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Research and Technology Organisations and Smart Specialisation

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Abstract

Research and Technology Organisations (RTOs) have developed in many European countries at both national and regional levels to assist in the support of local industry, often around specific industrial technologies or sectors. With a core responsibility for technological upgrading they play a key role in regional and national innovation systems. Yet there is great variety in the form and mission of such RTOs, especially in terms of the degree of regional alignment, and whilst some regions are relatively well endowed with multiple RTOs, others are reliant on national RTOs in other regions or even other countries. These geographical challenges are also compounded by changes in the funding of RTOs with a shift to greater reliance on non-government funding and the search for funds from international sources such as global firms or Horizon 2020 projects. So whilst regions may see RTOs as critical regional assets, the RTOs may have a more nuanced attitude as their client base extends beyond national boundaries and they search for new sources of revenue.

RTOs have an important role to play in smart specialisation (S3) though and three specific roles have been identified here. First, many RTOs have a policy role and have capabilities to identify industry needs and technological opportunities as a key input into the entrepreneurial discovery process. Second, RTOs, as increasingly international organisations, can facilitate the access to global knowledge for regional firms through their networks and research collaborations. Third RTOs often have a central role in the development of particular cluster groupings through their specialisation around core technologies, and as such can be a central player in the development of such clusters.

But all three of these roles involve potential challenges and difficulties as the interests of the RTOs do not necessarily align with the needs of the region. The case studies in this report on RTOs in Spain, Finland, Italy, and the UK illustrate the variety of RTOs and the complexities of their relationships with regional hosts, but also some of the initiatives that are developing to support smart specialisation.

Keywords: smart specialisation, research and technology organisations, regional innovation, research and innovation

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1 Introduction

National and regional governments across Europe have invested in the development of research and technology organisations (RTOs) over many decades as key innovation infrastructures often supporting particular technologies, industries or clusters. Some RTOs have also emerged as non-profit membership organisations with or without government support, again supporting particular groups of companies. These RTOs have quite diverse missions and contexts, but are united by the idea of knowledge transfer to industry and usually by a degree of technology or sectoral specialisation. Whilst many RTOs have a national orientation, some have very deliberately been designed to address regional innovation needs and have been designed specifically to support knowledge-based clusters at a regional scale. So the potential contribution of such RTOs to smart specialisation strategies is likely to be high, however the diversity of such institutions may be expected to lead to a high diversity of different roles and forms of engagement.

RTOs are present in many, but by no means all regions in Europe, although there is no complete list. The most comprehensive list is that of EARTO which lists members in 22 European countries, but, as a membership organisation, EARTO depends on RTOs opting to join, so there are some RTOs that are not yet members. Most EU countries though have some form of industrially oriented research organisations, and these are likely to be considered as important elements in the national and regional infrastructure for innovation strategies.

Whilst most RTOs are embedded in regions, and some have been explicitly established to support regional innovation strategies, there are others operating at a national or even on a transnational basis. There is therefore a considerable variation in the extent to which RTOs are engaged in regional strategies, and hence their engagement with smart specialisation initiatives is expected to differ. This paper will examine the different roles played by RTOs in smart specialisation, and how regions might involve them to a greater level in future.

Section 2 examines the nature of RTOs and illustrates the diversity of governance, business and financial models as well as the different kinds of roles which RTOs can take in their regions and in smart specialisation strategies. Section 3 then examines the role of RTOs in existing smart specialisation strategies and explores case studies. This is followed by policy recommendations (section 4) and conclusions (section 5).

Three key roles for RTOs are suggested:

1. Many RTOs have considerable experience in analysing firms' needs and technology forecasting and provide policy advice services to their regional governments. Such expertise may be used by regional governments to help identify opportunities and assist in developing entrepreneurial discovery processes, especially where governments have limited experience of collaboration with industry.

2. A particular strength of RTOs is their involvement in international networks, and whilst this brings potential challenges where governments fund them to support domestic businesses, the RTO may be in an ideal position to identify cross-border linkages and to source knowledge from other regions. The RTO can help bring a more global perspective, especially where the RTO has considerable international experience.

3. Many RTOs are central to particular clusters where they have a long history of supporting innovation. As such RTOs may be central to particular smart specialisation initiatives and play a central role in the coordination of support for groups of firms.

However, whilst RTOs are logically key actors in smart specialisation, in many regions there are a number of challenges to be faced. The diversity of RTOs and their governance arrangements implies a varied degree of engagement with a host region – some are rooted in the development of existing regional innovation strategies whilst others have a distant relationship with their local region and may be independent of local funding. There is also the question of how regions access RTO expertise from other regions, especially where a region lacks RTOs. RTOs may also be relatively slow to reshape their expertise to changing demands due to the need to build up expertise, whilst smart specialisation strategies may shift at relatively short notice.

2 The role of RTOs in smart specialisation strategies

2.1 The S3 concept

Smart specialisation is an approach to developing a regional innovation strategy which recognises the importance of specific regional knowledge, technological assets and critical mass. It builds on ideas developed during the 1990s on regional innovation systems and strategies and the concept of the innovation ecosystem.

> '*The idea is that regional authorities can exploit the smart specialisation logic by undertaking a rigorous self-assessment of a region's knowledge assets, capabilities and competences and the key players between whom knowledge is transferred. This militates against recommending off-the-shelf local economic policy solutions and instead requires a careful analysis of regional knowledge capabilities and research competences. However, following a regional innovation systems way of thinking, as well as technological, sectoral, and geographical features, this regional analysis would also necessarily involve a consideration of the local institutional and governance issues which foster or mitigate the diffusion of innovations.'* (McCann and Ortega-Argilés 2011, p.3)

A new dimension of smart specialisation is the focus on diversification of regional economies alongside specialisation. McCann notes that part of the advantage of the more successful regions is their diversity of economic activity. So although specialisation can contribute to growth through cluster economies, it can also be a source of fragility where regions have become specialised in weak or declining industries and are locked into relatively inflexible innovation support systems. So diversification brings opportunities for new growth, which may be realised through specialisation around those new growth areas. A central element of smart specialisation is therefore the identification of new growth opportunities which may develop out of existing strengths and draw upon existing assets but offer a new path away from what may become declining industries.

Central to the idea of smart specialisation is the idea of place-based policy, in which policies are developed according to the specificities of particular regions and their institutions. Regions should develop their own distinctive strategies rooted in their particular characteristics and the evolutionary paths they have followed. So diversification into new industries will reflect the asset base of the region, and path dependence, rather than imitation of policies adopted in other regions.

Also the Entrepreneurial Discovery Process (EDP) stands at the core of the smart specialisation concept. The process is initiated by national and regional authorities that invite a large number of regional and national actors to discuss regional R&I opportunities, strengths and challenges. According to Foray and Goenaga (2013) "entrepreneurs are in the best position to discover the domains of R&D and innovation in which the region is likely to excel given its capabilities and productive assets". Entrepreneurs[1] that are close to the market constantly collect information on business opportunities, economic trends, competitors, market gaps, industrial trends, new markets, etc. This information combined with the analysis of regional R&D and

[1] Entrepreneurs are all relevant actors that are active in research, development and business with innovation potential

technology capacities as well as the analysis of the structure of economy and business assets (critical mass, innovation potential) is very relevant to public administrations that are strategically planning and implementing research and innovation policies.

A final and important element of the smart specialisation approach is the idea of regions being interconnected rather than being viewed in isolation. What happens in a region is affected by developments elsewhere as a consequence of flows of capital, people, and ideas, as well as through supply chains and networks. Regions or firms in different regions may choose to collaborate and learn from each other. The development of a cluster in one region may be dependent on inputs from another region, either adjacent, or where there are strong technological and market inter-relationships. Many technology or knowledge generators work across different regions, so the resources that may be accessed by a firm in a specific region may include the knowledge infrastructure of other regions, and such possibilities need to be taken into consideration in the development of smart specialisation strategies.

2.2 The RTO concept

RTOs tend to be public or private non-profit organisations that provide a range of research, development and technology services, principally to business and governments. Although the definition of Research and Technology Organisations (RTOs) vary, reflecting RTOs institutional statutes, governance, business models, funding models and resources, the public missions and industrial support objectives of RTOs seem to be aligned. For example, VTT defines itself as a "leading research and technology company using its research and knowledge to provide expert services for their both private and public domestic and international customers and partners".[2] Fraunhofer defines itself as an application-oriented research organisation committed to address current and future societal needs and thus improve people lives.[3] Apart from research and technology services it offers training, courses and seminars at its Academy. EURAC is an interdisciplinary centre developing solutions for societal, economic, technological and environmental challenges. Tecnalia's mission is "to transform knowledge into GDP improving people´s quality of life by generating business opportunities for companies".[4] On the other hand, TWI view itself as "an independent research and technology organisations operating globally, with expertise in solving problems in all aspects of manufacturing, fabrication and management technologies".[5]

The European Association for RTOs (EARTO) defines RTOs as "regional and national actors whose core mission is to harness science and technology in the service of innovation or public bodies and industry, to improve the quality of life and build economic competitiveness in Europe. RTOs are generally non-profit organisations and their revenues are re-employed to fund new innovation cycles." Although not so frequently identified in studies of the innovation ecosystem as universities, they are significant elements in innovation systems at regional and national level. It has been estimated that RTOs across Europe have revenues of €18.5-23 billion with a wider economic impact of up to €40 billion (Technopolis, 2010).

[2] http://www.vttresearch.com/about-us (accessed 15/07/2015).
[3] http://www.fraunhofer.de/en/about-fraunhofer.html (accessed 15/07/2015).
[4] http://www.tecnalia.com/en/tecnalia/strategic-vision/strategic-vision.htm (accessed 15/07/2015).
[5] http://www.twi-global.com/about/ (accessed 15/07/2015).

As already noted RTOs come in a diversity of forms, size and governance, and hence can be classified on a number of dimensions which helps to explain their varied relationships with smart specialisation strategies. One important dimension is their geographical spread. Some RTOs are very regionally focused and were created to support industry in a particular region, so even if they have small offices outside the region, the bulk of their activity is focused in the region and their mission is primarily to support the region. Another common form is a national RTO which may be at a single location but addressing the whole of a country's needs, or distributed across the regions of a country. Finally there are some RTOs which are increasingly international, operating across borders both in terms of their market and the location of their offices and labs.

To some degree the geographical scale of operation is determined by the governance of the RTO: those that are largely established and funded by a regional government would tend to largely limit their activities to their home region, whereas national governments are more likely to support RTOs addressing national needs even if located in one region. The German Fraunhofer Institutes are interesting in that there is a national network of centres funded and answerable to both Federal and Laender governments, and indeed increasingly moving beyond national borders in partnership with other countries. Other national networks are funded purely at the national level but operate through a set of institutions distributed across the national territory. The more RTOs are asked to seek private sector funding the less likely are they to be purely regionally focused, and hence independent RTOs without core government funding are more likely to seek out international markets, with a greater reliance on large multinational companies as a core client base (Figure 1).

Figure 1: The geography of RTOs

	Governance or key funders			
Geographical scale of facilities and main client base	**Regional government**	**Regional-national collaboration**	**National Government**	**Independent**
Mainly region	Tecnalia*, Basque County; EURAC, Bolzano			CIRCE, Spain
National network across regions		Fraunhofer Institutes*, Germany	VTT*, Finland; RISE*, Sweden	
Single national location	IMEC*, Belgium			C-Tech Innovation, UK
Significant international presence				TWI

- Also have international offices

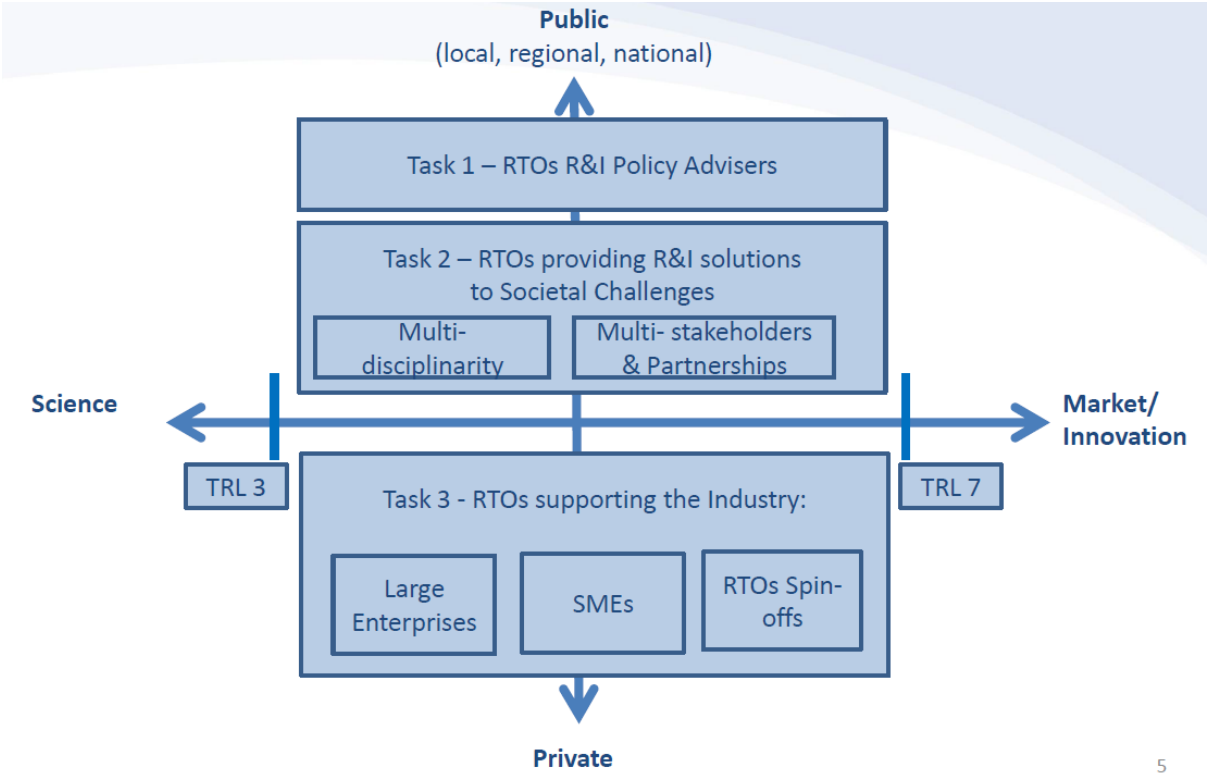
Source: developed by the authors

RTOs typically occupy a space between the public and private sectors, and between the development of basic science and the commercial application of technology. On the latter the Technology Readiness Level (TRL) 9-point scale can be used as indicative of RTO activities. Typically RTOs have limited engagement in level 1 and 2 which relate to basic science principles and the development of technology concepts, however, TRL 3 which relates to analytical studies around the proof of concept is where the RTO role is more prominent, running through to level 7 which covers a system prototype in an operational environment. The subsequent levels 8 and 9 relate to the implementation of actual

systems in demonstration and operational environments and these activities are driven by private firms, however RTOs can be found here as well. Different RTOs will operate in different spaces along the TRL scale depending on the capacities of firms and the willingness of firms to subcontract near-market work to the RTO.

Some RTOs play an important role in the development of new products which then may be commercialised by firms but examples exist of significant innovations developed in RTOs such as the MP3 compression system developed by the Fraunhofer Institute (Smith, 2015). However the primary role of RTOs is more focused around the support for innovation in companies than being the source of new innovations. On the public private scale there are again a variety of positions, some RTOs operating in a strong public sector role as policy advisors on research and innovation, perhaps helping regions in the design of innovation strategies. More frequently RTOs undertake projects for the public sector to develop innovation solutions to societal challenges. This might include both local projects as well as participating in Horizon 2020 projects such as on assistive technology for the elderly or sustainability. RTOs often bring back some regional components in the EU-funded projects by offering partnership with their regions as "test beds" for the new technology being developed (e.g. many examples in smart cities initiatives and in transport). Finally they play core roles in directly supporting industry through collective activities such as technology watch and awareness raising as well as direct subcontract research for individual firms. These activities are mapped out in figure 2 below.

Figure 2: The place of RTOs on the Technology Readiness Level scale and their orientation to policy



Source: Attané (2015) EARTO presentation

2.3 RTOs in innovation-based regional development

RTOs have been identified as key agents in regional innovation systems, and particularly as key elements of regional innovation strategies in many parts of Europe over the past 20-30 years. Even earlier though RTOs were established as national initiatives to promote innovation, in some cases with some form of regional delivery.

The conceptualisation of regional innovation systems identifies a regional knowledge generation subsystem and an exploitation subsystem, the latter consisting largely of firms. Research organisations both public and private constitute important elements in the knowledge generation subsystem, alongside universities and various forms of training and knowledge dissemination bodies (Cooke, 2004). However, until now, much of the theory of regional innovation systems (RIS) tends to focus on universities as perhaps the more ubiquitous and larger element of the knowledge generation infrastructure. RTOs though have typically been much more closely linked with the needs of business, as they do not have the additional roles of education and basic research that the universities have.

Asheim et al (2007) have stressed the importance of proactively creating regional advantage through the engineering of regional innovation systems. The sectors or clusters in such systems will require particular knowledge bases, defined by Asheim et al as analytical, synthetic or symbolic. The first two of these benefit greatly from the involvement of RTOs. Analytical knowledge bases are rooted in scientific knowledge and innovation depends on formal research and development, with knowledge often being exchanged via codified formats such as patents and publications. This is a core role for RTOs. However RTOs also engage in synthetic knowledge bases which are focused more around engineering type knowledge and the application and combination of existing knowledge. Here knowledge exchange has a stronger tacit component requiring closer collaboration between an RTO and its clients, often a core feature of the way RTOs work: direct contracts for R&D activities from industrial clients is a significant component of RTOs' revenues and a core element of knowledge transfer.. Symbolic knowledge bases are perhaps less significant for RTOs as this form of knowledge tends to be more closely associated with the creative industries and creative skills.

Accordingly many regions have invested in the development of RTOs as part of regional innovation strategies. Since the early 1990s and the introduction of innovation into the ERDF, a large number of regions have identified a need to develop industry or cluster oriented research organisations to promote innovation and its diffusion to industry groups as part of those strategies. The Basque Country, described in more detail in section 4 below, is a good example of this with the regional government supporting additional RTOs in their region around specific technology areas, and building on some pre-existing RTOs. One of the early examples of an RTO in the Basque region was the Ikerlan centre, developed in 1974 to support the cooperative companies of the Mondragon Group. The primary objective of this centre was to support innovation for a local cluster of firms. Subsequently many other regions have developed such regional centres, drawing on the experience of those regions which have benefitted from national investments in industrial research centres – the experience of Grenoble with major investments in CEA, CNET and CNRS labs being an example well recognised in the academic and policy literature (see for example Lawton Smith, 2003).

An important issue in the establishment of new RTOs, as with other forms of public research labs, is the question of how they fit in their regional context. There is a danger that without local networks and clusters that can absorb the knowledge generated and circulated by new labs they end up as cathedrals in the desert (Cooke 2001). So consequently, the development in recent years of regionally focused RTOs, often linked closely with regional cluster strategies, has been aimed at directly linking into regional needs. These developments in some case have formed the basis of 'pre-S3' good practice cases. Walendowski (2011) for example identifies the five centres of excellence developed in North East England in the 2000s as a distinctive regional strategy in which the research base was used to underpin the core growth pillars of the regional economy. Two of these centres in particular developed into mature RTOs which subsequently attracted national funding and a role beyond the immediate regional needs, yet still form crucial parts of the regional innovation system.

The contributions made by RTOs to regional innovation systems can be compared with those of universities and science parks as other key regional innovation institutions. Science parks similarly to RTOs are characterised by a diversity of models and strategies, and thus funding models, objectives, activities, size, etc. "that has to be taken into account when discussing their role in regional development and in S3 in particular" (Nauwelaers, Kleibrink and Stancova, 2014). The main difference between science parks and RTOs can be seen in the fact that science parks tend to be more focused on firms located within their premises and have a facilitative role in helping to promote networking among those firms as well as support for new firms in the park. RTOs main activity is by contrast to perform R&D&I and as such are much more focused on meeting the innovation needs of a wide range of firms across the region, and even beyond, with an emphasis on knowledge exchange and collaborative research with firms rather than just business support. Some RTOs are located on science parks, usually just as tenants, although there are a few cases of larger research organisations that have been the developers of science parks taking on the same role as universities. In the UK, MIRA, an automotive industry RTO is currently developing a technology park around its facilities for example.

Universities tend to provide a wider range of forms of support, although often as an activity that is peripheral to their main mission in education. The much greater scale of universities as research organisations, the wider breadth of discipline covered, their core education and training function, and their often large property portfolios give universities the options to get involved in a wider set of innovation support activities, especially as they have been increasingly asked to take on this role by governments. Universities also have been the promoters of science parks in some countries, where they own their own campuses and have the powers to develop part of the campus for commercial development. Compared with RTOs though, universities may focus more on the supply of training and on basic research, but can rarely match the scale and focus of RTOs on industrial technologies and the professional management of RTOs. Whilst an RTO may have several hundred staff devoted to support for specific industrial technologies universities will usually have much smaller teams in the same field, and with a number of other objectives. So whilst universities can offer support for innovation across a wide range of fields and using a wider set of interventions, they rarely offer the degree of industrial focus and depth provided by some of the larger RTOs. In some countries though, RTOs have spun off from universities in order to overcome the tensions between the need to be industrially oriented with more flexibility of operations (financially, hiring

different types of staff and expertise, etc.) and the wider mission of the university. CEIT in the Basque Country for example spun out from a university engineering school, and Warwick Manufacturing Group resembles an RTO in its role but remains within the University of Warwick in the UK. IMEC in Flanders is also a 30 year-old spin-off of KU Leuven.

Figure 3: Comparison of the innovation roles of RTOs, science parks and universities

Role	**RTOs**	**Science parks**	**Universities**
Research services	Yes	No	Yes
Knowledge exchange	Yes	Limited	Yes
Consultancy	Yes	No	Yes
Pilot lines for production	Often	No	Very limited cases
Business support	Rarely	Yes	Some examples
Property services	Few examples	Yes	Some examples
Training and skills development	Yes	Limited	Yes
Supply of human capital	In specific areas (Experts to industry and part-time professors in universities plus PhD hosting	No	Yes From the supply of new graduates through various forms of placement and secondment
Cluster development initiatives	Yes	Some	Some

Source: developed by the authors

3 RTOs role in smart specialisation

The RTOs play a multiple role in smart specialisation. First of all they contribute to entrepreneurial discovery process, secondly they play an important role in connecting actors, and thirdly they build research and technology capacities and contribute to technology transfer. There are three key contributions that RTOs make to the development and implementation of S3, and each of these are shown in Figure 4 and examined in detail below.

Figure 4: Roles of RTOs in smart specialisation

Entrepreneurial discovery process	**Connecting stakeholders**	**Capacity building and technology transfer**
Provide for evidence-based input	Connect stakeholders geographically (in the region, country and internationally) and among the sectors	Transfer knowledge to SME clusters and help SMEs articulate demand for research and technology
Involve different regional stakeholders	Interact continuously with the industry and public administration in the region	Support emerging activities and enhance capacity building close to the market
Are aware of regional strengths and weaknesses	Search for good national and international partners for the regional clients	Help create new business opportunities by creating accelerator incubators and involving disruptive technologies, entrepreneurs, capital, etc.
Have (long) experience with implementation of regional/ national research and innovation strategies	Connect with local population and make research and technologies popular across generations	Contribute to improvement of technological capabilities aligned with RIS3 priorities
Participate in monitoring - gather and organise information relevant to RIS3 implementation	Carry out forward-looking activities, consultancy and advise service for other regions	Help public administration innovate by means of independent competitive policies (consultancies, demonstrations, eservices, eGovernment, etc.)
Can provide advice on revising and updating the RIS3		Raise awareness and promote ongoing constant and effective discussions among stakeholders

Source: developed by the authors

First, is in the phase of development of the S3, in the analysis of needs and opportunities and participation in the entrepreneurial discovery process. Because RTOs are often closer to the businesses in a region, and engaged in monitoring and informing firms about technological and market opportunities, then they have a crucial role to play in ensuring that regions recognise real business opportunities at the centre of their smart specialisation.

Second is the difficult question of how regions develop a greater international dimension to their S3. There is an expectation that smart specialisation strategies will be internationally connected and that firms that are innovative will be well networked at EU level as well as globally. RTOs also seek to develop international networks especially through their participation in Horizon 2020 projects, and hence can be a vehicle for internationalising regional strategies through supporting inter-regional collaboration. In addition, internationalisation of regional smart specialisation strategies can take place

through collaboration between RTOs and the regions lacking RTOs. For example, the countries that joined the EU after 2004 and are lacking RTOs, might want to outsource specific research infrastructure, knowledge and services in order to meet their smart specialisation objectives. RTOs are ideal partners for these regions due to their specific expertise, infrastructure and skill base. Financial resources are available for the collaboration including ESIF funds and EU instruments to support twinning and teaming.

Third, the core role of RTOs is to provide technology and innovation support to companies and this is often focused around specialist areas of technology and hence particular industry clusters. So RTOs often act as central resources for industry clusters and hence would be key delivery elements of a smart specialisation strategy aimed at upgrading the technological capabilities of such a cluster.

While carrying out activities related to the development and implementation of RIS3 strategies, RTOs have been facing a number of challenges. Common challenges are: a dilemma of internationalisation, insufficient and short-term financial support, unsupportive policy instruments and differences in timescales. Internationalisation is both an opportunity and challenge.

On one hand, internationalisation is essential to increase RTO's competitiveness, growth and profit. On the other hand public authorities are afraid that internationalisation can cause ineffective employment of public investments and "expatriation" of RTO's R&I results. Internationalisation can thus generate conflicts and misunderstandings between RTOs and public authorities.

The problem of insufficient and short-term financial support is linked to the issue of decreasing availability of public resources for R&I activities and thus reduction of public funding devoted to RTO core funding. Generally, public resources are used for the establishment, maintenance and management of RTOs, giving them some freedom for road mapping and keeping their R&D&I facilities up to date. In the past the public core funding generally accounted for 1/3 of all RTOs resources, now in some cases it has been reduced to between 12% and 20%. The current situation of lower core funding requires RTOs to diversify their sources of funding and search for more competitive and industry funding. This can create some difficulties for RTOs in terms of road mapping activities based solely on addressing social challenges without any clear business case and industrial or further public support. Additionally, the need for funding diversification makes the alignment between the research and technology focus of RTOs and regional smart specialisation priorities a necessity while making it a challenge at the same time.

This is linked to the issue of policy instruments that are put in place by public authorities to implement RIS3. Public authorities are currently operationalising the RIS3 strategy and RTOs are useful partners in the process, e.g. advising with the financial instruments or available facilities and resources. Their role, however, can differ depending on RTO's status, size and activities.

Finally, the issue of timescales is a relatively minor issue, and it is linked to different business and industry production time series and operational time of public administration. For example, business and industry timescales are very short and requires private actors to take quick decisions, move quickly from the development to demonstration and use all possible resources to achieve their business objectives. They have at their disposal private financial resources that allow them to shorten the R&D and

production timescale and deliver results in shortest time possible. This is a case of i.e. disruptive technologies that emerge very quickly and thus pose high requirements on the market leaders. On the other hand, timescales within which public institutions operate are much longer given their institutional and political nature. Public financial resources are not available immediately because they are subject to approval based on political consensus. Also, public institutions have to apply transparent selection, distribution, monitoring and reporting procedures. Policy and financial instruments and transparent procedures need to be thus defined well before public money is distributed. These discrepancies in timescales can create great challenges to RTOs in bridging those gaps while responding to industry as well as public needs at the same time as depending on diversified funding sources.

3.1 Needs analysis and policy advice

Many RTOs have considerable experience in analysing firms' needs and technology forecasting and provide policy advice services to their regional governments. Such expertise may be used by regional governments to help identify opportunities and assist in developing entrepreneurial discovery processes, especially where governments have limited experience of collaboration with industry.

A key part of the RTOs' mission is to assess the needs of their clients and member companies and many RTOs have developed processes and tools to support this role. PERA Technology, for example, in the UK and Estonia, has a range of services including horizon scanning and concept generation, through to commercial and business planning. Swerea in Sweden have a method called MAKExperience which improves innovation capacity and helps firms to create technological offers based on companies' needs.

RTOs are also heavily involved in identifying future opportunities and forecasting the future directions of particular technologies, and often provide such services to their industrial clients. These services lie at the heart of the entrepreneurial discovery process – identifying the technological opportunities being pursued by the entrepreneurs within a region and how these combine with regional expertise and assets to form the basis of new clusters. RTOs then can be important players in the development of smart specialisation strategies, although in some cases there will be a risk that an RTO will promote its own area of expertise as a result of being more aware of the opportunities in that area.

3.2 Internationalisation

Internationalisation is both an opportunity and challenge. Internationalisation is essential for RTO's to increase their competitiveness, growth and profit. On the other hand public authorities may be afraid that internationalisation can divert the benefits of public investments and the "expatriation" of an RTO's research and innovation results.

A particular strength of RTOs is their involvement in European and international networks and value chains, and whilst this brings potential challenges where governments fund them to support domestic businesses, the RTO may be in an ideal position to identify cross-border linkages and to source knowledge from other regions. The RTO can help bring a more global perspective, especially where the RTO has considerable international experience.

Many RTOs are currently pursuing internationalisation strategies, driven by a need to seek out new sources of knowledge and revenue, especially from global companies, and a desire to participate in international collaborative research projects such as Horizon 2020 as this brings access to state of the art technologies. National and regional governments in some cases set targets for Horizon 2020 projects as an indicator of excellence and success as well as a means of increasing resources without needing further investment by the home sponsor. Such access to international knowledge is a great opportunity for the support of local companies, although direct participation of local SMEs in such international partnerships may be limited by the need to balance the membership of EU research consortia across several countries.

The challenge of internationalisation though is that RTOs will seek contracts with international firms which may be in competition with firms in the home region. For RTOs with a strong degree of regional governance and funding such as in the Basque Country the region seeks to influence the RTO strategy to avoid such competition as the prime function is to support local industry. Elsewhere though the international focus may be more significant especially as governments cut core funding, and there may be little power to prevent the RTO from undertaking projects for firms that compete with domestic firms.

3.3 Support for clusters

Many RTOs are central to particular clusters where they have a long history of supporting innovation. Often it is the presence of a particular regional cluster or industry that stimulated the development of the RTO in the first instance, as policymakers sought to enhance the prospects of a cluster through investment in a collective research capacity. In some cases the RTO has a national remit but the obvious location was to place it at the centre of a regional cluster. Thus the German Fraunhofer centres are often based in regions with a critical mass of potential client firms, and Spanish regions have established research institutes related with local clusters or areas of expertise. The RTO therefore provides a central innovation resource for the cluster as a 'club good' which firms in the cluster can access and benefit from. In this sense the availability of expertise from the RTO helps to raise the level of knowledge exchange within the cluster, and enhances the competitiveness of the cluster as a whole.

In establishing new cluster initiatives, the RTOs could play a core role in providing practical support to the cluster organisation in mapping out firms and technologies, as well as taking on an active role in the facilitation of cluster interactions amongst firms. A particular advantage of the RTO is that they build close working relationships with many firms through their knowledge exchange activities and membership schemes and hence become trusted partners. This is a great advantage in facilitating collective cluster activities, where one of the challenges is to win the trust of firms to commit time to cluster meetings and initiatives.

4 Examples of RTOs from a smart specialisation perspective

The following four cases have been developed from presentations and discussions at the EARTO-IPTS workshop that took place on the 28th May 2015 in Seville. They show the various models that exist and the nature of the potential contributions to smart specialisation and some of the difficulties to be overcome.

4.1 Tecnalia and the Basque Country

The Basque Country is located in the North East of Spain adjacent to the French border. It is a highly industrialised region with a population of 2.1 million. It had the highest level of GDP per capita in Spain at 122% of the EU average in 2011, equivalent to the national average for Germany. In the last two decades the region has invested heavily in R&D&I through the regional government and R&D levels are now at 2.14% of GDP, well above the average for Spain and of which more than half is contributed by the private sector. The Basque Country has a very high level of fiscal and financial autonomy and has pursued science technology and innovation strategies since the 1980s.

The most important industries tend to be in mechanical engineering, but the region is seeing diversification into new knowledge based sectors such as biosciences.

A key element in the innovation strategies has been the development of a portfolio of RTOs, which have more recently been combined into two platforms. Tecnalia is the larger of the two platforms and brings together 8 RTOs which together employ 1,415 people. The oldest of the labs in Tecnalia is Labein which was established in 1955 and Inasmet established in 1962, with the remainder being established between 1985 and 1999. Most of the recent establishments have been supported by the Basque Government.

The other platform is IK4 which groups together another 9 independent RTOs in the Basque Country, again most of which have been established as a result of regional government investment or which have received support from the Basque Government in recent years.

The RTOs are part of an integrated innovation system designed largely by the Basque Government which also includes sets of research centres attached to the universities for basic research (BERCs) and collaborative research (CRCs) (OECD, 2013). However, whilst the CRCs are aimed at developing new areas of knowledge and potentially new industries the RTOs tend to work very closely with existing industry in the region, using membership programmes as the basis for the distribution of current technologies and developing new projects in partnership with Basque companies. The Basque Government provides a base of funding for the RTOs to support their work in the region which is supplemented by project income from local companies, plus grants and contracts from national government and EU research programmes.

As such then the RTOs have always been a key part of the industry clusters supported by the Basque Government though its various rounds of regional innovation strategy dating back to the 1980s. But alongside the direct support for industrial technologies in firms, raising awareness of new technologies, and participation in technology development projects such as through Horizon 2020, Tecnalia also undertakes longer term prospective studies related to key societal challenges which will influence future

needs and business markets. These include for example studies on the future of cities, climate change, renewable energy and factories of the future (Tecnalia 2012)

With regards to implementation of RIS3 strategy, Tecnalia and other RTOs have a potential to contribute significantly by improving technological capacities aligned with the Basque RIS3 priorities, including energy, advanced manufacturing and biosciences. Moreover, they are in a best position to support the internationalisation of RIS3 activities taking advantage of its important presence in international networks.

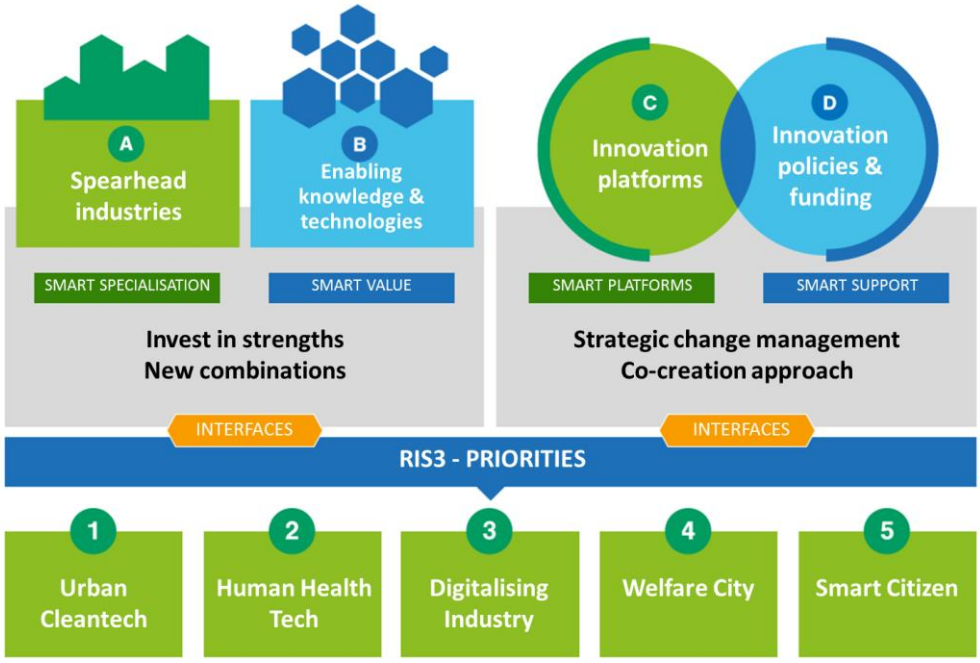
One concern, and an area of potential divergence of interests between RTOs and Basque Government, is around the increasingly international operations of Tecnalia. Tecnalia is charged by the Basque Country to obtain some of its funds from external sources such as Horizon 2020 and its competitiveness as a research institute depends in part on an increasingly international operation. However, this brings challenges when international partners and clients seek support from Tecnalia. If such international firms were to be in competition with Basque firms, then there is a potential for a conflict of interest, in which Basque government funding may underpin research which benefits competitors to Basque firms. Thus one of the possible ways to address this challenge is to make Tecnalia act globally while asking it to ensure local application and impact.

4.2 VTT and Helsinki region

The Helsinki-Uusimaa region has a population of 1.6 million, 29% of the Finnish population but accounts for 38% of Finland's GDP. Helsinki is one of the 'innovation leader' regions in Europe and as a result has experienced rapid growth in recent years and a high level of income: at €37,800 PPS per capita it was rated 16th in the EU in 2013. Levels of R&D investment are extremely high at 4.47% of GDP and the region has a dominant share of national R&D at 43% (RIM Plus, 2015).

The Uusimaa region has developed a rather complex smart specialisation strategy in which public and private sector organisations are brought together around specific innovation platforms or hubs and five priority themes are identified (see figure 5). These themes have a strong metropolitan orientation reflecting the parallel development of an innovative city strategy in response to national policies.

Figure 5: Uusimaa Smart Specialisation Strategy



Uusimaa Regional Council found the process of developing the RIS3 challenging, particularly in bringing together the different regional stakeholders especially as the region was already developing an Innovative Cities programme funded by the Finnish Government. There were particular problems of funding as the national government had cut previous regional programmes and there was limited resource within the regional governments.

VTT is a national RTO with its main location in Espoo near Helsinki but with branches in other cities, mainly Oulu, Tampere and Jyvaskyla. It sits within the responsibility of the Ministry of Employment and the Economy which provides partial funding of 35% of a total income of €251 million. A further 28% comes from other public sector projects, with 16% from domestic private sector firms and 21% from abroad. Although the organisation is divided among several locations, it is a single organisation without a specific regional remit. The areas of research covered by VTT are broad from ICTs and digital technologies to energy, industrial systems and nuclear safety and biotechnology and bioenergy. In total VTT employs 2,351 staff, of which more than half are based in Espoo.

VTT was invited to contribute to the S3 process as a key regionally-based research institute, even though it does not see its role as specifically serving the development of the region. The institute was also invited to get involved in other RIS3 strategies in Finland, although it only got involved where it was invited and not all regions chose to do so. In Uusimaa VTT will be getting involved in the Urban Cleantech element of the strategy through the Bioruukki Piloting Centre, a new facility for scaling up biomass processes based on a converted printing works. This project draws upon a number of areas of expertise of VTT, coupled with other partners such as Aalto University. However, VTT's involvement in these forms of project depends on the scale of resources available and regional budgets are normally too small to influence VTT's strategy. The national and regional public authorities fully support VTT in becoming more active on international R&D&I markets and extending its client and funding base outside of

Finland. Due to the small national R&D&I market, international funding is seen as a requirement in order to be able to maintain and develop sufficient competence for the future needs of Finland.

4.3 South Tyrol and EURAC Research

The Autonomous Province of South Tyrol (in Italian: Alto Adige) is an Alpine region in the North East of Italy adjacent to the Austrian border. Although part of the larger Trentino-Alto Adige region, power has been devolved to the province and it has a high degree of autonomy and is majority German-speaking. The province has a small population of 515,000, but is relatively wealthy with a per capita GDP in 2011 of €37,700 making it the 20th highest NUTS2 region in the EU and the highest in Italy (Eurostat, 2014). Accordingly the region also has a low unemployment rate of only 4.4% compared with an Italian level of 12.2% (2013).

The economy is heavily focused on SMEs and services, with a strong tourism sector. Agriculture remains important at 5% of GDP, and manufacturing accounts for 20% with a focus on handicrafts, energy and construction. A particular feature of the regional economy is the 160,000 members of 955 local cooperative businesses. As the economy is focused around relatively traditional sectors and SMEs then R&D investment is modest at only 0.63% of GDP, mainly in the private sector. Of a total of 1,559 R&D employees, 947 were in the private sector, with 612 in public research organisations and universities.

EURAC is a research organisation established by the provincial government in 1992 as a private non-profit association to support research related to mountainous regions. Over time the institute has expanded its fields of research into social issues (public management, minority rights, federalism), mountain area related issues (regional development, alpine environment, remote sensing), health (biomedicine and mountain emergency medicine), and technology (renewable energy). Currently the institute has 377 staff with a budget of €29.8 million of which 49% is derived from the Autonomous Province of South Tyrol. The RTO is therefore more specialised in applied R&D activity, especially in support of the public sector, and is additionally heavily involved in collaborative EU research with 52 active projects in 2014.

In the development of the RIS3 strategy for the region, the RTO played a supporting role to the province, especially in the analysis of regional needs and in the development of indicators and a monitoring system. The RTO was able to provide comparison with other regional contexts and identify areas of regional competence. However whilst EURAC was highly active in policy and scientific support (task 1 in Figure 1) to public authorities, its role in R&D support for local businesses could be improved. Business in the region tended to assume that all R&D was undertaken in the private sector and the research and innovation policy strands have been separate in the past and are only now being linked through the smart specialisation strategy. Although the region is already working on different areas of specialisation (energy and environment; ICT and automation; food technology; alpine technologies; creative industries and medical technologies) here is a need for further work to develop an integrated entrepreneurially based process for identifying the basis for future innovation policy.

4.4 TWI: an RTO without a specific region

The fourth example of an RTO drawn from discussions during the Seville workshop was that of TWI (formerly The Welding Institute) which originated as a research association in the UK, and now operates as a largely private organisation. TWI is headquartered near Cambridge and over half of its staff are based there, although hardly any of its client base are in the Cambridge region, and in recent years it has set up additional offices elsewhere in the UK and internationally in order to service its main clients. In addition to offices in four other UK regions it has offices in Australia, Bahrain, Canada, China, India, Indonesia, Malaysia, Pakistan, Thailand, Turkey, UAE and USA. Some of these overseas offices are now very large with 80 people in India and 120 in Kuala Lumpur, emphasising the global nature of their work, and the total group employment is over 1,000 staff.

TWI is a case of an RTO that has had to seek out private sector contracts in the absence of ongoing public support. They are highly focused on the needs of industry and have a large community of both professional or individual members and industrial corporate members from 60 countries. As such their focus is primarily on companies and markets rather than regions and hence the company has established overseas offices to support key international clients in sectors such as oil and gas. In their home base of the UK, their main links are with large engineering businesses, which are largely located outside of their home region of Cambridge. Consequently there has been little or no involvement of the TWI in the local Cambridgeshire smart specialisation strategy, although TWI has for example been identified as a key local asset in the Tees Valley strategy (home of one of the UK satellite units).

For such commercially oriented RTOs the main market is the larger firm rather than SMEs and hence support for SMEs tends to require public funding. Whilst some of the UK offices have undertaken such publicly funded work in the past, there is a reluctance to engage with ERDF support due to the complexity of regulations and risks of clawback. Hence there is a greater willingness to draw on ERDF for capital projects rather than business support measures. It is then a responsibility of regions hosting a TWI office to seek their involvement in smart specialisation strategies, and both North East England and Wales have identified TWI as a key asset. In Wales, TWI is identified as a key asset for the advanced engineering and materials cluster, and expresses the 'potential to attract greater activity to Wales based around their specialised facilities and expertise, especially in composite structures' (Welsh Government, 2014).

So RTOs without strong public funding and a close relationship with their host region have the potential to be involved in regional smart specialisation strategies, but may need to be encouraged to participate by regional governments with due recognition of the financial support needed to develop services for SMEs. A particular advantage of such RTOs for a region is their experience of working across borders, in the case of TWI on a global basis, and their ability to source knowledge globally. However what is less clear is how regions lacking a local branch of an RTO would be able to draw on the expertise of such a footloose RTO operating from an adjacent region or even a region in another member state, yet this might be a key input needed to ensure the success of a smart specialisation strategy.

5 Policy recommendations

- Public agencies involved in the development of smart specialisation strategies should seek to better involve RTOs in the design and implementation of RIS3s. Representatives of the RTOs should be included in working groups established to draw up strategies, and to advise on how to draw out the implications of entrepreneurial discovery processes. RTOs are well placed to assess the opportunities that are available around particular technologies and sectors and therefore review proposals made by industry for support programmes. RTO representatives may also have a role to play in the monitoring and evaluation of RIS3s.

- RIS3s may support interventions to encourage collaboration between RTOs and SMEs for knowledge exchange and innovation support. Many regions have encouraged the development of RTOs and their links with SMEs in recent years through projects to support collaborative research projects or through knowledge exchange projects. Such projects, aimed at target clusters within RIS3s, should be developed to facilitate collaborative innovation. RTOs may be supported in developing technological competences in RIS3 priority areas through targeted grants. RTO collaboration with SMEs may also be promoted inter-regionally through Horizon 2020 projects and through complementary projects to connect SMEs with the results of EU-wide collaborative research. So RTOs working in a RIS3 priority area could be encouraged to strengthen their capability around that theme with a regional research grant, encouraged to build on this through a Horizon 2020 project and then additional research or knowledge transfer support may be offered to ensure the wider uptake of the outputs of the research investments within the region.

- Internationalisation activities of RTOs may generate tensions and conflicts between public authorities and RTOs, mainly in the regions where RTOs are strongly rooted in the local innovation systems. How can this tension be managed? Public authorities and RTOs need to get together and discuss the threats and opportunities related to internationalisation including the return on public investments in the region as well as the need of RTOs to grow and compete internationally. Both partners need to understand each other needs and find a good balance between internationalisation and keeping the RTOs activities in the regions. Specifically, regional authorities might apply specific co-financing rules in case of international projects, e.g. provide financing only for the part of the project that is relevant for the region and where impact on the territory can be proved. Yet this rule is not easy to apply because regional authorities need to develop impact evaluation procedure, parameters (short-term, medium-term and long-term) and indicators (e.g. quality and quantity of jobs created) and these criteria are difficult to define. RTOs might be useful partners in the process. They can for example provide information on the results of their international projects, participation in Horizon 2020 together with other regional stakeholders (directly or indirectly) or estimated impact of their international activities on other regional stakeholders including SMEs, industry, Universities, civil society, etc.

- Many regions plan to use their RIS3 to help develop competitive clusters, drawing on existing strengths. Often these will include the RTOs as they have previously been developed to support significant local industries within the region. The

precise role of the RTO in a cluster initiative may vary depending on the needs of the cluster and the strengths of the RTO, but will usually involve technical support to SMEs, collective training activities and networking. A particular role for the RTO may be support for cluster coordination as an organisation trusted by the business community. The RTO could thus help to bring firms together at networking events, identify future opportunities and market trends and facilitate the identification of shared needs within the cluster. The RTO's international partnerships may also help in making links with similar clusters in other regions to facilitate collaboration and benchmarking.

- An identified difficulty for some RTOs is the integration of ERDF support into their financial model. ERDF support is not available in all regions. Some regions provide project funding for RTOs which can be matched with ERDF support to enable the RIS3 roles identified above. In other cases where RTOs are more dependent on private sector funding it may be more difficult to find matched funding for an ERDF project, and the RTO may consider that ERDF part funding for a project represents an opportunity cost. Regions may therefore consider how best to support RTO involvement through different funding models. If matching funding is not available from the regional government then RTOs should be assisted in developing interventions in which private sector contributions from industry users can be used for matched funding. In addition care should be taken on the specification of required outputs or results so that RTOs can have a high degree of certainty about their ability to meet output targets for what might be speculative research projects where the outcomes are not always knowable in advance. A special challenge is that even if there were willingness to use RTO competence from another region, the funding rules may in practice prevent the use of this kind of competence as in the case of knowledge work, the work would be carried out outside of the boarders of the region.

6 Conclusions

RTOs offer a core set of skills and competences needed by regions to successfully develop smart specialisation strategies. These skills sit in a number of areas from support for policymaking to longer term opportunity recognition and direct support to firms within the S3 clusters. Specific opportunities for RTOs to engage with regions in S3 plans have been identified to include support for the entrepreneurial discovery process, support for internationalisation and the development of cluster groupings.

Yet there are a number of challenges to be faced by regions and RTOs in maximising the contribution that can be made by the RTOs to S3s. RTOs are distributed unevenly across Europe, some regions having a wide range of RTOs and others having few or none. Some are more industrially focused and more likely to fit with the areas of specialisation selected by the region. They are perhaps more important industrial sectors and less well developed around social innovation areas which may be more important in regions lacking a strong industrial tradition.

Another key challenge to be faced by regions is the way in which RTOs may be used to support a greater internationalisation of the firms in smart specialisation clusters. Some RTOs are more international in their orientation, whilst others are more restricted by the regional funding bodies to focus their activities within the region. Yet it is mostly the international RTOs that might be most effective at helping firms to reach out to sources of technological knowledge in other regions or countries and bringing back to the region ideas and knowledge from elsewhere.

A particular challenge is for the regions lacking RTOs and the relationships they may form with RTOs in other regions (either national RTOs with responsibility across a national territory) or more commercially oriented RTOs that seek to sell services internationally.

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