewer TTOs providing for a higher level of critical mass. Today, 6-7 institutions account for more than 90 per cent of the public research patenting and licensing.

In 2005, the Act on Technology Transfer at Public Research Organisations was adopted allowing universities to organise relevant research and technology transfer activities and spinout support in subsidiary companies. So far, three universities have utilised this option, whereas a fourth operates a different company structure for historical reasons. At all major universities there are co-located science park facilities and related incubators, which offer housing and laboratory facilities, early stage funding and counselling for entrepreneurs and spinout companies. Furthermore, an independent network of so-called technological service institutes (GTS) provide commissioned R&D support and advanced technical support for small and medium-sized enterprises (SMEs).These institutes diffuse new knowledge to a broad range of SMEs without internal R&D capacity yet with potential for university collaboration.

The transfer of IP is often an integrated part of research collaboration contracts between universities and industry. In cases where a collaborative project subsequently results in new IP, such projects are often followed by a supplementary licensing contract. As regards marketing of IP, a national network for technology transfer professionals used to run a joint web-based patent exchange portal for all public Danish research organisations. This web-based portal has, however, been discontinued. Today, the Danish Patent Office operates a broad internet IP Marketplace for marketing of IP to and from private enterprises and other players. The Danish Patent Office has also developed the valorisation tool IPScore in order to facilitate market transactions. Finally, national or international license brokers and on-line marketing platforms are used when considered relevant.

Financial framework conditions for research and technology transfer
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 by funding best

practice projects. From 2007 onwards a Proof-of-Concept scheme provided early stage gap-funding for universities. And from 2000-2010 funding was available for the National Network of Technology Transfer Professionals. Following a period of substantial increase in block funding to the universities it was eventually decided that the universities themselves must cover all research and technology transfer costs - including proof-of-concept from 2013 onwards.

In addition, an innovation incubator scheme provides risk capital for early-stage start-ups, while the national foundation *Vækstfonden* has been set up in order to provide follow-up capital for enterprises and co-funding for private venture capital funds.

Success criteria for research and technology transfer

National criteria for measuring the success of research and technology transfer have been outlined in various different government strategies. In 2006, the then government's "Strategy for Denmark in the Global Economy" (the Globalisation Strategy) thus stated that Danish universities should rank amongst the world's best for transforming research results into new technologies and services. At national level, the objectives of the Globalisation Strategy have been systematically monitored in the "Annual Competitiveness Report" while progress with regard to research and technology transfer has been measured by the number of patent applications, license deals and spinouts generated from public research.

In December 2012, the present Government launched its "Innovation Strategy", replacing the previous objectives with a new national target: to continue the growth rate in commercial utilisation accomplished during the period 2000–2011 towards 2020 by more than doubling the number of license assignments and option agreements signed annually by public research organisations in Denmark. Furthermore, performance agreements between the Ministry of Higher Education and Science and the individual universities were introduced at national level in 2006. Some contracts have included targets for research and technology transfer, depending on the individual profile of the university. For the period 2012-2014, a target of "increased capacity for innovation" has been included in the performance agreements of all universities, with universities defining their own individual indicators. Progress with regard to targets in the performance agreements must be documented in the annual reports of the individual institutions.

Since 2000, an annual national "Public Research Commercialisation Survey" has provided systematic information on research and technology transfer activities and IP exploitation based on a number of key indicators. Subsequently, in 2013, the Danish Parliament decided to further evaluate the performance within research and technology transfer. Hence, a national evaluation on research collaboration and technology transfer shall be carried out during 2014.

There is no specific correlation between the objectives concerning research and technology transfer (as defined at the governmental level) and the targets included in the performance contracts with the individual universities. Moreover, given the universities' status as autonomous entities, they are entitled to define their own criteria for the success of research and technology transfer.

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Annex 4:
Finland – Framework conditions for research and technology transfer

General information

Population: 5,363,000 (2010)	GDP annual growth rate: 2.7 % (2011)
GDP: USD 208.1 billion (2011)	R&D as percentage of GDP: 3.55 (2012)
GDP per capita: USD 36,307 (2010)	R&D personnel: 54,047 FTE (2012)

The Finnish research system is rather decentralised and there are several public organisations conducting research. Currently, there are 15 universities, 26 polytechnics and 17 state research institutes in Finland. There are 14 universities and 24 polytechnics under the Ministry of Education and Culture, The National Defence College is a university under the Ministry of Defence. Åland University of Applied Sciences is a polytechnic in the self-governing Province of Åland, and the Police College is a polytechnic under the Ministry of the Interior. As part of a reform of the research institutes and their funding launched in 2013, some state research institutes will be merged into larger entities by 2015.

Universities are responsible for research and education in the arts and sciences while research in polytechnics is focused on applied research and development activities which serve regional development needs. Doctorate degrees can only be earned at universities. State research institutes, i.e. research institutes in the sectors of different administrative fields, play a significant role in the research system. The largest research institutes, as measured by their volume of research funding, are the VTT Technical Research Centre of Finland (Ministry of Employment and the Economy), the Finnish Forest Research Institute (Ministry of Agriculture and Forestry), MTT Agrifood Research Finland (Ministry of Agriculture and Forestry) and the National Institute for Health and Welfare (Ministry of Social Affairs and Health).

Of the USD 7,530.1 million spent on R&D (GERD) in Finland in 2012, 63.1 per cent was financed by industry; 68.7 per cent was performed by the business enterprise sector while 21.6 per cent was performed by the higher education sector and 9 per cent by the government sector. The vast majority of enterprises (93.4 per cent) in Finland are micro-companies (1-9 employees); 6.4 per cent are small and medium-sized enterprises (SMEs) and 0.2 per cent are large companies (more than 250 employees) (2010).

Legal framework conditions for research and technology transfer

In Finland, the transfer of intellectual property rights (IPR) between public research organisations and private enterprises is governed by several national regulations. In state research institutes inventions are regulated by the Act on the Right in Employee Inventions. In most cases, the institution can claim the right to the invention and the inventor must receive a reasonable compensation.

As concerns higher education institutions (universities and polytechnics), the Act on the Rights in Inventions made at Higher Education Institutions (HEIs) came into force in the beginning of 2007. The aim of this legislation was to clarify questions of rights to inventions made in HEIs and to promote the utilisation of these inventions. In the legislation, inventions are divided into three categories: 1) Open research (rights assigned to the inventor); 2) contract research (rights assigned to the institution) and 3) inventions made in other situations (rights assigned to the inventor). The inventor must disclose his patentable invention to the institution in all cases and the institution has six months to consider the disclosure. Most inventions belong to the contract research category, which has a broad definition in

the Act. In these cases, the institution can claim the rights to the invention while the inventor has the right to a reasonable compensation.

The national legislation concerning inventions does not regulate the terms of contracts concerning collaboration, assignment or licensing in regard to the transfer of ownership, exclusivity, and sub-licensing, pricing, etc. Indirectly, the negotiation of such contracts is affected by other national and international regulation, such as university law, budgetary guidelines, state aid and competition law.

In 2009, the government adopted a national strategy on IPR aimed at improving the operational environment surrounding IPR in a number of areas. Key reforms are related to competence-building and education with a focus on business management expertise, including managerial expertise and knowledge of international contracting being included in education on IPR.

Neither nationally approved model contracts nor other model contracts are provided by public funding organisations. However, universities and research institutions have drafted such contracts in close cooperation with each other.

Organisational framework conditions for research and technology transfer
According to the Finnish Universities Act, universities have a large degree of autonomy in deciding how to organise their activities in general and hence also their research and technology transfer activities in particular. The Act on Inventions at HEIs requires the institutions to establish adequate procedures and structures to deal with invention disclosures, patenting and licensing, but does not specify a specific design for this organisation. In practice, major institutions with substantial patenting activities have established dedicated technology transfer units whereas others have integrated this function into the general administration.

The Finnish Universities Act was reformed in 2009 with a new act coming into force from the beginning of 2010. The reformed act gave independent legal status and full financial responsibility to universities as well as granting the universities better possibilities to enhance their research and technology transfer activities.

Since the introduction of national legislation in 2007, the research and technology transfer activity of HEIs has become more professional and transparent. Research and technology transfer experts at Finnish universities have established a network (FINN-ARMA, Finnish Association of Research Managers and Advisors) where they can share experiences and develop expertise.

Science park facilities and related incubators that offer housing, laboratory facilities and professional counselling for entrepreneurs and spinout companies are co-located at all major universities.

Financial framework conditions for research and technology transfer
Tekes (the Finnish Funding Agency for Innovation) has several funding instruments which promote research and technology transfer between public research organisations and businesses. In 2012,Tekes launched a new funding instrument (TUTL) to facilitate knowledge and technology transfer between public research organisations and private companies. The aim of the funding instrument is that each project examines possible paths to utilisation and the most promising route for taking the idea further. In addition, the possibility of using the idea in a start-up company or developing it into a new business area in an existing company is investigated. Support can be granted to several lines of action: exami-

nation of the research idea from a commercialisation perspective (proof of relevance); examinations of novelty; determination of customer value; surveys of competitors; examinations of IPR; experimental verification of the viability of an idea (proof-of-concept); mapping of funding models and mapping of business models.

There are also national programmes that promote the cooperation between public research organisations and the business community and focus on enhancing the transfer of knowledge. The Strategic Centres for Science, Technology and Innovation (SHOK Centres) support the long-term development of research and innovation activities pursued by the strong sectors of Finnish business. In addition to companies, the SHOK Centres' research programmes are also implemented by universities and state research institutes.

Through the Innovative Cities (INKA) programme and growth agreements, the 12 largest urban regions in Finland and the government join forces to improve the preconditions of the selected urban regions to develop into attractive local innovation hubs.

A new funding instrument will also be established to finance long-term problem-oriented and programme-based research focusing on solutions to societal challenges. This funding instrument, i.e. the Strategic Research Council, will have an annual budget of EUR 70 million which will come from the appropriations of the state research institutes, from the Academy of Finland and from Tekes (the Finnish Funding Agency for Innovation).

Success criteria for research and technology transfer

In its Research and Innovation Policy Guidelines 2011-2015, the Finnish Research and Innovation Council included strategic development policies stipulating that incentives for business cooperation should be created at HEIs and that efficient utilisation of research results from HEIs should be promoted, including the reorganisation of innovation and support services into larger units that enhance competence. However, no national-level success criteria have been defined. The knowledge transfer performance of public research organisations and key figures are documented in the annual reports of individual institutions.

Tekes also follows the performance of its funding instruments and has a post-project reporting procedure in place. These reports provide Tekes with information about e.g. IPRs, licensing agreements, utilisation and publications. This provision has been in force since before 2010, but, in line with the 2012 Tekes Public Funding reform, there will be an increased focus on technology and knowledge transfer and societal impact going forward.

Four-year performance agreements exist between the Ministry of Education and Culture and the individual HEIs. In the funding model of the HEIs, other science policy objectives are included in the strategy-based funding, which is determined on the basis of strategic priorities of the individual institutions and which include knowledge transfer activities. Currently, it is being considered which indicators may be relevant and which indicators can be developed in order to better integrate the impact of research and the utilisation of research results into the funding model. However, it remains a challenge to identify suitable knowledge transfer indicators for HEIs which take into account the diversity of these activities.

Universities updated their strategies in 2009 and the Ministry of Education and Culture requested them to take into consideration knowledge transfer and the utilisation of research findings. In 2011, the Ministry of Education and Culture requested universities to report on their activities regarding knowledge transfer and utilisation of research results. These reports were discussed in the spring of 2012 at negotiations between the ministry and universities. The reports showed that knowledge transfer activities differ among universities, depending on e.g. the scientific disciplines in the university. Tekes funding has evidently played an important role for universities as regards establishing and improving their knowledge transfer activities.

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Annex 5:
Ireland – Framework conditions for research and technology transfer

General information

Population: 4,474,000 (2010)	GDP annual growth rate: 2.2 % (2011)
GDP: USD 196.6 billion (2012)	R&D as percentage of GDP: 1.66 (2011)
GDP per capita: USD 40,478 (2010)	R&D personnel: 21,560 FTE (2011)

Ireland has seven universities and fourteen institutes of technology, colleges of education and other recognised institutions, including private colleges. In 2010/2011, the seven universities were responsible for 93 per cent of doctoral candidates in Ireland, 98 per cent of research expenditure, 99 per cent of research contracts and grants and 84 per cent of research staff. Ireland also has a few public research institutions. The activities of these organisations are mostly focused on natural resources (food, agriculture, forestry and marine), health, energy, and the environment.

Industry financed 48.4 per cent of gross domestic expenditure (GERD) on R&D in 2011 while 69 per cent of GERD was performed by the business enterprise sector and 26.1 per cent and 4.9 per cent by the higher education sector and the government sector, respectively. Foreign-owned enterprises represented almost 71 per cent of all research and development expenditure in 2011; medium and large enterprises (more than 50 employees) accounted for almost three quarters of business expenditure on R&D (BERD) in 2011. The number of R&D-performing firms increased by 25 per cent from 2009 to 2011 to over 1,600 with almost three quarters being Irish owned.

In 2011, research and development spending was highest in the services sector which accounted for 61 per cent of all expenditure. In excess of 80 per cent of total business research and development expenditure in 2011 was concentrated in four sectors: 'Manufacturing'; 'information and communication services'; 'real estate activities' and 'professional, scientific, and technical activities'.

Legal framework conditions for research and technology transfer

According to the Irish Universities Act (1997), the objectives of a university in Ireland include "to support and contribute to the realisation of national economic and social development" as well as "to disseminate the outcomes of its research in the general community".

In Ireland, legislation assigns intellectual property rights to the public research organisation following the principle of institutional ownership. It is a system of automatic ownership where the first owner is automatically the employer and not the researcher. By law, no rights for remuneration of researchers exist, but such an obligation can be negotiated between the parties by contract. Furthermore, since there is not a strong legislative framework regulating research and technology transfer, university bylaws play an important role in regulating conditions and procedures related to IPR.

In Autumn 2012, the Department of Jobs, Enterprise and Innovation (DJEI) published a document called "Putting public research to work for Ireland", also known as the national IP Protocol. This new IP Protocol was informed by a group of experts from industry, the venture capital community, Research Performing Organisations (RPOs), Technology Transfer Offices (TTOs), the Enterprise Agencies, and the Irish University Association. It is a single reference document and replaces three earlier guidelines and codes of practice documents, building on the lessons learnt from their use. The document outlines how intellectual property arising from Irish state-funded research should be managed and best used for national economic return. The national policy covers the State's aims in encouraging in-

dustry and public research organisations to work together, principles for commercialisation, including IP Identification, IP Protection, IP ownership, IP access and IP Commercialisation & Management. The IP Protocol aims to provide more clarity for industry when engaging with HEIs.

The national IP Protocol also sets out a Framework for Industry Engagement with Public Research and the governance and reporting arrangements within the national technology transfer system. The aim is to provide more clarity for industry when engaging with higher education institutions (HEI).

Organisational framework conditions for research and technology transfer
Each public research organisation (HEI) has its own (or access to) technology transfer/knowledge transfer office, although the size and skills level of these vary. The TTO's primary role is to maximise the interaction between industry and the public research organisation. Most TTOs are located in a public research organisation and are part of the management structure of that organisation. The public research organisation provides the TTO with financial and management support. One TTO is a wholly owned subsidiary of the HEI. TTO infrastructure is funded by Enterprise Ireland (at State Agency level) and in part by the HEI itself. Performance is measured against targets and monitored by KTI Knowledge Transfer Ireland (previously the central technology transfer office, cTTO). Furthermore, all universities have incubator facilities available which are in a few instances managed from the TTO.

The national IP Protocol sets out a vision for a competitive technology transfer system. This includes the creation of a new central TTO (the "cTTO", now rebranded as Knowledge Transfer Ireland (KTI). KTI's overall purpose is to deliver an efficient and productive research and technology transfer system, to make IP and expertise within public research organisations visible for companies, and to act as a central point of contact. It supports the public research organisations' (HEIs') research and technology transfer infrastructure and provides services complementary to already existing TTO structures. KTI has an Industry Advisory Board and a Stakeholder Forum that offer advice and share intelligence.

TTOs market the IP available for commercial utilisation through direct marketing to known companies using market research, through websites (own and KTI) and through attending events.

Technology Ireland Forum includes representatives from Ireland's main state research funding organisations, including Science Foundation Ireland (SFI), Enterprise Ireland, IDA Ireland and *Forfás*[21]. It acts as a problem-solving and decision-making body where input is required from across the state funding agencies.

Financial framework conditions for research and technology transfer
Venture capital is generally well developed in Ireland. Furthermore, there are public funding schemes available to support the very early stages of commercialisation of research-based ideas and inventions.

Science Foundation Ireland in cooperation with Enterprise Ireland has launched the Technology Innovation Development Award (TIDA), which is designed to enable researchers to focus on the first steps of an applied research project which may have a commercial benefit if further developed. Awards may be given up to a maximum of EUR 100,000 direct costs for a period of 12 months. Applicants must hold

21 IDA Ireland is Ireland's inward investment promotion agency and Forfás is Ireland's policy advisory board for enterprise, trade, science, technology, and innovation.

or have held within the past 5 years an SFI award as lead principal investigator (PI) or co-PI under a number of specific programmes or be/have been lead PI on a competitively awarded, internationally peer reviewed research grant worth more than EUR 200,000 in the last 5 years. The purpose of the initiative is to realise a greater economic impact from the state investment in basic research.

The Commercialisation Fund Programme of Enterprise Ireland offers state funding for the creation of technology-based start-up companies and the transfer of innovations developed in HEIs and other public research organisations to industry in Ireland. The programme funds (typically EUR 80,000-350,000) support the development of innovations at all stages of the commercial pipeline to the point where they can be commercialised as new products, services and companies. Commercialisation Fund support is available for projects that address a gap or need in the market by developing innovations that will ideally be ready for licensing to Irish industry or may form the basis of a new start-up in 2-5 years. It is recognised, however, that some innovations may need longer time before they are marketable than others. Funding is also available in the form of a Commercial Case Feasibility Grant (EUR 10,000-15,000) where researchers in partnership with their TTO or equivalent office, can obtain funding for a short Feasibility Project (up to 3 months) to scope and develop the commercial case for their innovation in advance of submitting a Commercialisation Fund support application to the programme. The overall aim of the programme is to improve the competitiveness of the Irish economy.

Through the Technology Transfer Strengthening Initiative introduced by Enterprise Ireland in 2007 general infrastructure support is provided for HEIs for research and technology transfer, including patent support. From 2013-2016, EUR 5.5 million is provided annually with the aim of boosting interaction between industry and HEIs. The first five years of the initiative have proved extremely successful with a 3-fold increase in the average number of spinout companies created in this period of time. Simultaneously, a 400 per cent increase in the amount of technologies licensed to companies by public research organisations was achieved. The objectives of the second phase of the initiative include the development of a fast, flexible response to industry's requests for access to intellectual property (IP), giving spinout companies the best possible start. A new dimension to the initiative focuses on the formation of regional clusters of public research organisations, with the aim of sharing of resources and expertise to deliver enhanced services for industry.

Finally, a range of schemes support collaboration between industry and public research organisations. For example, the Innovation Partnership Scheme, funded by Enterprise Ireland with a budget of USD 12 million in 2012, provides financial support for industry-university collaborative research projects with direct industrial and commercial applications. Another example is the Innovation Voucher Initiative, which aims to support collaboration between public knowledge providers and small businesses.

Success criteria for research and technology transfer

National metrics and data on research and technology transfer are collected through monitoring by the Technology Transfer Strengthening Initiative as well as through an Annual Commercialisation Survey. Both are carried out by KTI. Indicators included are: Volume of license option agreements, volume of spinouts, volume of invention disclosures, volume of patent filings, collaborative research with industry (volume and revenue), and licensing revenue. In addition, narrative case studies are collected.

Furthermore, reporting and assessment is in-built in funding programmes. Bespoke evaluations include economic evaluation (and job creation) as well as evaluation of commercialisation support programmes through Enterprise Ireland.

Public research organisations also normally report on institutional objectives related to research and technology transfer to senior HEI management. The specific design and objectives do, however, vary by institution. HEIs play an important role in regional development.

Some correlation may be detected between the metrics followed at national level and local level. Thus, funding organisations such as SFI and Enterprise Ireland have certain requirements and monitor outcomes. Furthermore, performance criteria are linked to funding channeled directly to TTOs through the TTSI where performance is measured against targets and monitored by KTI. Additionally, performance criteria are being developed in relation to Higher Education Authority arrangements with HEIs. All these are linked to national policy, e.g. the Action Plan for Jobs.

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Annex 6:
Israel – Framework conditions for research and technology transfer

General information

Population: 7,624,000 (2010)	GDP annual growth rate: 4.6 % (2011)
GDP: USD 234.2 billion (2011)	R&D as percentage of GDP: 4.21 (2011)
GDP per capita: USD 26,531 (2010)	R&D personnel: 68,175 FTE (2011)

Israel has seven research universities with a faculty of approximately 7,000 and approximately 10,000 technical and administrative staff. Public research is also carried out in hospitals and other government-owned research institutions. Israel has a high R&D intensity even when excluding the defence sector. Industry funded 36.6 per cent of gross domestic expenditure on R&D (GERD) in 2010 while the business enterprise sector performed 83.2 per cent of GERD and the higher education sector and government performed 13.6 and 1.9 per cent of GERD, respectively.

Priority sectors with a view for future development include: brain research, biotechnology, nanotechnology, clean technology sectors, and renewable and sustainable sources of energy. About 80 per cent of the R&D budget goes to small and medium-sized enterprises (SMEs), including an R&D fund specifically created to reduce risks for industrial innovators.

Israel leads OECD countries in terms of the relative number of PCT patents filed by universities and public labs. Most of the revenues from sales of IP and gross royalties received in 2009 came from life sciences and medicine (approximately 92 per cent).

Legal framework conditions for research and technology transfer

Israel has a generic legislation on intellectual property (IP) which was implemented already in the 1960s. According to Israeli Patent Law, an invention is owned by the employer (the public research organisation) if the invention is considered a work-made-for-hire. An invention is considered a work-made-for-hire if it fulfils four conditions: 1) an employee-employer relationship exists; 2) it is a mature invention and not a raw undeveloped idea; 3) the employee reached the invention due to his employment; 4) the employee reached the invention during the course of his employment. The employer has the responsibility to prove that an invention was made on a work-made-for-hire basis. The Patent Law obligates the employee to notify the employer with respect to any patent application submitted or any invention made due to or during his/her employment. If the public research organisation does not inform the employee of its intent to claim rights to the invention within six months, the employee is considered the owner of the invention. As concerns the ownership of copyrights, a similar legislative framework exists.

The inventor is entitled to reasonable and fair compensation if the employer chooses to claim the rights of the invention. This reimbursement and its conditions may be determined in an agreement between the employee and the employer or by a committee of reimbursements and royalties. Revenue originating from IP is usually allocated with 40-50 per cent assigned to researchers and 50-60 per cent to the university.

Each research university decides on its own policy and regulations in relation to research and technology transfer. However, they share common principles.

Organisational framework conditions for research and technology transfer

Each research university has set up a technology transfer company (TTC) in order to manage the commercialisation of IP developed by the institution. The TTCs are owned by the university but are for-profit and run like private enterprises by people with business expertise. The first TTCs were established already at the end of the 1950s and during the 1960s and 1970s. TCCS provide infrastructure and applied research facility support, they assist in business development, patenting, legal issues, strategic alliance development and identification of investors; establishment of start-ups, administration, and other areas associated with research and technology transfer.

TTCs act as the exclusive channel for patenting, commercialisation and protection, and inventors have to cooperate and disclose relevant knowledge to the TTC. If the TTC does not submit a patent, inventors can try to commercialise their invention on their own, but they still have to repay part of any profits to the TCC. If the TCC decides to patent, they are in full charge of the process, and they focus on licensing contracts. TTCs actively search for internal IP and therefore know what researchers have accomplished. Furthermore, they have close contacts with industry.

Since their establishment, TTCs have been involved in the establishment of 151 start-up companies of which 44 are non-operational. Most commercialisation done by the TTCs is to Israeli companies.

Hospitals and other public research institutions have hitherto been regulated by a different legislative framework than universities and have been less free to operate. Yet, within the last decade, research and technology transfer activities have been set-up at these institutions following a structure and arrangement similar to the bottom-up initiatives of the research universities.

The success of university research and technology transfer in Israel has led the government to study research and technology transfer in universities and to look for unexploited potential for research and technology transfer. The government has decided to adopt successful research and technology transfer tools from the research universities and to provide them to others. To explore the potential of technology transfer in colleges (of which there are 36) and another ten research institutes, the Israeli government has initiated a national TTC with a structure of operation similar to that of university TTCs but financially supported by public funds[22]. This TCC must provide subsidised technology transfer services to budgeted higher education institutions and can provide technology transfer services to others.

Financial framework conditions for research and technology transfer

Generally, Israel leads the OECD countries in terms of access to venture capital. Furthermore, TCCs have traditionally had internal pre-seed funds available to bridge the funding gap and accelerate commercialisation of potential research-based inventions and technologies by demonstrating feasibility. These funds were based on philanthropy or semi-philanthropy resources, and many of them disappeared with the 2008 financial crisis. Based on the existing internal model, the Ministry of Finance there-

22 The national TTC is financed by The Planning and Budgeting Committee (PBC), which is a sub-committee of the Council for Higher Education (CHE). CHE serves as the guiding institution of the State of Israel in all matters related to higher education. PBC exclusively determines budget allocations and approvals for Israel's accredited, public higher education institutions.

fore has initiated a national "bridging-the-gap" fund called KAMIN, which is operated by the Office of the Chief Scientist[23].

In addition, there are several other public sector programmes focused on "bridging the gap" between universities and industry. The Technological Incubators programme supports early-stage technological entrepreneurship by providing support for turning innovative ideas into potentially successful commercial products. The programme budget is about USD 40 million (2012). The TNUFA programme also supports innovative technological entrepreneurship at the pre-seed stage by helping to prepare patent applications and through evaluating the initiatives' technological and financial feasibility. The NOFAR programme actively supports commercialisation by financing applied research in biotechnology and nanotechnology to adjust innovations for use by industry and promote their take-up. Budgets allocated for these 12-15 month projects tend to be around USD 100,000 (2012). All three above-mentioned programmes are focused on the pre-seed phase. Furthermore, several programmes support interaction between public research organisations and business. For example, the MAGNET programme supports pre-competitive generic research conducted by consortia of industrial firms and academic institutions. It was established in 1994 and has a budget of USD 57 million (2011).

Success criteria for research and technology transfer

TCCs work on a highly professional level in order to commercialise research. All Israeli TCCs are run like private companies with clear missions, clear incentive structures, and professional staff.

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23 The Office of the Chief Scientist belongs to the administration of the Ministry of Industry, Trade and Labour and oversees all government-sponsored support of R&D in Israeli industry.

Annex 7:
The Netherlands – Framework conditions for research and technology transfer

General information

Population: 16,615,000 (2010)	GDP annual growth rate: 0.9 (2011)
GDP: USD 720.3 billion (2011)	R&D as percentage of GDP: 2.03 (2011)
GDP per capita: USD 42.847 (2011)	R&D personnel: 116,326 FTE (2011)

In the Netherlands there are 14 research universities, 8 medical centres and approximately 30 state-funded research institutes, of which the two largest, Netherlands Organisations for Scientific Research (NWO) and Royal Netherlands Academy of Arts and Sciences (KNAW), carry out basic research. Furthermore, there are 41 universities of applied sciences where research plays an important role. In 2011, approximately 56 per cent of R&D was carried out by the business sector, while 33 and 11 per cent was carried out by higher education institutions and the government sector, respectively.

Small and medium-sized enterprises make up more than 99 per cent of companies in the Netherlands, However, large companies with more than 250 employees account for approximately 75 per cent of the R&D expenditure of all companies in the Netherlands. Eight multinational companies each spend more than EUR 100 million on R&D annually. The majority of Dutch R&D is invested in six industries: food, beverages and tobacco; chemicals; pharmaceuticals; electric apparatus and equipment; machinery and equipment, and information technology.

The core of the Dutch government's enterprise policy is the so-called 'top-sector policy', which involves making targeted investments in nine leading sectors of the economy: water, agro-food, horticulture, high-tech, life sciences, chemistry, energy, logistics and creative industries The primary aim of the 'top-sector policy' as regards innovation and research is to promote closer cooperation between knowledge institutions, businesses and public authorities in the programming of basic and applied research.

Legal framework conditions for research and technology transfer

Traditionally, research and technology transfer has not been regarded by the Dutch government as an important task for universities. Since 2008, however, knowledge transfer has by law become one of the three core missions of research universities (besides research and education). All public research organisations are likewise required by law to cooperate with the private sector and society in order to improve knowledge transfer. Nevertheless, knowledge transfer is primarily promoted through non-legal policy initiatives with funding being the primary mechanism/driver behind such initiatives.

All results of publicly-funded research belong to the institution (university or public research institution) in which they were developed. The principle of institutional ownership is rooted in the default IP ownership provisions in the Netherlands.

Accordingly, the Patent Act passed in 1995 states that the employer is entitled to the patent of an invention made by an employee of a university or research institution. Dutch law acknowledges a right to remuneration in the case of patents, but the law does not prescribe the size of such remuneration or what criteria the institution should use to arrive at the compensation figure. However, the norm is that the employee receives an extra months' pay. Many of the public research institutions in the Netherlands have additional internal arrangements on the division of invention revenues where 1/5-1/3 of the revenues is assigned to the employee responsible for the invention.

Universities and other public research institutions are relatively autonomous, and procedures and practices concerning research and technology transfer are not specified in national legislation. The owner of the IP is thus usually responsible for the negotiation of IPR contracts, which may be carried out by the TTO or through a third party. The latter is, however, an exception in the Netherlands, as most public research organisations handle the IPRs themselves.

Organisational framework conditions for research and technology transfer
The organisational framework for knowledge transfer is generally decentralised because of the strong regional function of knowledge transfer and the differences in profiles between universities in the Netherlands. Universities and the university medical centres associated with them have Technology Transfer Offices (TTO) in charge of converting academic (and medical) knowledge into useful applications. The TTOs provide support for a wide range of market-oriented knowledge transfer activities, including patenting, the licensing of inventions or setting up of spin-off companies. It is quite common for TTOs to cooperate with external patent attorneys. Marketing of IP is generally based on the networks of the TTOs and the individual researcher. Some institutions also make use of the institution's own or other websites. However, the procedures implemented and the degree of institutionalisation of TTOs varies between institutions.

Some Dutch universities have opted to contract out all their knowledge transfer activities (including non-market-oriented activities) through holding companies. The holding companies are private entities that are legally separate but owned by a university. The company holds shares in university spinout companies, coaching those companies on IP, taxation and financial matters. The holding companies acquire and retain IP and may enter into joint ventures with private entities, and the university receives dividends from the shares owned by the holding company. The range of holding activities varies across the universities. Some universities have one or more additional organisations alongside their TTO, which function like incubators and perform specific knowledge transfer tasks such as providing help with the acquisition of research funding or research contracts, public-private partnerships, entrepreneurship training and services for young start-up companies. The formation of science parks has stimulated companies to relocate into the vicinity of knowledge institutions thereby strengthening interaction between the parties.

Netherlands Organisation for Applied Scientific Research (TNO) works to apply scientific knowledge with the aim of strengthening the innovative power of industry and government. The TNO works together with universities and companies in centres of expertise, and receives part of its funding from government though a large proportion comes from contract research. In addition, the four Large Technological Institutes (energy, maritime research, aerospace, and water) have two main functions: acting as centres of technological information for companies and government, and developing technology and making it available to companies and government.

At a national level, the NL Agency focuses on providing services to entrepreneurs. The national organisations support research and technology transfer primarily through funding. Please see the description of the financial framework conditions below.

Financial framework conditions for research and technology transfer
Generally, research commercialisation possibilities have been perceived as limited due to a lack of venture capital and business angels. Entrepreneurs generally find the lack of finance the most problematic factor in doing business in the Netherlands, especially in the seed and early-stage phases. The

government has initiated a number of grant schemes to foster collaboration between public research organisations and businesses. Some programmes have been designed for specific sectors, such as nanotechnology and life sciences, while others have a more general focus. A funding mechanism to promote spinouts was launched in 2000.

The realisation of knowledge transfer between academic research and users in general and industry in particular is a core activity of the funding schemes of the Technology Foundation (STW), which has existed for 30 years. 50 per cent of funding goes to high-tech systems and materials (including ICT and nanotechnology), 25 per cent to life sciences (including medtech) and 25 per cent to chemistry, water and engineering. The STW brings together researchers and potential users from the beginning and during the project through user committees. 50 per cent of users must be companies, and users are expected to contribute to the research project in cash or in kind.

About 20 per cent of the STW's approximately EUR 90 million budget is allocated to an *Open Technology programme*, which consists of independent research projects. 35 per cent of the budget goes to the *Perspective Programme*, which promotes public-private partnership on carefully selected subjects. 17 per cent of the budget goes to a so-called *Partnership Programme* that aims to address questions and requirements in the business community by means of high-quality science and technology. Six per cent goes to the *Valorisation Grant*, which is a personal subsidy granted to enterprising researchers for the development of innovative high-tech activities on the basis of knowledge they have developed at the university or research institute. Finally, one per cent of the STW budget is allocated to the *Demonstrator Grant*, which is a relatively new programme that supports the development from proof-of-principle to proof-of-concept of research results without a commercial partner (up to EUR 150,000). There are no other national programmes supporting proof-of-concept.

At the institutional level there are generally limited funds available for gap funding. However, some institutions have worked to make funds available through public, institutional, private or other sources in the seed and pre-seed phase for the development of research-based ideas and start-up companies. One such example is 'BioGeneration Ventures', initiated in 2006 by the Leiden University holding company, which invests in the next generation of life sciences companies.

In 2012, the current Dutch government established a EUR 500 million "Innovation fund for small and medium-sized enterprises-plus (MKB+)" for the purpose of assisting innovative entrepreneurs in sourcing funding for innovative projects that cannot be completely financed through the market. The fund, which will be fully implemented in 2015, is managed by the NL Agency and will double the previous resources for innovation loans for small and medium-sized enterprises.

Success criteria for research and technology transfer

Societal relevance is one of the criteria in the Standard Evaluation Protocol which is used to evaluate all research within the Netherlands, and the transfer of knowledge is an important part of this criterion. According to the strategic agenda for higher education, research and science of the current Dutch government, knowledge institutions are asked to pursue an active policy of stimulating and rewarding scientists and researchers for their knowledge transfer efforts.

There are currently no nationally determined success criteria that apply to all universities and other public research institutions. Such criteria have been opposed by the universities on the grounds that institutional research profiles differ and, therefore, there can be no "one size fits all". A process was

initiated in 2012 to develop a knowledge transfer framework. Within this framework, each university can choose a set of indicators based on its own research profile. These sets have just been finalised and in the coming two years a test phase will be implemented in which the practical use of the indicators will be tested and optimised. This process involves the establishment of a baseline for the different indicators and developing procedures for follow-up. In 2016, the indicators will be presented to the government, and the knowledge transfer indicators are expected to form part of the performance agreements between the individual institution and the government. These agreements already include indicators for the performance of the institution in the areas of research and education. The level of institutional funding may be affected by the institutions' performance as measured against the indicators.

Not only the government but also the institutions that are part of the Dutch science system, such as the KNAW, NWO and TNO, make (science) policy. In the area of knowledge commercialisation, policies have been complemented by initiatives from such intermediary organisations and university representatives. Due to the tradition of consensual democracy in the Netherlands, such agreements have significant influence. In 2008, the Valorization Agreement was signed by a range of stakeholders who agreed to promote research commercialisation. The agreement includes a shared vision on how to approach knowledge transfer, concrete actions for each stakeholder to take, and joint knowledge targets for all stakeholders.

Success criteria may be set at the institutional level. Procedures for follow-up and reporting differ among the institutions. Some TTOs work very professionally with research and technology transfer and have clearly-defined success criteria that are reported on regularly to the board of the institution.

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Annex 8:
New Zealand – Framework conditions for research and technology transfer

General information

Population: 4,368,000 (2010)	GDP annual growth rate: 1.3 % (2011)
GDP: USD 139.0 billion (2011)	R&D as percentage of GDP: 1.27 (2011)
GDP per capita: USD 29,711 (2010)	R&D personnel: 23,600 FTE (2011)

Public research is primarily carried out at eight universities and seven Crown Research Institutes (CRIs). CRIs are the largest providers of scientific research in New Zealand. They undertake basic and applied research, and technology research and development. Universities also carry out a large part of New Zealand's R&D. Furthermore, there are 18 polytechnics/Institutes of Technology in New Zealand that focus both on delivering vocational training and undertaking applied research to support vocational training.

Of the USD 1,766.6 million spent on R&D (GERD) in New Zealand in 2011, 40 per cent was financed by industry and 45.4 per cent was performed by the business enterprise sector while 31.8 per cent was performed by the higher education sector and 22.7 per cent by the government sector. 92.7 per cent of enterprises in New Zealand are small businesses with less than 20 employees, while one per cent of enterprises have more than 50 employees. Large enterprises generate the majority of jobs, innovation and exports.

Legal framework conditions for research and technology transfer

Under New Zealand law, if an employee invents a patentable invention during the course of their employment, or, if the author of a work is an employee acting in the course of their employment, the employer will usually own the rights to the invention or be the owner of the copyright and design rights in the work, respectively.

New Zealand does not have any specific legislation regulating the transfer of research and technology between universities and other public research organisations and businesses. However, the CRI Act states that CRIs must operate in accordance with the principle of promoting and facilitating the application of 1) the results of research and 2) technological developments. The act moreover stipulates that CRIs must deliver a Statement of Corporate Intent which includes information on the performance targets and other measures by which the performance of the group may be judged in relation to its objectives. CRIs all have generic objectives relating to technology transfer, and the CRI Act sets out the responsibility of the CRIs for reporting against these measures.

Each New Zealand university and CRI is thus responsible for formulating its own intellectual property policies and procedures, rendering any commonality between institutions unintentional. The fact that university intellectual property policies are neither coordinated nor consistent can complicate cooperative research ventures as commercialisation involving multiple institutions may feasibly prove more complex than would be the case under more consistent rules. Some discontent also registers among university faculty members concerning the lack of a common understanding of applicable rules. As a consequence, universities are required to spend more time and resources preparing and revising intellectual property and commercialisation rules and processes than would be likely if clearer guidelines prevailed. On the positive side, this autonomy allows for potential innovation in the way intellectual property is handled and for the ability of institutions to create policies which reflects their individual cultures, programmes and experiences.

It is clearly indicated by the New Zealand government that research and technology transfer from universities and CRIs is a key goal for these institutions. Yet, national guidelines relate only to high-level objectives of institutions and as such do not provide guidance on the process of research and technology transfer.

The draft 2014-2019 Tertiary Education Strategy (TES) recognises supporting business and innovation through development of relevant skills and research as one of the four key outcomes that New Zealand needs to elicit from tertiary education organisations over the coming decades. The strategy includes knowledge transfer with external stakeholders, including business and industry, as a core goal for the higher education sector. However, there are no formal requirements for universities to implement the TES goals, and so they are free to commit resources to knowledge transfer activity as they see fit.

As concerns the CRIs, their purpose, scope and operating principles are codified in a Statement of Core Purpose which underpins any performance expectations of the CRI. The CRI toolkit provides guidance for CRI boards, management and staff as regards improving performance, providing assurance and meeting accountability arrangements. The guidelines state that Shareholding Ministers expect CRIs to remove barriers to technology and knowledge transfer, especially those barriers relating to accessing Crown-funded data, contracting processes and intellectual property. CRIs are also expected to develop strong, long-term partnerships with industry, government and Maori, and to work with them to set research priorities that are well-linked to the needs and potential of their end-users. CRIs are expected to transfer technology and knowledge from domestic and international sources to New Zealand industry, government and Maori. The guidelines moreover state that reasonable steps should be taken to protect IP that is discovered in the course of research and operation of the CRI.

Finally, Cabinet Guidelines for IP from public research contracts were introduced in 2004 for use by departments or ministries when negotiating the purchase of research from providers. These recognise that research is valuable for New Zealand in many ways and that commercialisation of IP is one way to realise part of that value. The guidelines are intended to clarify the government's expectations if and when contentious issues should arise in negotiations on use or ownership of intellectual property.

Organisational framework conditions for research and technology transfer

All New Zealand universities have established a Technology Transfer Office (TTO). The TTOs are involved to differing extents in facilitating and supporting, consulting, contracting, licensing and patenting, and spinout company formation activity. Most universities are affiliated with one or more intermediaries or incubators; these include the BioCommerce Centre, PowerHouse and IceHouse.

In 2010, the New Zealand government established the Commercialisation Partner Network (CPN) with the aim of developing a centre (or centres) of excellence in research and technology transfer to aggregate the research and technology transfer activities of New Zealand's public research system. The CPN was intended to create an integrated approach to commercialisation, where those involved in all aspects of commercialisation work together to create scale, enhance capability and improve collaboration. The New Zealand government provides NZL $3.2 million annually to support the CPN. There are three partners in the CPN: The Kiwi Innovation Network (KiwiNet), Return on Science, and the Canterbury Regional Innovation System (CRIS Limited). All three partners work together to deliver results in terms of improved and increased commercialisation of publicly funded research.

KiwiNet is a consortium of 13 different universities, CRIs and crown entities. The purpose of KiwiNet is to empower and enable New Zealand's public research organisations to better commercialise their ideas, intellectual property and capability to boost economic outcomes for New Zealand. KiwiNet provides skill and capacity building for research and technology transfer professionals, networking between organisations and between organisations and the private sector. Furthermore, an investment committee reviews and provides recommendations on PSAF projects.

Return on Science contributes to the overall outcomes of the CPN by providing a suite of collaborative commercialisation services, investment tools and expertise. Such services are provided principally by Uniservices[24] and delivered in conjunction with technology incubators throughout New Zealand. Return on Science also provides strategic guidance for commercialisation projects. It provides relevant expertise early in the project's life cycle through access to four specialist investment committees which review commercialisation projects from universities and CRIs across the country and make recommendations on project milestones, funding and project development. Each committee's membership is sourced from leading national and international industry experts, advisors, venture capitalists and commercial R&D specialists.

CRIS Limited is a company which holds assets and cash to the value of more than NZL $5 million, using this vehicle to facilitate commercialisation of innovation primarily in the Canterbury region. CRIS Ltd. is uniquely positioned in that it has significant capability and a long track record of engaging with local business through the Christchurch Development Corporation, and hence has many existing relationships that can be used to quickly identify and develop routes to markets. In addition, CRIS Ltd. encompasses two universities, a polytechnic, five CRIs and the Canterbury Health Board, all of which provide a rich source of IP suitable for commercialisation. CRIS Ltd. is therefore well placed to connect the private and public sectors as well as to increase commercialisation capabilities and practice in the private sector.

In addition to the organisations mentioned above, Callaghan Innovation is a relatively new (January 2013) crown entity[25] charged with working across the whole innovation system to accelerate growth, scale, intensity and success of innovation in New Zealand firms. It does so by offering technical services to individual firms, brokering access by firms to appropriate research providers, supporting the development of technology platforms and by assisting with commercialisation.

Finally, the government is currently developing a number of innovation hubs and precincts aimed at facilitating innovation. These include the Christchurch Innovation Precinct, Lincoln Hub, Food HQ and the Wynard Innovation precinct.

The universities and CRIs market IP on a case-by-case basis, often using the CPN to facilitate connections with private sector partners and investors. Commonly, if no New Zealand partner exists, licenses are sought. Some CRIs, for example, market IP opportunities on their website. Furthermore, KiwiNet

24 Uniservices is the TTO for the University of Auckland.

25 A crown entity is an organisation that forms part of New Zealand's state sector established under the Crown Entities Act 2004, a unique umbrella governance and accountability statute. The Crown Entities Act is based on the corporate model where the governance of the organisation is split from the management of the organisation. Crown entities can be contrasted with other New Zealand public sector organisational forms: departments of state, state-owned enterprises, offices of Parliament and sui generis organisations like the Reserve Bank.

has developed an online Innovation Database that includes new inventions, intellectual property, researcher capability and commercial expertise from across New Zealand research organisations. The KiwiNet Innovation Database aims to facilitate collaborations between complementary technologies and increase investor and industry connections by showcasing the commercialisation capability and distinctive portfolio of innovations that New Zealand has to offer. It currently hosts over 70 innovations as well as profiles on research organisations, commercial staff and research groups.

Financial framework conditions for research and technology transfer

In 2003, the government established the Pre-Seed Accelerator Fund (PSAF), which is devolved to publicly funded research organisations and is used for undertaking early-stage commercialisation activities. PSAF aims to maximise the commercial benefits to New Zealand from publicly funded research; to improve the commercial capability and skills of public research organisations and to promote collaboration between public research organisations and potential private sector partners. These goals are achieved by guiding and supporting technology prospects through a commercialisation process towards a point of investor readiness. The end goal of PSAF is to attract investor interest to publicly-funded research and development. The government provides funding for PSAF in the range of NZL $5.3 million per annum.

In addition, KiwiNet have their own PSAF which allows them to actively advance commercialisation projects from each of their partnering members.

Success criteria for research and technology transfer

There are no nationally defined success criteria for research and technology transfer as concerns universities. Each CRI, on the other hand, is required under the CRI Act to produce a Statement of Corporate Intent, which must include information on the performance targets and any other measures by which the performance of the group may be judged in relation to its objectives. The CRI Toolkit sets out generic indicators for measuring performance against the generic operating principles included in the CRIs Statement of Core Purpose. The indicators for measuring performance against the principles relating to research and technology transfer are currently being reviewed. Examples include:

- Number and percentage of joint scientific peer-reviewed publications and IP outputs with other New Zealand or international research institutions per annum (administrative data).
- Total number and percentage of licensing deals of CRI-derived IP (including technologies, products and services) with New Zealand and international partners per annum (administrative data).
- Percentage of relevant end-users who have adopted new knowledge and/or technology from CRIs (survey data).

Percentage change in the number of requests and enquiries for the CRI's publicly available collections (administrative data).

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Annex 9:
Singapore – Framework conditions for research and technology transfer

General information

Population: 5,312,000 (2012)	GDP annual growth rate: 4.9 % (2011)
GDP: USD 274.7 billion (2012)	R&D as percentage of GDP: 2.23 (2011)
GDP per capita: USD 61.103 (2011)	R&D personnel: 38.996 FTE (2011)

The framework conditions for research and technology transfer in Singapore are based on the following basic policy premises:

- Government is not in the best position to spot "winners". The private sector is in a better position than public agencies and universities to assess potential for commercialisation of inventions. Thus, an ideal IP exploitation system should encourage interactions between universities, research institutions (RIs) and industry, and tap into the strengths of all parties involved.
- Innovation is a collaborative process. Corporations have moved from having large in-house corporate labs to a more collaborative approach involving other firms and universities. It is therefore critical to have an incentive structure for universities and public RIs which encourages research results to be exploited as quickly and effortlessly as possible.
- It is sub-optimal to focus on maximising income from licensing. The revenue maximisation model of technology transfer risks focusing limited resources on a few technologies that appear to be the "winners", while other technologies with longer-term potential are overlooked.
- There is a need to facilitate the process of technology transfer. Government should encourage rapid and efficient translation of publicly-funded research ideas and inventions into new processes to spawn new high-tech companies, uplift existing companies, and enhance long-term economic competitiveness.

Singapore has four public universities, five polytechnics and 20 public research institutes, centres and consortia. The major TTOs are based at the National University of Singapore (NUS), Nanyang Technological University (NTU) and the Agency for Science, Technology and Research (A*STAR).

Legal framework conditions for research and technology transfer

Singapore does not have specific legislation regulating research and technology transfer. Instead, it has a National Framework of Intellectual Property Principles (IP-principles).

The IP Principles provide a common framework, and all public research institutions and agencies (PRIs) in Singapore adhere to them. The aim of the IP Principles is to provide a frictionless process to accelerate the translation of R&D into innovations in the market, and to secure that inventions reach the widest possible use. The key principles are as follows:

- To implement policies that promote exploitation of publicly-funded research ideas for the benefit of Singapore, and which allow the Public Agency to grant licenses to other parties if current licensees are ineffective at commercialisation.
- To provide attractive incentives for inventors involved in the creation of IP.
- IP exploitation should, where possible, be based in Singapore. Preference should be given and reasonable efforts made to license publicly-funded research results to Singapore-based companies, particularly SMEs.
- PRIs shall have a clear policy on whether they will claim any ownership and/or rights for IP generated from R&D that they have funded.

- If the PRI does not claim ownership and/or commercialise the IP within an agreed-upon timeframe, it may permit the inventor(s), where appropriate, the right to own, license, protect and commercialise the IP at his/her own expense.
- The PRI should reserve a royalty-free, irrevocable, worldwide, perpetual and non-exclusive right to use IP for its own non-commercial and R&D purposes.

The IP Principles is an overall framework which leaves room for interpretation on the part of public agencies, and this can lead to long and unproductive negotiations when the IP rights have to be cleared with the inventors and private companies.

The schemes of ownership and distribution of proceeds generated from the technology depend on the adopted policy of the institution. NUS divides net profits (net of cost up to 15 per cent of income) as follows: 50 per cent to inventor(s), 30 per cent to the department and 20 per cent to the university. At NTU, royalties are split with 75 per cent going to inventor(s) and the balance going to the university for the first USD 500.000, with a decreasing proportion going to the inventor as the royalties increase.

Organisational framework conditions for research and technology transfer

Singapore does not have a separate Ministry of Science and Technology. Instead, the policymaking and implementation functions are handled by the ministries involved in economic development, particularly the Ministry of Trade and Industry (MTI). MTI is responsible for coordinating science and technology policies and formulating key economic policies for the country. The main statutory boards implementing STI policies under the MTI are the Economic Development Board (EDB), the Agency for Science, Technology and Research (A*STAR) and the Standards, Productivity and Innovation Board (SPRING).

The Prime Minister-led Research, Innovation and Enterprise Council (RIEC) co-ordinates the different programmes and initiatives by the ministries and agencies. The National Research Foundation (NRF), a department in the Prime Minister's Office, supports RIEC and is responsible for developing policies, plans and strategies for research, innovation and enterprise and funding strategic initiatives. The NRF's tasks include facilitating technology commercialisation and the growth of high-technology start-ups as well as running the national programme to grow innovation and entrepreneurship called National Framework for Research, Innovation and Enterprise (NFIE).

Finally, the Intellectual Property Office of Singapore (IPOS), which is a statutory board under the Ministry of Law, provides the infrastructure, platform and environment for the creation, protection and utilisation of IP. The actual handling of the technology transfer, however, is run by special departments at the universities and other PRI.

The TTOs interface at the national level through membership of the Sub-Committee for Innovation and Enterprise (SCI&E) under RIEC. At the programme and sector level, specialised so-called Executive Committees[26] oversee the specific needs in the entire spectrum from research priorities to manpower planning to industry development and the portfolio of activities within their respective fields and focus areas. They also coordinate with other agencies/committees to ensure suitable allocation of financial resources according to the specific needs of the field.

26 The following scientific areas have Executive Committees: Bio-Medical, Energy, Water, Digital Economy, Land & Livability NIC.

The higher education sector's share of R&D expenditure is approx. 15 per cent (2010), while the public research institutions account for approx. 13 per cent (2010). Patenting is a relatively recent activity in the universities, with the bulk (87 per cent) issued since 2000. Most of the technology transfers happen through licensing. The TTOs employ a variety of approaches to publicise the availability of technologies that they have at hand. First of all, they try to market the technologies directly to selected companies. If the company is interested in exploiting the technology, it can submit a business plan which is then negotiated with the public research institution. The TTOs also place the technologies on offer in a "technology database" on their institution's website. As is the case in many other countries, the universities in Singapore also suffer considerably from a lack of expertise in various fields of IP and technology transfer. There is a need for personnel with a good deal of business expertise who can handle the administrative tasks and general business procedures associated with university–industry collaboration and technology transfers.

Financial framework conditions for research and technology transfer

Singapore is in the process of planning for the next 5-year national research and innovation strategy, RIE2020 (2016 – 2020). Much attention has been given to commercial development by bringing scientific knowledge from the lab to the market. There are also current efforts underway to review the definition of IP translation as along with other indicators related to technology transfer. Moreover, Singapore is reviewing its various programmes and funding schemes according to their performance over the current 5-year block. The intention is to try to streamline overlapping programmes by consolidating efforts with similar objectives and functions, which are currently run by different agencies.

In addition to the overall and general funding for research activities at universities a further portfolio of initiatives and schemes aims at forging university-industry collaborations. These initiatives cover the entire business cycle, from research, IP protection, and support for commercialisation, start-ups, business development, investment, tax incentives and venture developments. The EDB and A*STAR schemes are the major sources of government funding. The NRF runs NFIE - a specific programme aimed at encouraging universities and polytechnics to translate their research into commercial products for the market and assist entrepreneurs in setting up technology-based companies. The schemes include Early Stage Venture Fund, Proof-of-Concept Grants, the Technology Incubation Scheme and Global Entrepreneur Executives. Moreover, there are specific programmes for cluster funding. A*STAR moreover has a central marketing and commercialisation arm to identify, protect and exploit promising IP created by its public research institutions.

Success criteria

At national level, the most significant quantitative parameter is the number of IP translations. Types of IP include patents, trademarks, industrial designs, trade secrets and confidential information, plant varieties, layout-designs of integrated circuits, geographical indications and copyright.

For a project to be considered a successful IP translation, it must meet all of the following criteria:

- Project must be initiated from a documented background IP.[27]
- Industrial relevance demonstrated through industry's monetary investment or resource contribution in-kind to the project.

27 Background IP is defined as all IP in existence prior to the commencement of the translation project and Foreground IP is defined as all IP generated during the course of a translation project.

- Significant technical development must be shown through the difference in technology readiness for commercialisation between the Background IP and possible translation outcomes listed in the figure below.
- Projects must result in at least one of the following translation outcomes: Process Improvement, Foreground IP, Development of New Products, Development of new service, others. Agencies have the discretion to assess the qualification of translation if outcome falls under 'Others'

In addition to the number of IP translations, Singapore also follows the economic outcomes of an IP translation in a broader sense, such as:

- Industry verticals translated from Background IP.
- Number of foreground IPs filed and awarded.
- Number of new products/processes and services that arise from IP translation.
- Revenue generated from projects conducted by translator with industry, i.e. project cost/fees.
- Revenue that arises from IP licensing, i.e. upfront payment and/or royalties collected.

In general, the institutional TTOs will monitor success criteria as set at the national level because they are expected to contribute to the national-level objectives. Yet, the technology transfer offices in Singapore share the belief of their colleagues in many other countries that their performance should not be judged purely by their generated income, but also by the impact the transfer of technology has on national businesses and society.

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Annex 10:
Switzerland – Framework condition for research and technology transfer

General information

Population: 7,822,000 (2010)	GDP annual growth rate: 1.8 % (2011)
GDP: USD 405.9 billion (2011)	R&D as percentage of GDP: 2.87 (2008)
GDP per capita: USD 48,657 (2010)	R&D personnel: 62,066 FTE[28] (2008)

Switzerland has 12 research universities, including two federal institutes of technology, and seven universities of applied sciences. Most publicly-funded basic research is carried out by the cantonal universities and the FIT domain, which is comprised of two federal institutes of technology and four affiliated research institutes. Universities of applied sciences focus mainly on applied research and development to serve the needs of the private sector, culture and the public sector.

Over two thirds of all research in Switzerland is funded by the private sector. In 2008, the total expenditure on R&D amounted to CHF 16.3 billion of which the private sector invested 11.1 billion. Industry R&D activities are strong within pharmaceuticals, bio-technology, chemical and mechanical engineering. 99 per cent of all Swiss companies are small and medium-sized enterprises which provide two-thirds of the country's jobs. However, Switzerland is also the home and decision-making centre of many large Swiss and foreign multinationals.

Legal framework conditions for research and technology transfer

Due to the decentralised nature of the political and legal system in Switzerland more than one act governs research and technology transfer in Switzerland. The institutes in the FIT domain are thus governed by federal legislation while the research universities and the universities of applied sciences are mainly governed by cantonal legislation. The federal institutes of technology are obligated by law to support the commercialisation of their research results. Similarly, by law all universities of applied sciences must support research and technology transfer. Provisions on technology transfer also apply in the legislation governing regular research universities.

Institutional ownership of intellectual property (IP) generated at public research organisations has existed *de facto* since the beginning of the 20th century due to default IP regulation. However, since 2004, the ownership of IP generated by all staff (i.e. professors, scientific collaborators et cetera) has been clearly regulated and belongs to the institution. The exception is copyrights on scientific publications and teaching books, which belong to their author. Any IP generated by undergraduate students, trainees or visiting professors does not belong to the institution. Swiss law allocates ownership of IP to the institution employing the inventor(s) automatically with no rights to the Swiss government.

The institutions may take equity in start-ups as payment for the grant of a license. There are certain rules limiting the freedom of the institutes as a shareholder in a start-up.[29] If the institution decides not to pursue the commercialisation of an invention or other IP, the IP may be assigned to the inventor.

28 FTE: Full-time equivalent.

29 Equity positions must be minority positions; the institution may not send a representative to the board of directors; equity must be sold when it becomes liquid.

The Research and Innovation Promotion Order regulates the IPR of joint R&D projects funded by the Commission for Technology and Innovation (CTI), i.e. the Swiss innovation promotion agency. Usually, the CTI asks that an IPR agreement be drawn up.

Organisational framework conditions for research and technology transfer
Both federal institutes of technology and three of four public research institutes within the FIT domain have a technology transfer office (TTO). The vast majority of universities also have an individual TTO although there is an example of three universities sharing a TTO. At some universities a centralised TTO has been created only recently. At the universities of applied sciences the management of technology transfer activities varies widely though the majority has staff supporting research and technology transfer. However, it should be noted that the universities of applied sciences are much younger organisations and therefore less experienced in working with research and technology transfer. The federal institutes of technology have a very long tradition for research and technology transfer; both EPFL and ETH Zürich set up their first office for patents and licenses in the late eighties.

The size of TTOs varies. The largest TTO has 14 FTE, but the average size is 4.3 FTE. Swiss TT professionals are on average well-educated (many have a research background) and possess more working experience from industry than in other countries. TTOs usually collaborate with external patent attorneys and may also use external consultants on particular occasions. The majority of institutions deal with management and commercialisation of IP, which includes the evaluation of the economic value of research results, the protection and management of IP and the licensing or sale of IP to business. Some institutions also provide support for the coaching of start-up projects. Marketing of patent portfolios is carried out by the research institutions through various channels. The existing contacts of researchers are often used to approach companies. TTOs also scan the market for potential business partners and market IP through participation in relevant trade fairs. At universities, SMEs are partners in 26 per cent of projects, large companies in 35 per cent of projects and public institutions in 39 per cent of projects.

At national level, technology transfer is part of the portfolio of CTI. CTI supports individual R&D projects between public research organisations and companies where the business partner contributes with at least 50 per cent. Funds always go to the public research organisation as law prohibits direct subsidisation of private companies. CTI also supports new firms creation through two initiatives: CTI Entrepreneurship and CTI Start-up. CTI provides advisory and coaching services for entrepreneurs and the granting of a CTI label to best performing start-ups used to facilitate access to finance. Furthermore, CTI supports knowledge and technology transfer (KTT Support) between public research organisations and companies, particularly SMEs, by promoting networks and employing innovation mentors.

At cantonal level, incubators provide coaching for start-ups, laboratory facilities, etc.

Financial framework conditions for research and technology transfer
CTI provides an important source of funding. In 2012, CTI provided federal funding for a total of CHF 154.7 million. Of these funds, approximately 88 per cent were spent on individual joint R&D projects between business and research partners distributed within the scientific fields of enabling sciences (27 per cent), life sciences (23 per cent), engineering sciences (34 per cent), and micro and nanotechnologies (16 per cent). Furthermore, in 2012, six per cent (CHF 9.7 million) were spent on supporting start-up and entrepreneurship (primarily through coaching and training) while three per cent (CHF 4 million) went to networks through KTT Support. In 2012, approximately 48 per cent of CTI funding went

to universities of applied sciences; 32 per cent to the FIT domain and 15 per cent to universities. In the R&D projects, 73 per cent of participating companies are SMEs while the rest are large companies with more than 250 employees.

Often the individual institutions can provide some gap funding for the very early stage towards commercialisation (such as proof-of-concept) in the range of CHF 10,000-30,000. Mainly when licensing to start-up companies, some institutions may accept equity in such companies as a partial compensation for the licensing of technology. Such equity transactions usually replace down payments or early milestone payments in order to avoid any cash drain from the start-up through license fee payments at the early stage of development. However, there is a perceived gap between the funding provided to fundamental/basic research by the Swiss National Science Foundation (SNSF) and the funding provided by CTI because the majority of funding from CTI requires a business partner.

At the regional level there are some funds available in the early stages of project feasibility. Examples are *Eclosion2* (life sciences) and Foundation for Innovation in Technology (FIT, ICT, life sciences, cleantech and micro/nanotechnology). Private money channelled through foundations also plays an important role. However, risk aversion is generally perceived as a barrier to start-ups and early stage commercialisation of research and technology as such.

Success criteria for research and technology transfer

Swiss innovation policy is characterised by a non-interventionist stance: instruments target mainly research in the public sector and focus on framework conditions. This principle can be illustrated by the bottom-up nature of the R&D projects funded by the CTI, where suggestions come from scientists and no overall thematic framework exists. Furthermore, the state is expected to play a role in areas where there are particular challenges, one of which is promoting knowledge and technology transfer. The targets of Swiss federal policies are the high-tech sector and science-based industries and companies.

By law, research and technology transfer is part of the mission of the federal institutes of technology and the universities of applied sciences. This implies that the area has the attention of the institutional management. At the federal institutes of technology, TTOs typically have to report on progress according to generic objectives set by the board. However, research and technology transfer is not a strategic priority at all universities. The TTOs in the federal institutes of technology are typically less regulated and success criteria are often defined by the TTO itself.

There is no standardised monitoring at federal level of the TTOs' efforts in this area although a status on research and technology transfer must be included in each institution's annual report. Meanwhile, there is a political demand for impact assessment. The CTI to some extent focuses on how to assess impact and for example monitors the development of start-ups supported by looking at their survival rate after 5, 10, 15 and 20 years and their marginal earnings after 5 and 10 years.

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Annex 11:
Methodology for data collection

For the purpose of this project, a template for data collection has been produced. The template specifies a number of questions related to the legislative, organisational and financial framework conditions for research and technology transfer as well as the application of success criteria. The template is appended overleaf as annex 12 of this report. In accordance with the terms of reference for the project, data has been collected partly through desk research. Besides country-specific reports, analyses, etc., supplementary information on the subject of research and technology transfer has been gathered through the consultation of general reports and analyses.

Furthermore, as regards Switzerland and the Netherlands, the secretariat of the Danish Council for Research Policy has gathered information through study tours. The secretariat visited Switzerland on 17-18 February 2014 and held meetings with: Unitec, the technology transfer office of the University of Geneva; the State Secretariat for Education, Research and Innovation; the Commission for Technology and Innovation and the technology transfer office of the Ecole Polytechnique Fédérale de Lausanne. In addition, a telephone interview was conducted with the Fondation Eclosion in Geneve. The study trip to the Netherlands took place on 24 February 2014 where meetings were held with the Technology Foundation STW and LURIS - the technology transfer office of Leiden University. Furthermore, a telephone interview was conducted with VSNU – the Association of Dutch Universities. The Danish Council for Research Policy is grateful for the assistance provided by representatives of these institutions.

Data for Finland, Ireland, Israel, New Zealand and Singapore has been collected through the network of *Small Advanced Economies*. The Danish Council for Research Policy would like to thank Kate Harland, of New Zealand's Office of the Prime Minister's Science Advisor, who has been extremely helpful in coordinating the collection of data among these countries. The council would also like to thank the representatives of the individual countries for taking the time to make the relevant information available.

As regards Baden-Württemberg (Germany), the Danish Council for Research Policy received valuable assistance from 'Innovation Centre Denmark' in Munich, which carried out the data collection on behalf of the council; in addition, the council would like to thank Vice Consul & Innovation Attaché Nikolaj Helm-Petersen. Data for Denmark has been provided by the Danish Agency for Science and Innovation.

Annex 12:
Template for the description of systems for research and technology transfer between knowledge institutions and the business community

Contact person(s) *(please list the contact information for the primary contact person(s) in your country/region)*
Name:
Title:
Organisation:
E-mail:
Tel.:

Preamble

The Danish Council for Research Policy considers the exchange of research based knowledge with society to be one of the core missions of universities and other public research institutions. Knowledge exchange encompasses a number of different activities, where research based knowledge and know-how is shared, developed and exchanged with external stakeholders including, but not limited to Industry, NGO's and public institutions. Regarding this particular project, the Danish Council for Research Policy has chosen to focus on one element of these activities namely technology and research transfer.

For the purpose of this study, the Danish Council for Research Policy defines technology and research transfer as the identification, valuation, protection, sharing and assignment of intellectual property rights with the purpose of commercial utilisation.

The objective of the Danish Council for Research Policy is to establish the degree to which the framework conditions regulating technology and research transfer between universities and other public research institutions and the business community in the selected countries are similar, and whether the design of the framework conditions might explain why these countries are doing particularly well as regards the commercial utilisation of public funded research.

1. **Please describe the legislation regulating research and technology transfer between universities and other public research institutions in your country/region and the business community** *(what does regulation specify in relation to technology and research transfer? Examples of aspects that may be included are: ownership of IPR related to public research results, negotiation of IPR-contracts, effect of funding on IPR-ownership, distribution of revenue from IPR, organisation of tasks and responsibilities related to technology and research transfer; please include links to relevant legislation if possible)*
2. **Please describe the most significant negative elements of this legislative framework if any**

3. Please describe the most significant positive elements of this legislative framework if any
4. Please describe any national guidelines regulating research and technology transfer between universities and other public research institutions in your country/region and the business community *(please include links to relevant guidelines if possible)*
5. Please describe the most significant negative elements of these guidelines if any
6. Please describe the most significant positive elements of these guidelines if any
7. Please describe the organisational framework supporting research and technology transfer between universities and other public research institutions in your country/region and the business community in accordance with the legislative framework *(which responsibilities and tasks are placed at national, regional and institutional level? For example has the state/region established joint technology transfer organisations? Has the task been outsourced to institutionally owned technology transfer companies? Are technology transfer organisations an integrated part of institutional staff functions? Do private companies play a role in technology and research transfer? Please include links to relevant information).*
8. Please describe how universities and other public research institutions market the IP available for commercial utilisation

9. **Please describe the financial framework for research and technology transfer between universities and other public research institutions in your country/region and the business community, specifically the availability of gap funding and pre-seed funding** *(the availability of funding to support the development and testing of research based ideas and inventions before they reach a stage where the commercial potential can be assessed; do funds come from public, institutional or other sources; please include links to relevant information)*
10. **Please describe whether and how the financial framework for technology and research transfer in your country/region accommodates the different financial needs of research areas** *(for example the commercial development of research based ideas and inventions within life sciences require substantially more financial resources than for instance within information technology)*
11. **Please describe the success criteria by which technology and research transfer between universities and other public research institutions in your country/region and the business community is assessed at national/regional and institutional level** *(which parameters – quantitative and/or qualitative – are used to describe and assess the impact of technology and research transfer at the national/regional and institutional level respectively)*
12. **Please describe the procedures established to follow up on the success criteria set at the national/regional level and the institutional level**
13. **Please describe the correlation between the success criteria set at the national/regional level and the institutional level** *(is there a match between success criteria set at national/regional and institutional levels so as to provide incentives for all players at national and institutional level, including technology transfer professionals, individual researchers and research departments, to work to meet the success criteria set)*

Annex 13:
Terms of reference for the contribution of the Danish Council for Research Policy to the evaluation of the effectiveness of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions

Context

At its meeting on 29 November 2013, the Danish Council for Research Policy (DCRP) decided to produce a delimited and independent contribution to the evaluation of technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions which is to be conducted according to the Agreement on Denmark's Innovation Foundation of 3 October 2013. The contribution of the DCRP will be made independently of the overall evaluation, which means that two independent terms of reference are drawn up for the two tasks.

The responsibility for the implementation of the overall evaluation lies with the Danish Agency for Science, Technology and Innovation. The evaluation is expected to be completed in the first half of 2014. This evaluation is to assess from an overall perspective whether it is possible to create better incentives for collaboration between the business community and knowledge institutions, and whether there are any inexpedient barriers to this collaboration, including the legislative framework. Furthermore, the evaluation is to assess the current organisation of tasks in terms of technology transfer at the knowledge institutions, including the technology transfer organisations of the universities.

The focus of the DCRP's contribution

The delimited and independent contribution of the DCRP to the overall evaluation consists of a comparative review and analysis of technology transfer systems in a number of selected countries.

Technology transfer, commercialisation and knowledge collaboration between the business community and knowledge institutions have constituted a significant element of the DCRP's work on "The Value-generating University" over the last three years. In its 2011 annual report, the DCRP recommended e.g. that the Minister for Science, Innovation and Higher Education should ensure an appropriate organisation of the framework conditions for the universities' work on knowledge transfer. It is, therefore, of particular interest to the DCRP to contribute to the evaluation that is now being launched.

Furthermore, the DCRP wishes to foster an international perspective in the evaluation of the effectiveness of technological transfer, commercialisation, and knowledge collaboration between the business community and knowledge institutions. It appears from its legal framework that the DCRP must ensure that its advice includes relevant international experience and trends.[30]

Description of task

The contribution of the DCRP to the evaluation is to constitute the basis for placing the Danish framework and the Danish organisation of technology transfer into perspective in relation to the framework and organisation in other countries.

The description of technology transfer systems for the selected countries is structured around four elements:

- The legislative framework for technology transfer

30 Section 3 of Consolidated Act no. 1064 of 6 September 2013 on the Research Advisory System, etc.

- The organisational framework for technology transfer, i.e. the division of work between different levels (centralised, decentralised)
- The organisation of the financial framework for technology transfer, i.e. the supply of risk capital
- Success criteria for technology transfer.

The countries to be comprised by the review have been selected on the basis of the following criteria:
1. Countries that resemble Denmark and, therefore, face the same types of challenges.
2. Countries that do well with respect to research and technology transfer measured on the following parameters: a) number of spin-outs, b) high productivity growth, and c) high international level in research.

Against this background, the DCRP's review will comprise the countries that participate in the group of *Small Advanced Economies* (Finland, Ireland, Israel, New Zealand and Singapore) as well as a few other selected countries/regions (Baden-Württemberg (Germany), Switzerland and the Netherlands).

On the basis of the descriptions of the technology transfer systems in the selected countries, the DCRP will assess which elements in the various countries' technology transfer systems function well and can be singled out as sources of inspiration and imitation.

Method

The description of the technology transfer systems in the selected countries will take its point of departure in desk research as well as in dialogue with relevant players in the countries concerned. With regard to the group of *Small Advanced Economies,* the DCRP will use this network to collect information on technology transfer systems in these countries.

Form and time frame

The DCRP's contribution is to be submitted in the form of a short report (15-20 pages). The final report is scheduled to be available by 1 April 2014 when it is expected that the new Danish Council for Research and Innovation Policy will be established. The report will be made public by the DCRP in the form of an independent publication. It will be drawn up in English with a view to being used as a source of inspiration and application also abroad.

A number of DCRP members will be associated to the project. They will function as primary sparring partners and, on an ongoing basis, ensure progress and quality in the DCRP's contribution.

Furthermore, progress in and the content of the DCRP's contribution will be ensured at the two DCRP meetings scheduled for 7 February and 20 March 2014:
- Milestone 7 February 2014: First draft report, including clear structure
- Milestone 20 March 2014: Draft final report, with all necessary and relevant information collected

Resources

The DCRP will allocate human resources equal to one staff member from the secretariat for this task in the first quarter of 2014. The DCRP will bear the costs of the preparation of the report, including any travel activity. No funds have been earmarked for any purchase of external analyses in connection with this report.

Annex 14:
Members of the Danish Council for Research Policy

CEO **Peter Høngaard Andersen**
European Brain Council

Professor, chairman of The Carlsberg Foundation **Flemming Besenbacher**
Aarhus University

Professor, Head of Department **Susana Borrás**
Copenhagen Business School

R&D Director, Head of Group R&D **Claus Hviid Christensen**
DONG Energy (chairman)

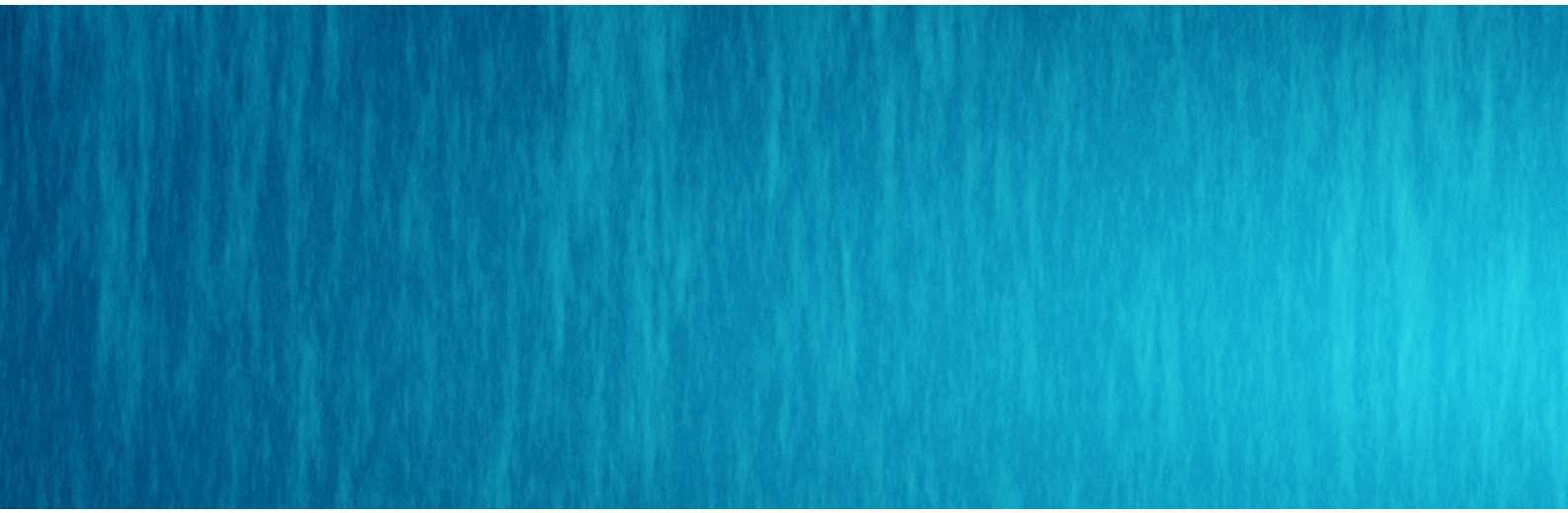
Professor, Dean **Allan Flyvbjerg**
Aarhus University

Professor **Per Kongshøj Madsen**
Aalborg University

Professor **Birger Lindberg Møller**
University of Copenhagen

Professor **Marie-Louise Nosch**
University of Copenhagen (deputy chairman)

Professor **Harriet Wallberg-Henriksson**
Karolinska Institutet



The objectives of the Danish Council for Research Policy is to further the development of Danish research to the benefit of society.The Council advises the Minister for Higher Education and Science and the Danish Parliament on research at a general level.