

The Roles of Research and Technology Organizations in Europe

Viabile strategies for RTOs

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Master thesis Science and Innovation Management (45 ECTS)

ABSTRACT

The phenomenon of Research and Technology Organizations (RTOs) has been around since the early 1930s. Most countries or regions now have their own RTOs that were originally founded to assist local industries and organizations in the development and implementation of technologies and products. In current times the innovation and research services that the RTOs aim to deliver are increasingly coming under pressure due to an ever-changing environment. Due to technological developments, globalization and the changing roles of competitors RTOs need to take notice of these changes and seek out viable strategies in which they are able to fulfil their mission and the critical role that they play within the national context. At the moment these changes lead to more and more questions concerning the relevance and justifiability of the large sums of government funds supporting RTOs in their endeavours to fulfil their roles. In this paper we will utilize Porter's Five Forces model and innovation system theory to assess the position of four European RTOs and generate insights into viable strategies that will allow the RTOs to continue their endeavours to drive innovation and economic growth. For the foreseeable future the results indicate that there are two general strategies that the RTOs can pursue. They can either pursue the increased legitimization to assure government funding in the future or they can commercialize and decrease the social aspects of their current role. Depending on the strategy the RTOs decide to follow, a gap will be created in the knowledge routes of the current NIS that will need to be filled. From a policy viewpoint, the governments will need to decide whether they want the RTOs to oil the NIS interactions, generate knowledge or do both. In either case the alignment of mentalities between RTO management and local governments seems to be key to the future survival and performance of RTOs.

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Foreword

I've read that every thesis contains within it the shadows of other theses not written. It passes through several transformations before settling on its final scope and focus. This has most certainly been the case in this instance. Starting my research with a vision of things to come and research to be done, how different it has turned out to be. The experience has not been an easy one but one at which I'll surely look back with joy and a feeling of achievement. But above all, it has been a very valuable period in which I've grown and one which I'm sure will prove to be an important chapter in my life.

Throughout my time at TNO I've learned a lot, not only in the educational sense but also at a personal level, it has truly been a period of growth. For this I would like to thank everybody at TNO, with special thanks for Jos Leijten and Govert Gijsbers. Outside of TNO I would like to thank everyone from Joanneum Research, VTT and Tecnalia who have participated in this research and for sharing their visions on the subject.

For this journey I've also required guidance, both educationally and in my research, I've found this guidance in my mentor at the university, Harro van Lente, and would like to thank him for that.

I would like to give a final word of thanks and praise for the support and encouragement that I've received from home. Thanks for believing in me and sticking with it throughout this period!

With this thesis I hope that I've been able to open some doors, raise questions and lead the way to new and further research.

Introduction

According to many scholars, economic growth and prosperity in western economies is based on the development and diffusion of knowledge among key actors in the country (OECD, 1998; CEC, 2000; Chesbrough, H.W., 2003; Leijten 2007). To support these processes is essential and Research and Technology Organizations (RTOs) are expected to play a key role in this respect (Oxford Economics, 2008). Following the European Association of RTOs (EARTO, 2007 p. 3) we define RTOs as: “specialized knowledge organizations dedicated to the development and transfer of science and technology to the benefit of the economy and society.” RTOs operate in many different forms and activities across Europe and the rest of the world (Leijten, 2007). Yet, all face changes brought about by technological developments, rising economies and globalization. How RTOs are affected by these (anticipated) changes and how they strategically could respond is the topic of this research.

In order to answer this question we will call upon two different theoretical strands to both understand and analyze the current situation in which the RTOs reside. Firstly we will look at national innovation system (NIS) studies that seek to understand the dynamics of the innovation system at a national level and the innovative performance of the system. Innovation is an inherently cumulative process where learning, the development of new knowledge and combinations of knowledge stand central. As many authors (e.g. Malerba, 2002 and Lazaric et al., 2004) indicate the development of knowledge is not enough for a good innovative performance. It also requires the diffusion and assimilation of the knowledge among the actors of the system, and active learning by all relevant players. Edquist (1997) defines the innovation system as, “all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations.” (p. 14). This approach thus describes a highly interrelated model in which performance is based on the interplay between various parties. The model moves away from linear innovation and the hero entrepreneur and describes the importance of interaction between scientific, technological, economic and political activities in which the development and transfer of knowledge between actors is key (Metcalf, 1995).

In this literature one type of actor is seen as particularly important to these processes. These actors are commonly referred to as intermediaries or knowledge brokers (Arnold, 2007 and van Lente et al., 2003). There are a variety of intermediaries ranging from the technology transfer offices at universities to dedicated private organizations performing consulting and research services. Considering the tasks and activities of RTOs they too can be seen as intermediaries within the NIS.

As Leijten (2007) indicates, most countries and regions have RTOs located within their borders and as such there is a wide variety in organizational and legal structures, ownership, funding structures, activities and size. Often, there is a strongly social mission involved, which explains the large subsidies that RTOs receive from their governments. Although all organizations within the IS need to deal with the changing operating environment, this is especially important for RTOs due to their central role. If RTOs are to remain a valuable addition to the system they need to take their position therein and their roles into account, more so than other actors. This leads to the following question that stands central in this research; *What are viable strategies for RTOs in a changing innovation system?*

Although IS theory gives us insights and understanding of the role that RTOs fulfil and the workings of the system in which they operate it does not allow us to measure and analyze their position, nor does it indicate the sources of pressure or the available paths for RTOs, i.e. strategic insights.

As IS theory gives no means of measuring their current situation or generate insights into how this position can be maintained we turn to industrial organization economics. Specifically we will use Porter's Five Forces model as a method to measure the current situation and generate insights into the paths available to the RTOs.

This model is based on the measurement of the forces that affect the position of an organization and these measurements allow for the development of strategic insights that concern the future path of the organization in question. It also helps indicate sources of pressure, threats to ones position and the available opportunities.

In this study we will address the strategic challenges for RTOs. Through a study of four European RTOs we will map their current situation, analyze the changes that threaten their position, and give insight into their viable strategic options. We will do so using Porter's model that we will strongly base on the insights and knowledge gained from IS theory.

This paper will firstly discuss both theoretical strands in the given context. This is followed by the explanation of the research design and the methods used. The results are discussed next and finally we will list our conclusions and recommendations.

Theoretical framework

This research is based on two different strands of theory; innovation system theory and industrial organization economics. This combination is used to generate insights into the role of the RTOs within the innovation process and performance and also allow a strategic vantage point to assess their position within a nation and the most immanent threats and opportunities.

Innovation system and RTOs

In the study of the innovation processes it has long been recognized that the environment and actors therein have an important effect on the innovativeness of local/national organizations. This environment and all actors therein are referred to as the innovation system, a group of components, devices, or agents that work together serving a common purpose. Edquist (1997) defines the innovation system as, “all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations.” (p. 14). This approach thus describes a highly interrelated model in which performance is based on the interplay between various parties. The model moves away from linear innovation and the hero entrepreneur and describes the importance of interaction between scientific, technological, economic and political activities in which the development and transfer of knowledge between actors is key (Metcalf, 1995). Thus within innovation system literature the process of interaction and combining new knowledge is critical to the innovative performance of the actors within the system. In essence these interactions and the creation of novel combinations of knowledge is a process of learning that leads to new understandings and new applications, i.e. innovations (Lundvall, 1992; Oerlemans e.a., 2000).

The innovation system theory can be, and is, applied at various levels. Most commonly the notion of the innovation system is applied to a country, a region or a specific technological field. As we are dealing with broad organizations operating at a national level we will use the so called national innovation system (NIS) approach. This thus deals with and describes all relevant actors at the level of a nation. Following Arnold and Kuhlman (Arnold, 2007) we identify three systems within the NIS, the industrial system, the education and research system and the political system.

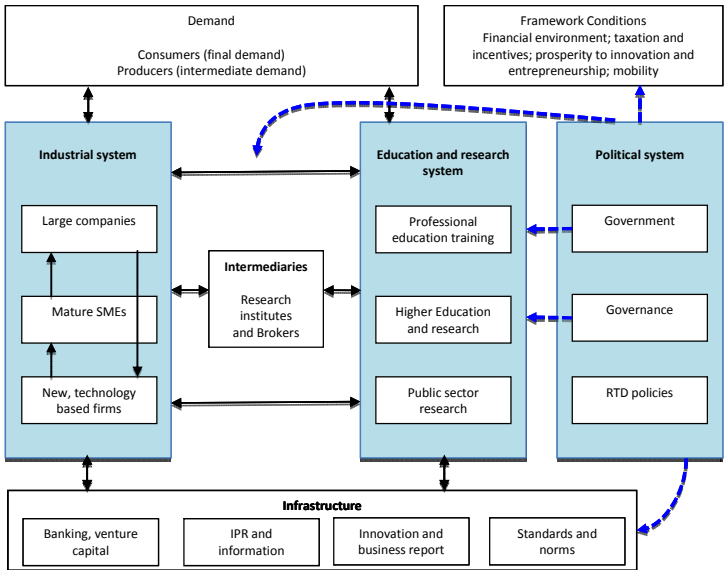


Figure 1: Model of the national innovation system.

Source: Arnold, 2007.

This model shows the three systems, various actors in the systems and the links between them. As indicated in innovation system analysis knowledge flows are key to innovation and thus the links between various systems and actors are essential to the performance of the NIS (OECD, 1997). A focal point in the model is the position of intermediaries. They act as an active link between the research and the industrial system effectively facilitating diffusing knowledge between the sub systems. This shows the critical role that they play in the system and – in the case of RTOs – the power of government to drive innovation through RTOs. Beyond facilitating interaction between the sub systems, RTOs also allow actors to create novel combinations of knowledge through accessing the broad and diversified knowledge of the RTOs. This knowledge can be accessed through direct interaction with RTOs in the form of contract research.

As has become evident this method of analysis focuses on knowledge flows and the effects of the environment on these flows. It thus generates critical understanding of the workings of the system and effects of environmental change on innovation. As indicated RTOs play an important role in the system, this means it is important to assess the effects of change on the roles of the RTOs and their position in the innovation system. These changes will shape the roles that they play, and with whom they interact in the future. Insights from innovation system theory allow us to assess in what way the most significant changes will affect RTOs and their surroundings.

RTO strategy

As indicated above innovation system literature gives insights in the workings of the innovative process at various levels and allows us to analyse the role of RTOs within such a system. It however does not generate any strategic insights to help assess the most imminent threats and opportunities. But as the roles of RTOs and intermediaries in general are so inherently embedded with in the innovation system it is this context with which we can't do without. It will help formulate the roles and the positions of the RTOs as we now see them. Furthermore, it will allow us to interpret the future roles of the RTOs within its context.

For the development of strategies organizations can take two different approaches; one looking at the organization it self, the other looking at the environment in which they operate. Due to the important role that RTOs play within the NIS it is the outward focus that is the most logical approach to assessing viable strategies.

For such insights we will thus turn to industrial organization economics, especially to Porter's Five Forces model. This is a model that has been developed by Michael Porter and is used to assess the competitive position of an organization and the strategic implications this position brings with it. Although this model is most commonly used for industrial and other business organizations it is also applicable to RTOs and their unique roles and business models. This is the case as the model analyses different aspects of an organizations' position with respect to its environment and competitors.

As the environment is changing due to technological developments (e.g. globalization supported by telecommunications) and paradigmatic shifts seem to occur (e.g. rise of open innovation) all actors in the NIS are faced with strategic uncertainties. Due to the important role of RTOs within the NIS, both as developers of knowledge and their roles as intermediaries and policy instruments, they need to take extra notice of their position and the threats they face (Leijten, 2007). In the case of RTOs we thus need to identify threats and possibilities at the organizational level. A useful framework to assess the pressures that the individual organizations face is Porter's five forces model (Porter, 1980).

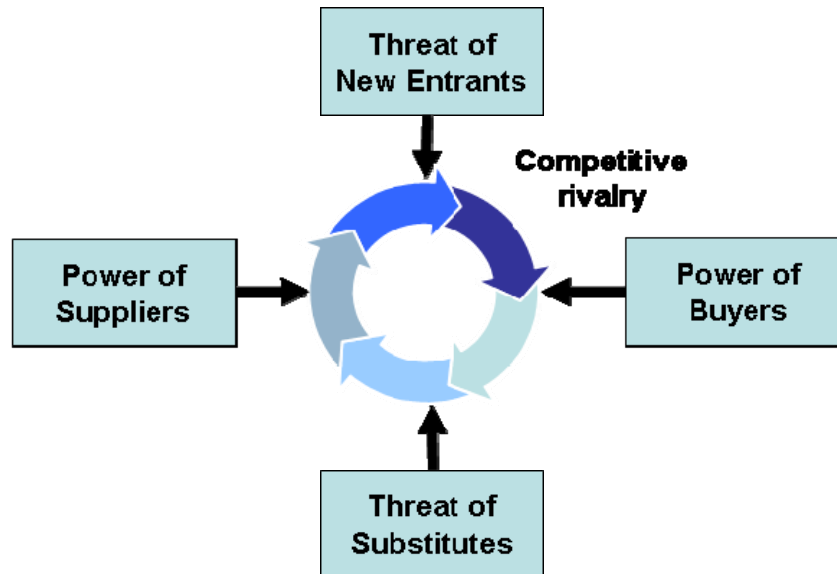


Figure 2: Porter's five forces

The model was first introduced in 1980 and describes how five external forces shape industry competition and subsequently shape strategy (Porter, 2008). It starts from the competition beyond the established industry rivals and includes four other competitive forces to take the organizations surroundings into account. These forces stem from the power of buyers and suppliers, the threat of new entrants and the threat of substitute product or services. The rivalry described using these forces defines an industry's structure and in this case is an indication for the position of RTOs and the industry pressures they deal with. It thus allows for the comparison between countries and indicates the most imminent threats. However, using the five forces model opportunities also become apparent. The selection of the specific indicators that are used in this study are based on the insights from IS theory and the role of RTOs and will underpin the basis on which RTOs provide society and industry with added value.

Within these forces several indicators can be selected depending on the case and the available data. Through a careful selection of the indicators these forces allow the assessment of the competitive position of an organization and the threats and opportunities that it faces.

The assessment of the forces generally gives insight into the rents that organizations can acquire from their products in a specific market. This means that the position with respect to environment dictates the power of the organization in question and thus its ability to dictate terms with regards to buyers and suppliers alike. In this instance we can also use carefully selected indicators along the lines of the Porter model to assess a RTO's competitive position and their ability to perform their all-important tasks. This is done by focusing on their mission, their role in the NIS and aspects that are essential to fulfilling them, further details with regards to the selection of these indicators can be found in Research design section on page 7.

The first force in Porter's model – competitive rivalry – describes the competition from established rivals in the industry. Key in this respect is not only the number of competitors but also the size of the market and the product in question. These aspects dictate the intensity and basis on which companies compete. In the case of RTOs these indicators are very important for assessing the ability of the RTOs to fulfill their mission through preventing market failures and performing an industry supporting role. With higher the levels of competition and increased pressures from outside, the RTOs' ability to perform the social aspects of their role diminishes due to the necessity to become more commercially oriented and as such industry.

Related to competitive rivalry is the threat of new entrants. Attractive markets are likely to attract organizations that are new to that market. New entrants means that competition will increase as more capacity is introduced. In the classic sense of the Porter analysis the threat is seen as to compromise the level of returns that organizations can ask. In the case of RTOs new entrants will mean that their ability to disseminate knowledge across industry groups is diminished¹. Depending on the type of new entrants – e.g. universities or consultancy companies – the stream of new knowledge into the industrial system could diminish.

The threat of substitutes puts pressure on the level of returns that an organization can ask for its products. Substitute products, similar or very different to the original product, mean that customers have additional options to fulfil their needs. This pressure also affects the returns that organizations can attain from the market. In the case of RTOs substitutes lead to a commercialization of RTOs, putting the social role they perform at risk.

The power of buyers is dictated by an organization's dependence on a specific group of buyers. In cases where a specific buyer or group of buyers forms the primary source of income they are in the position to dictate price and product specifications. Considering the role of RTOs the power of buyers to dictate price is less relevant than the ability to fulfil their bridging and social role. For RTOs to disseminate knowledge and have the ability to create novel combinations of knowledge they require a large and diversified customer group.

Finally the power of suppliers in Porter's model indicates the power that suppliers of products or materials to dictate prices, i.e. it describes an organization's dependence on suppliers. In the case of RTOs we cannot speak of suppliers as such, as RTOs cannot purchase the essential inputs required for the production of their services. RTOs require qualified people, funding and access to knowledge most. It is for this reason that we will refer to inputs rather than to the power of suppliers. Through assessment of these inputs, i.e. availability of the aforementioned aspects, RTOs are not only better able to fulfil their role but also deliver higher quality services. Thus the dependence on inputs is not so much relevant to the price position of RTOs, but rather to their knowledge position and ability to perform their social tasks within the NIS.

It is important to note that indicators and forces are strongly interrelated and overlapping. These synergies will be accounted for in the assessment of the model. As mentioned the selection of indicators for these cases is further elaborated in the Research design section on page 7.

¹ This is only the case in instances where the capacity for knowledge absorption grows faster than the total amount of knowledge.

Research design

In the following sections we will discuss the research design. This consists of the case selection, the selection of the indicators and the methods to be used in this research. This research attempts to measure the current position of four RTOs in their respective countries in order to shed light on viable strategies for the future. As aforementioned this will be done using two different theoretical strands that complement one another. In the following sections we will discuss the selection of the cases, the methods used for data collection and the operationalization of the assessment model.

Case selection and methods

In this research we will compare four RTOs dispersed throughout Europe. In the selection of the cases the accessibility and willingness to cooperate with the study has been the critical factor. The RTOs selected for the study are TNO in the Netherlands, Joanneum Research in Austria, VTT in Finland and Tecnalía in Spain. These four RTOs have been selected as they hold close ties and work in close liaison on a variety of projects, which makes the collection of data easier. Further, the organizations are reasonably similar in their missions and modes of operation which will allow for better comparisons between the organizations.

For the collection of the data two different methods are used, firstly we have interviewed and discussed the topic with key personnel within the selected organizations at the JIIP² conference focussing on future strategies of RTOs and secondly we used a model based on the combinations of theory to develop a comprehensive database with data concerning the positions of the organizations in their respective countries.

As indicated earlier we will use four different cases in this research. The collection of data will involve two steps. The first step consists of interviews with key personnel in the respective organizations. The interviews are strongly based on the literature and the knowledge we have of NIS theory and the roles of RTOs. The interviewees will not be board members but people involved in future studies and familiar with the topic. The second part of the research and the majority of the work will result in the development of a comprehensive database describing the five forces of the organizations and their respective situations. This will also include general country and organizations specific data that will be collected from a variety of sources. We will ensure that the sources used in the development of the database are trustworthy and/or peer-reviewed.

The database will contain multiple data points for each organization that will allow us to analyse the current situation of the organizations and markets. This will thus be used to indicate any pressure points and/or opportunities for the organizations. As the database will form the bulk of the data it is important that the indicators are carefully selected based on what we have learned from the literature and the interviews with the aforementioned people.

For the collection of the data used in building the database various methods and sources are utilized. This ranges from patent searches in international patent databases to utilizing company specific data sources such as annual reports. An important note in this instance is that all data will come from trusted sources.

The following schematic functions as a summary of the above and indicates how the various methods will come together for generate answers to the questions posed.

² JIIP (Joint Institute for Innovation Policy) Summer School conference held in Brussels with representatives from all partners present www.jiip.eu.



Figure 3: Schematic depiction of research design

As shown in the above schematic there are three clear steps and methods that will lead us to the desired data and answers. Firstly literature based on IS theory will help in the formation of context and the description of the roles the RTOs currently hold. This forms the basis of the research.

The second step consists of firstly discussions with key personnel involved in related topics and future studies. These are to be held in an early stage. They will strengthen the basis of the research and help in forming the interviews and the indicators used in the Porter analysis. It will also help in generating organization specific data. The interviews will then be used to generate further data and expert views on the matter.

Finally, based on the above-mentioned discussions and corresponding literature, a Porter analysis is done. This will quantify the forces relating to the RTOs. It will help describing their operating environment, indicate areas of change and identifying both threats and opportunities.

Bringing these three sources of information together will help formulate strategic possibilities for the RTOs; both at a higher level applicable to RTOs in similar situations and more specific for the selected cases.

The selection of indicators

In the selection of indicators for RTOs it is important that these indicators underpin the role and mission of RTOs as they come forth from both literature and the interaction with key personnel within the organization. These missions – as indicated earlier – generally are social and industry supporting in nature and form an important part in creating and maintaining a competitive economy. It is therefore important RTOs remain able to perform their role despite outside pressures and a changing environment. Through Porter's model we will be able to indicate the direct pressure points and from an IS theory view point devise a viable route where they may remain relevant and beneficial to a nation. Hereunder the selection of the indicators and the rationale for the selection are discussed, a table with all indicators can be found hereunder.

In the case of RTOs the number of actors – universities, PROs and R&D service companies – combined with the contestability of the market are used as indicators for the intensity of competition. Looking at Porter's model we can conclude that the basis of competition here will be price, as products are very similar and switching costs for buyers are low. Having said this, we will not take this into account, as these figures are very difficult to attain for the parties in question. However, what will be used is the level of competition through assessing the number of competitors and the R&D climate in the home market. Counting the competitors and assessing the levels of investment and the investment culture does this. For the counting of competitors we will count the number of universities, the number of government research organizations and service companies. The universities are selected, as they are the primary knowledge source in most countries and are increasingly interacting with industry, moving into the territory of the RTOs. Government research organizations pose the same threat and competition to the RTOs as the universities. The service companies in this instance are categorized as professional, scientific and technical services. These are thus consultancy organizations that base their competitive advantage on research and knowledge development. These organizations are categorized under the NACE code 73 as part of the business services.

Further we will also take into account to what extent universities are pursuing the so-called third mission of commercialization of their research. These indicators will show the pressure from competition in the home market. This is important as high levels of competition mean that RTOs will need to become more commercially oriented, their ability to prevent market failures through performing an industry-supporting role will diminish (Dutrénit, 2010).

Moving on to outside forces of competition we start with the threat of new entrants. This threat increases in cases where the markets are attractive to outside actors. New entrants bring new capacity, which means that market shares need to be divided between more actors, subsequently increasing competition. The threat depends on the height of entry barriers and the attractiveness to entry. In the case of RTOs we will look at three aspects; the growth of the market, the capital requirements and the accessibility of new knowledge to the industry.

The growth of the market shows the attractiveness of the market to new entrants, this is measured through the growth in R&D investments and the growth in the number of competitors. The capital requirements in the industry form a barrier to entry for new comers, this is measured in two ways; the costs of human capital as they form the competitive advantage and the levels of investments in tangible goods as they are required for the performance of research. Finally, as knowledge is the primary product in the industry, we assess the accessibility of new knowledge by looking at the levels of patenting in the respective countries. Through these three indicators we can assess the size of the threat of new entrants, but is also tells us something about the position of RTOs with respect to other actors in the market. For instance, in the case where it would be very attractive for universities to enter the market they will become

competitors rather than partners, reducing the RTOs' ability to disseminate new knowledge into the industrial system.

The threat of substitute products puts pressure on the market as customers get an additional option to satisfy their needs, increasing their leverage to negotiate. Substitutes can come from similar products, but more often they come from very different products. In the case of RTOs substitute products might be reverse integration in the form of in-house R&D or the establishment of research joint ventures with competitors or it could mean the recruitment of a skilled workforce, in either case it means that they will cut the middleman. To measure the threat of substitute products we will assess the uniqueness of the product through the level of product standardization that RTOs deliver and the added value with respect to competitor products. If the RTOs primarily perform simple and standardized tasks they will be easy to substitute, in the case where RTOs deliver unique and tailor made services or products they are difficult to imitate or substitute. Since the RTOs are partially dependent on commercialization of research substitution of their services means that loose income and with that funds to perform research and services which could divert the research orientation away from their social role and mission (Dutrénit, 2010).

Buyers can put further pressure on organizations if they have a strong position to make demands. This is the case when they represent a significant part of the market or if they can plausibly threaten to produce the product or service in-house. In the case of RTOs, buyer power is not as relevant as the ability of RTOs to perform their roles as intermediaries in the system. To disseminate new knowledge throughout the system they need a diverse customer group that covers the three indicated systems.

Here we will assess the composition of the customer groups of the RTOs as to say something about their position and their access to the weakest links in the system. We will do this by looking at the diversity of the customer group and the size of the respective customer types.

The power of inputs depends in the level of dependence of an organization to their supplier. In the case of RTOs we can indicate three sources essential to the creation of added value; funds for research, knowledge and skilled personnel. These come from two places, (1) government through their grants and (2) universities through knowledge and highly educated personnel. Thus important here are the levels of government funding for the creation of knowledge, the quality of the higher education system and the RTOs' ability to attract talented personnel. In the case that either of these is lacking RTOs will not be able to fulfil their roles. With a lack of government funding RTOs will not be able to perform risky research and prevent the market failure of risk avoiding behaviour by industry. On the other hand, with a lack of educated personnel RTOs will also lack the ability to perform the research and they will lose new knowledge from entering the organizations. The quality of the educational system and the ability to attain good personnel are also important factors as they indicate the quality of the personnel at the respective RTOs.

The selected indicators thus on the one hand indicate the competitive position of the RTOs in their respective markets and on the other hand generate insights into their ability to perform their roles and fulfil their missions. Assuming that the RTOs operate as fully manegrially independent organizations we will then be able to generate insights into viable strategic paths for RTOs from this point of view

Table 1: Operationalization of Porter's five forces model for European RTOs.

Industry force	Variable	Indicator	Measure	Source
Competitive rivalry	Competitors	Number of competitors	Number	OECD
	Contestability of markets	Research climate	R&D investments €	Eurostat, OECD, Statistics
		Funding structure RTOs	€	Annual reports
		Funding structure top 5 universities	€	Annual reports
Threat of new entrants	Industry growth rate	Market size per year	€/yr	Eurostat, OECD
		Number of competitors	Per year	OECD
	Capital requirements	Investment in tangible goods	% of total industry	OECD + RTOs
		Cost human capital	% of total industry	OECD + RTOs
	IP Strategy	Patenting at universities, industry and RTO	No. of patents	OECD, Annual reports, Statistics offices
Threat of substitute products	Level of standardization	Product portfolio (consultancy vs. research orientation)	Qualitative	RTOs
	Relative price performance	Cost of personnel	Qualitative	RTOs
Power of inputs	Levels of government funding	% of revenue	Number	RTOs
	IP strategies of universities	Patenting behaviour and revenue	Number	Various statistical offices
	Strength of higher education	Ranking of universities	Rankings	Leiden ranking, Shanghai
	Popularity among university graduates	National ranking for best employer	Ranking	Various
Power of buyers	Size of customer group	Number of customers	Number	RTOs
	Composition of customer group	Number of customer groups based on	Number	RTOs
	Turnover from customer groups	% of turnover/customer group	Number	RTOs

Results and Analysis

Using the indicators selected earlier a large database has been developed to map all the data and the forces that the selected RTOs need to take into account. The database allows for accessible comparisons between the RTOs and their operating environment. In the following sections the cases will be discussed per force. The data is presented and analysed following the selected literature.

The Cases

As indicated four cases have been selected for this research. The cases, TNO, Joanneum Research, VTT, and Tecalia. These case will now be briefly introduced before moving on to an analysis of the interviews with the experts from the organizations and the Porter analysis.

TNO

TNO is the oldest of the four RTOs selected for this research. Founded in 1932 to support specific industries across the Dutch landscape TNO has grown out to one of the larger RTOs in Europe. With approximately 4000 employees and an organization wide turnover of some 576 million Euros in 2009.

In it's history TNO has gone through many changes. Starting as separate industry specific organizations it has grown to cover a very large variety subjects and industries. TNO has most recently moved towards a matrix organization structure to accommodate all the fields and topics that are worked on throughout the organization.

In its most recent strategic plan the organization strives towards a more international role and has a strong focus on increasing income from direct contract research performed for and with industry. One point the organization sees as critical is to increase the income from IPR. This is to serve a dual purpose, increase income and increase knowledge transfer. As this research has been performed from within TNO multiple people have been involved in discussion concerning the RTO's position. The primary experts consulted for the research have been Govert Gijsbers, a senior research within the organization involved in innovation policy research and Jos Leijten also a senior researcher involved in both innovation policy research and heavily occupied with questions concerning the future of RTOs. Besides his research for TNO Jos is also currently leading JIIP a joint initiative between four European RTOs, namely those selected for this research, which supports the internationalization of innovation and innovation policy at research centers.

Joanneum Research

Joanneum Research counting some 400 employees is the second largest independent R&D centre in Austria. Joanneum Research with some 24 research units spread across 5 general areas attempts to meet the short and medium-term technology needs of the business sector in the Styria region.

Joanneum Research is the second largest independent R&D Centre in Austria outside of the University sector, with approximately 400 employees and 14 research units in a variety of scientific disciplines. It is a not-for-profit organization, governed as a limited company largely owned by the state of Styria. The focus of Joanneum Research is applied research and technological development: it performs project oriented research work, financed for a large part by federal state and local authorities, public and semi-public institutions as well as private enterprises.

The Institute of Technology and Regional Policy (InTeReg) is a socio-economic research institute of Joanneum Research with a staff of 34 employees, located in Graz and Vienna, and specialized in areas of science policy, technology policy, regional policy and labor market policy. In the field of technology and innovation policy InTeReg focuses on: development of technology and innovation policy concepts at the national and regional level; analysis and comparative assessment of international technology policy; development of strategies and measures in different areas of technology policy (e.g. strategic governance, technology transfer, financing of innovations, SME-networks etc.); development of regional innovation and technology indicators. Performed work covers a range of activities, including research on governance mechanisms, assessing impacts of government policies and evaluation of policies, institutions and policy instruments. The research and consultancy is financially supported by national (amongst are Germany, Austria) and international organizations (e.g. European Commission and OECD).

VTT

VTT, short for Valtion Technillinen Tutkimuskeskus or Finnish Technical Research Centre, was founded in 1942. This makes VTT the second oldest European RTO after TNO.

VTT is the biggest RTO in northern Europe and provides high level technology solutions and innovation services. To provide customers with innovative solutions VTT strives to combine inputs from their wide knowledge base and broad range of technologies. Through their services VTT aims at improving clients' competitiveness and competencies.

One important aspect of VTT, which they see as especially valuable to their customers, is their strong international network. VTT is involved in many international scientific and technology oriented networks through which they produce new knowledge and attempt to remain at the cutting edge of developments in science and technology. Through their international involvement VTT attempts to create business intelligence and value to their customers. VTT operates under the Finnish ministry of Employment and Economy. As of 2010 VTT operates in a group structure with a variety of groups focusing on research and technology, business and strategic research, testing and certification and various forms of valorization including spin-off activities.

Of the €274 million turnover approximately 70% comes from external sources, i.e. contract research and joint research projects. Government funding gives VTT a base income through providing just over 30% of their total turnover. Of the total turnover VTT currently generates almost 20% from foreign sources.

VTT is not only large in monetary terms, with a personnel base of some 2800 employees they are also a physically large organization. The workforce, as is the case for the other RTOs, is highly educated with some 80% of employees holding an university degree.

As indicated VTT is active across a broad variety of disciplines and they do this in several project forms:

- Commercial projects (tailor made solutions for industry)
- Joint projects (ventures with industry and/or government agencies)
- Self financed projects (high risk research projects)

Through these three forms of projects VTT strives to further their own knowledge-base and technological capabilities as to continue to improve their own competitiveness and expertise so they can continue to deliver added value for their customers and society.

Tecnalia

Tecnalia is an exceptional case as it has recently been formed from eight separate institutes with their own focal areas and expertise. These organizations (Azti, Cidemco, ESI, Fratronik, Insamet, Labein, Neiker and Robotiker) formally formed the majority of research capabilities for the Basque Country region.

Since combining forces in 2001 they have been steadily growing to not only become an important actor in the Basque region, but also on a national and European level. Between 2001 and 2008 their turnover has steadily grown from almost €25 million to €144 million making them the third largest among the cases selected for this study.

As a group they are highly focused on R&D projects with and for industry. Some 83% of their turnover was generated from R&D projects. Projects with industry represent some 54% of turnover. Although they strive to work for and with industry, almost half of their income still comes from various government sources. 21% of their turnover is given to them in the form of basic funding. The remaining 25% comes from competitive government sources.

To Tecnalia a future perspective is of the up most importance. Some €86 million have been invested in research, equipment and infrastructure. Besides the financial investment Tecnalia makes, they also partake in many emerging areas of research and development that involve high risk projects, On a annual basis 0.5% of their turnover is invested in promoting ground braking technologies that will give rise to the future.

Tecnalia currently also pursues a strong international presence. They primarily do so through participation in the EU framework programs. This has made them the No. 1 private Spanish entity for European returns. Next to their participation in EU research programs they also have representations on 5 continents.

These facts and figures show that they live their motto “Together we have no limits”. Together they strive to be a valuable contribution to science, technology and society.

Expert views

Discussing freely with experts on RTOs and their challenges combined with interviews has lead to some interesting insights concerning their visions on the future of RTOs.

Asking them to describe their role, now and in the future, together with a variety of related topics is important to give direction to the further analysis and supplement the insights gained from figures only.

Literature has shown us that the roles of RTOs are first and foremost nationally oriented. Talking to the experts the vision of an internationally oriented and important player surfaces in most conversations. Asking the experts to describe the role of the RTO another item stands out, delivering benefit to society and economy alike. Achieving this is their primary goal as it forms the justification of their existence and the funding they receive. Primarily they attempt to achieve their goals through offering R&D and consulting services to industry.

This notion of the role of the RTOs is supported by the interviewees and is probably best summarised by Javier Ruis from Tecnalia. He says that the current role is best described as; *“providing value based on science and technology to society through the industrial sectors and economic activity”*.

We thus see the strong regional or national focus and an aim to support industry in attaining a competitive advantage. It can only be assumed, but it would seem that their mission thus aims at promoting the national economy with respect to international competitors.

As mentioned the RTOs use a variety of methods to achieve their mission and fulfil their role within the national context. Primary tools for this lie in the real of applied research. According to literature and mission statements found at the RTOs they perform this in name of customers but also as a means to take risk away from industry and upon them selves. This vision is confirmed by the interviewees who indicate that the basic funding from government sources play a large role in achieving this. Torsti Loikkanen from VTT probably best formulates this notion by saying *“emphasise the role of being proactive and foresighting activities that VTT is doing because I think the future perspective is first of all a critical element in research development because, as you know, these developments aim at future businesses, future production”*. From both the literature and the statements we’ve heard during various conversations it becomes quite clear that the RTOs need to act as front runners in within the National context and look to the future in order to develop an impact for the local industries.

In attempting to fulfil his role the RTOs compete with other organizations that attempt to generate income from similar activities. The primary competitors for the RTOs are universities, professional consultants and other PROs. Literature is some what biased in this respect. As we can see from the interview with Joanneum Research’s Reinhold Hofer co-opetition is not uncommon, or at least the feeling of co-opetition. This is further acknowledged in the discussions held with a variety of people within TNO who feel that a competitor at one moment will be a partner the next. To quote Reinhold Hofer; *“the competition depends on the respective institute and activity – in general cooperation is an important characteristic the activities - so co-opetition is a more familiar pattern”*.

Although we cannot speak of the levels of competition we see in industries such as fast moving consumer goods, the notion of competition is most certainly there. The levels of competition are also growing. There is a notion that the levels of funding are not sufficient and as such these organizations are increasingly impeding on one another’s terrain. The so called third-mission at universities means that they increasingly compete with RTOs for research contracts and the desire within the RTOs to serve industry also means the more often find themselves on the terrain of professional consultants.

Beyond the challenge of fading boundaries leading to increased competitiveness within the industry, the RTOs also see globalization as a major challenge in the near future. Not only their customers are increasingly operating on an international level but also R&D is becoming an increasingly global affair. Through this internationalization the RTOs are also forced to follow, which leads to questions concerning the justification of basic funding from taxpayers money. The notion of *“forced globalization”* is something that worries the RTOs. They feel that the conflict between their national context and the international pull to become a critical issue in the near future.

Already in the mind of the experts it is this conflict that seems to form the biggest obstacle to moving operations to a more international plane. From the interviews we have learnt that the feeling with the home base is important and will remain so in the future. What will change is the manner in which the organizations deliver added value to the home base. Reinhold Hofer has a very clear and nice way of putting it, he says the following; *“The regional role – still being most important – will be fulfilled when Joanneum is seen as a hub in international research networks with some special attention for relations to the Adria-Alpe-Pannonia region”*. This means that for them the regional role remains on the forefront and the international role will only partially be followed. For the ‘bigger’ RTOs, in this instance TNO and VTT it is expected that the international role will be both necessary and desired. Govert Gijsbers from TNO sees the future RTO as a so-

called “*system integrator*”. These visions reflect the general feeling at the RTOs concerning their international activities.

Furthermore, something that all the interviewees seem to agree with is that policy at a national and a European level will be the driving factor in the direction in which the RTOs will develop. As they put it, “*it depends on how governments decide to use us*”.

Irrespective of the direction in which the RTOs develop they expect that increased income from contract research, i.e. working for and with industry, will be essential to the continuation of their organizations. This notion is also shared by higher management and has been adopted into strategic plans. Not only direct contract research will play a role but also increasing income from IPR is key in all four organizations.

The down side of these trends will be the loss of contact with the home base, especially interactions with SMEs are expected to suffer. Due to the need for a more international focus and increased income from industry project size and cost effectiveness are essential. It is felt that the smaller organizations in the home nation will not be able to partake in such activities without financial support from government sources.

To accommodate these strategic goals the interviewees see their route in strategic partnerships, fast growing and dissolving networks and knowledge transfer. So, on the one hand its more difficult to remain connected nationally, but on the other hand the RTOs will gain international knowledge and insights which will also help national companies in gaining competitive advantage abroad.

A final trend that stems from the interviews is the growing importance of the socio-economic challenges, or the grand challenges as it is referred to by the interviewees. What lacks is a vision of how to achieve this, delivering bigger impacts for in the socio-economic context.

Roles and challenges

From the interviews with the key personnel at each of the four organizations in combination with literature on RTOs we have seen that the roles of the RTOs is normally seen as threefold. We see that the RTOs segment their roles into performing applied research, commercialization and distribution of knowledge and assisting government in policy development. This means they hold essentially the task of being R&D performing intermediaries within the NIS.

In performing these tasks they have three primary sources of competition. These are universities that increasingly seek out collaborations with industry, other national research institutes and knowledge based service companies. These three sources are able to either take the role as knowledge developers through a differentiation of their core competencies; universities and other research institutes can attempt to increasingly also perform applied research with direct applications in industry and the consulting organizations can attempt to develop more knowledge to disseminate throughout industry.

From the interviews we have also learned that competition will increasingly come from international sources and the increased market activity at universities. This also has to lead to changes in strategies for the western developed RTOs who will increasingly compete with other western RTOs and the rising powers in the Far East and South America. As technological developments increasingly facilitate organizations working for and with international partners, the sources of competition are shifting and the number of competitors is increasing. This also means that the international role of RTOs in becoming increasingly more important. This not only the case for the RTOs, but also for the economy as a whole. This is also where RTOs see both problems and opportunities. There is a conflict of interest within the national governments who want national funding to be spent nationally and overlook the importance of the internationalization of the RTOs. On the other hand the position that RTOs hold within the NIS

allows them to move into the role of integrating internationally developed technology and knowledge for the local economy.

Other challenges come from the decreasing availability of national funds to the RTOs, both in terms of basic funding and competitive funding. These funds are essential to the RTOs in performing the social aspects of their roles when assisting the growth and development of the needy within the NIS.

According to the interviews further threat comes from universities increasingly taking the so-called third mission upon themselves. Increasing activity within industry by universities means that they move into the classical role of the RTOs; translating basic science into industry applications and products through applied research.

RTO position and assessment

Having seen the roles and the challenges that the interviewees indicate as key to RTOs now and in the near future we move on to assessing the position of the RTOs at the current time. As said, this is done through the application of the Porter Five Forces model to four RTOs in four European countries. In the following sections we will discuss the data and the forces one at a time starting with competitive rivalry for RTOs.

Competitive rivalry for RTOs

The competitive rivalry that the RTOs deal with in their respective countries or regions depends on the number of competitors and the size and dynamics of the market. In the case of RTOs they hold a special position that protects them from competitive forces as they are heavily subsidised organizations. The subsidies come from a variety of governmental organizations and mean that they are able to perform the societal aspects of their roles.

When assessing the competitive positions of the four selected cases we can divide them into two distinct groups; the RTOs operating in strongly regionalised countries (Tecnalia and Joanneum Research) and those operating in centrally governed countries (TNO and VTT). This is an important distinction as RTOs in regionalised nations have a biased competitive field and position in the sense that they are eligible to receive local funding that other actors in the country aren't whilst still operating at a national level. Furthermore, they will hold an advantaged position within the region in attaining contracts.

We will assess the four cases together and discuss the individual organizations there after.

Spain: Counts 135 CISC acknowledged research institutes with a total budget of 858.7 mln of which 526.7 mln comes from government. Some 294.3 mln comes from competitive tenders.

Basque Country: In 2006 908 mln was invested in R&D, approximately a 10.6% increase of 2005 spending (euskadi.net). Basque Country has undergone exceptional growth and remains one of the leading countries considering private funding of R&D (555 mln in 2006).

Netherlands: With relatively low investments efforts to increase R&D activities have fallen short. Also the lack of science and engineering students has troubled the country since the early 90s ([CPB](http://cpb.nl)). 100% of the universities actively pursue third party income but tend to license before patenting (OECD).

Austria: Due to federal and Lander governments the NIS is very regionalised. The country expects to reach the Lisbon target of 3% by 2012. In 2005 Styria spent 3.7% of GDP on R&D, leading the country and matching top research nations in the world ([Wirtschaftsstrategie](http://wirtschftsstrategie.at)).

Finland: The 18 PROs receive 295 mln of the joint 550 mln they spend on research comes from government. Furthermore, higher education receives €1.18 bln the country also has the highest levels of doctorate students in Europe.

When assessing the number of competitors in the four countries we see that the levels of competition vary significantly per RTO. We thus assess the number of universities, the number of government research organizations and the number of research based service companies (i.e. enterprises). These have been selected, as they are the primary competitors for RTOs. Although the selected competitors form different threats to the market position of the RTOs we will assess them together. We do so as we want to indicate the total competitive threat that the selected RTOs need to deal with. For this reason we will use the sum of all competitors and assess them as such.

When looking at table 2 we see that in 2008 the Netherlands has the highest number of competitors by far. However, the number of competitors is only a relevant and comparable measure if the size of the market is incorporated in the assessment.

As we need to look at the relative number of competitors per country we need to take market size – i.e. R&D expenditure – into account. We do this by incorporating the total R&D expenditure (GERD) in 2008 for each case by calculating the number of competitors per million Euros spent and visa versa. This shows us the following (see table 3).

Table 2: Competitors per country

	Spain	Netherlands	Austria	Finland
No. of PROs	166	28	37	18
No. of enterprises	1444	2045	559	393
No. of universities	61	19	22	17
Total competitors	1671	2092	664	428

Source: National statistics offices; Eurostat

Table 3: Relative market competitiveness

	Spain	Netherlands	Austria	Finland
No. of competitors per €mln	0.11	0.22	0.09	0.06
€mln per competitor	8.79	4.64	11.38	16.09

From this we can see that the Dutch market is the most saturated followed by Spain, Austria and finally Finland. The Dutch market is almost three times more saturated than the Finnish market. Competitive levels as such are also higher. The Finnish situation is thus the least competitive, with the least companies per million euro spent on R&D.

As indicated the cases of Spain and Austria differ from the other two due to the regionalised nature of the countries. In the case of Spain Tecnalia is located in the Basque Country, a region to the north of Spain known for its trade and engineering. The region is strongly developing ([euskadi.net](http://www.euskadi.net)³) and invests heavily in the transition towards a knowledge-based economy. This also means that funding for universities and research organizations are relatively high. Tecnalia has relatively many locally based competitors comprising of 3 universities – of which one major – one other RTO and several research organizations (see figure 4). Although many research centres reside within Basque Country region, there are few direct competitors. On the other hand Basque Country is performing exceptionally well increasing R&D investments by 10.6% between 2005-2006. This means that they enjoy a relatively protected space that protects them from national competition, albeit still a moderately competitive one.

³ http://www.euskadi.net/t32-6874/en/contenidos/noticia/descubre_euskadi_2007_12/en_i_d_06/i_d_06.html visited 09-2010

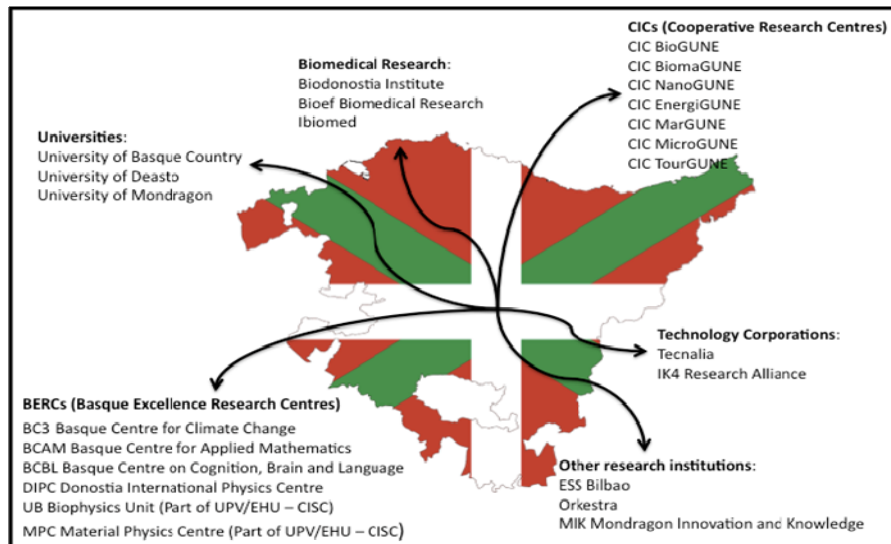


Figure 4: The Basque Country science system

Source: ikerbasque.net

For Joanneum Research this is a little different, they reside in possibly the most competitive region of Austria. The region of Styria contains 5 universities, 2 Fachhochschule and 17 of the total 46 Kompetenzzentren. At the same time the region is the most progressive and has enjoyed the strongest development in the past decade (Wirtschaftstrategie, 2006). It is the research capital of the country and will therefore also enjoy the highest level of investment and outsourcing, i.e. opportunities and spending. This means that although they reside in a very competitive region, they also enjoy the benefits there of in the form of high outsourcing and R&D expenditure levels. Furthermore, Joanneum Research holds stakes in all clusters that reside in the region allowing them to partake in all activities that come to the region (Annual Report, 2008-2009). Their positioning not only gives Joanneum Research access to additional local funds, it also the Styria region also gives them a competitive advantage over the rest of the country. Although, it has to be noted that Joanneum Research would not be able to remain solvent without the financial support from national and Lander government (Annual report 2008-2009).

The small size and high competitiveness of the Dutch market is reflected in the composition of TNO's revenue and the fact that they generate on average 22.3% of their revenue from foreign sources (TNO Annual reports 2006, 2007, 2008, 2009).

When we consider R&D expenditure and look at the four countries we see that spending levels differ significantly. The general measure for R&D expenditure in a nation is the % of GDP that is spent per country (see table 4). Distinction can then be made between the gross expenditure of R&D (GERD) and the business expenditure of R&D (BERD), or the private spending. This thus shows the levels of combined (public + private) spending and private spending and are indicators for the R&D expenditure climate in a country.

Table 4: GERD in 2008

	ES	NLD	AUT	FIN
GERD (% GDP)	1.35	1.63	2.67	3.73
GERD (€mln)	14694.78	9712.89	7558.38	6887.41
GERD growth (2000-2008)	0.44	-0.19	0.73	0.38

Source: National statistics offices

Table 5: BERD in 2008

	ES	NLD	AUT	FIN
GERD (% GDP)	0.74	0.83	1.88	2.77
GERD (€mln)	8054.92	5303.36	5322.00	5114.78
GERD growth (2000-2008)	0.25	-0.18	0.44	0.40

Source: National statistics offices

Several things stand out from these tables. Firstly, we see that Finland is the only country to have attained, and exceeded, the Lisbon target of 3% R&D expenditure. However, expenditures as a percentage of GDP give a skewed vision of actual R&D expenditures, although Spain has the lowest expenditure rate in relative terms (% of GDP) they have spent the most in absolute terms. So although this forms a good comparable measure and a good indicator of the investment climate, it doesn't tell the complete tale. Besides being the only country to attain the Lisbon target, Finland's NIS is characterised by very high levels of business R&D and R&D outsourcing (ARITAKE-WILD, 2009).

Secondly, the Dutch investment climate is deteriorating, or at least not in line with the growth of the economy. In the period between 2000 and 2008 the levels of investment have decreased, both in total as well as from private sources. However, in absolute terms investments have steadily grown during this period by €2.1 billion. The Dutch government says the low investment rates stem from the high levels of knowledge intensive services on which the economy is based. These don't lone them selves for large R&D investments (60% of the problem) and the fact that large Dutch companies perform a lot of research abroad whilst the Netherlands is generally bad at attracting foreign research ([Rijksbegroting.nl](http://rijksbegroting.nl)).

Thirdly, the Austrian R&D climate has undergone the strongest growth. This has been an objective from the government as they still strive to attain the Lisbon target by the end of 2010 (Ministry of Transport, Innovation and Technology Austria⁴). This intended growth can have two affects for the research market and the organizations therein. Firstly, it can lead to a market situation that is attractive to new entrants and will also attract them, leading to higher competitive rivalry. The other scenario is one where the market grows but new entrants stay away. In this scenario the additional funds will lead to a significant decrease in competition with in the market.

Finally we can see that the investment climates in the countries are relatively healthy, although in most cases not at the desired levels according to the Lisbon targets. They are healthy as they follow EU guidelines that suggest that business and government spending should stand at a ratio of 2 to 1; meaning that industry is responsible for the bulk of spending (source). This thus shows that they are moving in the right direction and that industry is able to make the necessary investments in the development of their products and the economy at a national level.

In the case of the RTO's competition is not solely measured by the number of competitors, their interests in the market also count. For universities we can assess the level of third party income as a proxy for their activity in the market. For competitive reasons and due to large number of actors it is very difficult to attain these figures for enterprises and as such these have not been used in this research.

When we look at the levels of third party income at universities we use figures from the top 5 universities in the country according based on the webometrics ranking. This ranking is based on the institution's size, research output and impact (see [webometrics website](#) for more details). Due to the large difference in the number of universities and the poor availability of annual

⁴ <http://www.bmvit.gv.at/en/innovation/policy/role.html> visited 09/2010

reports for universities we have chosen to use the top 5 universities only as it will give a good indication of university culture and the need for third party research contracts in the countries.

Table 6 gives the average income generated (% of total revenue) by the top five universities in the four countries over a two-year period. The data is collected from annual reports that have been published on university websites.

Table 6: Average annual third party income as a % of revenue during 2008-2009 for the top 5 universities.

	University third party income
Spain	17.38 %
Netherlands	23.33 %
Austria	13.20 %
Finland	8.58 %

Complete data sets can be found in the appendix.

This shows that again the Dutch market is most competitive in the sense that universities are most active in attaining third party income from services and research. Finland is again the least competitive environment. This can be explained by the levels of funding given to the universities in the four countries.

When looking further into the data we expect the Spanish universities to generate higher third party income due to the large nation wide network of technology transfer offices (TTO). As a government initiative a network has been created and is centrally governed that assists the universities in their effort to generate additional income. This also means that all universities in Spain have a TTO and are actively perusing income from research (RedOTRI, 2008). In the Netherlands we see that the top 13 large research universities have TTOs and that they generate almost a quarter of their income from third party sources. In the Netherlands we also know that the universities are very actively licensing their research to companies, however they primarily licence before patenting. Some 52% of licensing agreements concern non-patented licenses (OECD Science and Technology Scoreboard, 2009).

Competitiveness from universities is a very two-sided matter, one the one hand the initiative and effort to valorise the research performed at universities is very positive but on the other hand it introduces a threat to RTOs and could lead to competition between two parties striving for the same goal.

Different industries will have different levels of competition. In the biochemical and pharmaceutical industries for instance the levels of competition will be much higher due to high levels of internal R&D. On the other hand the building industry performs virtually no own research and as such levels of competition will be very low.

In general we can say that as for now, that the contestability of the market for RTOs is relatively low. Their products are based on highly knowledge intensive applied research services that are very difficult to internalize or imitate. In this respect the biggest threat will come from universities. However, RTOs have a stronger position with respect to industry – and thus contract research opportunities – than universities. Furthermore, the breadth of the RTOs network and research groups allows them to create novel combinations and valorise knowledge across all key industries in a country.

So to summarize, we can generally say that as for now the contestability of the market for RTOs is relatively low. Their products are based on highly knowledge intensive applied research services that are very difficult to internalize or imitate. In this respect the biggest threat will come from universities however, RTOs have a stronger position with respect to industry – and thus contract research opportunities – than universities. Furthermore, the breadth of the RTOs network and research groups allows them to create novel combinations and valorise knowledge across all key industries in a country.

Threat of new Entrants

The threat of new entrants depends on two factors, the attractiveness of the market and the barriers to entry that are in place (Porter, 1979). When assessing the attractiveness of the industry we will look at two aspects the growth of the market in monetary terms and the increase in the number of competitors.

The barriers to entry that we will use underpin the role of the RTOs within the NIS. We will look at the accessibility of new knowledge – i.e. the levels of protection of new knowledge – and the capital requirements for new entrants.

Again we will assess the four cases in relation to one another but also discuss the cases individually where necessary.

Firstly we will assess the attractiveness of the market, starting with the growth of the market in monetary terms. We will do so by assessing the change in gross domestic expenditure on R&D for the four countries (see table 7 below).

Table 7: GERD as a percentage of GDP and in million euros

	Spain		Netherlands		Austria		Finland	
	%GDP	€mln	%GDP	€mln	%GDP	€mln	%GDP	€mln
2000	0.91	5735,39	1.82	7606,87	1.94	4026,06	3.35	4425,69
2001	0.91	6194,16	1.80	8059,16	2.07	4398,72	3.32	4621,37
2002	0.99	7219,13	1.72	8001,68	2.14	4683,34	3.32	4765,56
2003	1.05	8220,75	1.76	8394,23	2.26	5046,63	3.44	5002,31
2004	1.06	8915,04	1.81	8890,43	2.26	5260,87	3.45	5249,11
2005	1.12	10178,47	1.79	9189,99	2.45	5967,83	3.48	5474,28
2006	1.20	11811,41	1.78	9615,84	2.47	6346,68	3.48	5764,38
2007	1.27	13369,67	1.71	9724,15	2.54	6909,06	3.48	6253,63
2008	1.35	14694,77	1.63	9712,89	2.67	7558,38	3.73	6887,41
Difference	0.44	8959,38	-0.19	2106,02	0.73	3532,32	0.38	2461,72

Source: Eurostat

From this data we can see that the strongest growing market in relative terms is the Austrian market. The Austrian government has set themselves the goal of attaining the Lisbon target of 3% R&D expenditure in 2010 which has led to steady increases in R&D expenditure during previous years. The increases in Austria total additional expenditures of approximately 0.73% or €3.5 billion in 2008 with respect to 2000.

Most surprising is the apparent lack of R&D investment in the Netherlands. As indicated the Dutch government ascribes this lack to the nature of the Dutch economy, which is not suitable for large R&D investments (Rijksbegroting.nl).

We also see small growth in both Finland and Spain. In the Finnish case this might be expected due to the already high levels of investment. Finland is the only country to have fulfilled and exceed the Lisbon target. In the Spanish case we see that the investments are steadily increasing

albeit at a low rate. However, due to the large size of the Spanish market absolute growth has been the biggest of the four countries, spending more than €8.9 billion in 2008 with respect to 2000.

When we compare the figures above with the number of competitors we see a different picture. Assuming that the high levels of competition we saw in the Dutch market and a relative decrease in spending we would expect the number of enterprises to follow these trends and stabilize or even decrease. When looking at table 2, we see that this is not the case.

To measure the increase in the number of competitors we will look at enterprises only. We do this as universities and PROs are a very stable group that is not likely to change irrespective of market fluctuations. Again using the enterprises registered in NACE code 73 Research and Development, we will measure the number of competitors and change therein.

Table 8: Number of enterprises in NACE 73 per country

	Spain	Netherlands	Austria	Finland
2000	3191	1720	100	239
2001	2694	1525	220	270
2002	2129	1705	515	298
2003	1936	1835	477	305
2004	1531	1985	487	325
2005	1325	2115	572	338
2006	1501	2350	503	357
2007	1444	2045	559	393
Difference	-1747	325	459	154

Source: Eurostat

From this table we see that in the Netherlands, although their small market size and decreasing R&D expenditures, the number of enterprises has increased significantly. Furthermore, the Netherlands has the highest number of organizations registered within NACE 73. Like in the Netherlands the industry in Austria has also grown significantly. This thus reflects the large investments in R&D. The Finnish case is best described by moderate growth, both in monetary terms as well as in the number of actors. Spain on the other hand has seen a strong decrease in enterprises; between 2000-2008 1747 enterprises have disappeared from this industry.

When we look at the number of actors in relation to the expenditure in the industry we see the effect of change in funding and organizations. It is important to note that in these cases much of the expenditures on research happens within organizations, i.e. service companies are not involved. This means that the actual size of the R&D outsourcing market in the respective countries is smaller.

Table 9: Number of enterprises per billion euros spent on R&D

	Spain	Netherlands	Austria	Finland
2000	556	226	25	54
2001	435	189	50	58
2002	295	213	110	63
2003	236	219	95	61
2004	172	223	93	62
2005	130	230	96	62
2006	127	244	79	62
2007	108	210	81	63
Difference	-452	-16	56	9

Source: Eurostat

Here we again see that the Dutch market is most saturated and the Finnish is least saturated. We also see that besides the Spanish market the situation the other countries are relatively stable. What is most surprising is the improvement of the Dutch situation; due to the growth in the number of enterprises and the relative decrease in spending we expected that market saturation would increase, however the opposite is true. The effect we thus see here is that the strong growth in GDP of the four countries has absorbed the changes in the number of competitors in the Netherlands, Austria and Finland. In Spain the growth of GDP has only increased the effect of a decreasing number of competitors.

We thus see that the markets seem to be attractive to new entrants; not only are the investments in R&D steadily growing in absolute terms, an increasing number of enterprises is already entering the market without upsetting the system. Furthermore, we expect that R&D investments will grow in the future as more and more countries and companies are realising the importance of investing in the development of new knowledge to gain a competitive advantage.

The second aspect of industry attractiveness is the barriers to entry that new entrants have to face. We assess the capital requirements and the accessibility of new knowledge in the respective countries.

The value proposition of RTOs lies within the highly educated nature of the workforce. The work requires a highly skilled and knowledgeable workforce; this is reflected in the employee costs of the organizations (see table 10).

When comparing the costs for personnel we indeed see that they form a large part of organizational expenses within RTOs. In fact, within this sector they make up approximately half of the total costs that any given organization makes. It is thus an expensive sector for an organization to enter. Furthermore, it will be difficult for new organizations to expand the existing personnel base with a large number of highly skilled and highly educated employees.

Also when looking at wage adjusted labour productivity – a measure for the productivity across sectors and organizations – we generally see high productivity levels with the exception of Finland. This makes the Finnish market unattractive to enter as it indicates that the employees generally cost more than they produce on an annual basis. In the other countries, especially in Spain, we see good productivity levels and employees whose work is worth more than they cost.

Besides personnel costs we also need to take investments in tangible goods into account. Table 12 shows the investments in tangible goods of organizations in NACE 73 in the four countries.

Table 10: Personnel costs as a percentage of the total sector productivity

	Spain	Netherlands	Austria	Finland	4 country average
2003	54 %	49 %	50 %	48 %	50.3 %
2004	60 %	50 %	48 %	47 %	51.3 %
2006	50 %	45 %	79 %	49 %	55.3 %

Source: Eurostat

Table 11: Wage adjusted labour productivity

	Spain	Netherlands	Austria	Finland
2003	111.2 %	118.8 %	118.8 %	84.8 %
2004	109.9 %	110.3 %	111.1 %	94.0 %
2006	127.5 %	116.9 %	98.8 %	83.1 %
Average	116.2 %	115.3 %	109.6 %	87.3 %

Source: Eurostat

Table 12: Investments in tangible goods

	Spain	Netherlands	Austria	Finland
2003	25 %	5 %	20 %	8 %
2004	18 %	4 %	19 %	4 %
2006	-	-	-	-

Source: Eurostat

Here we see clear differences between the countries. The Dutch and Finnish economies are more service oriented than the Austrian and Spanish. This results in higher investments for the latter two. These investments will concern the necessary equipment for research. This also means that the overall investment costs in Spain and Austria are higher than in the Netherlands and Finland.

Finally we will look at the accessibility of newly produced knowledge in the four countries. We will do so by assessing the patenting behaviour, the number of scientific publications and the patenting behaviour at universities.

We see in assessing the patent applications per year for the four countries that the Dutch system is far more active in this respect than the others. This indicates a more closed system of knowledge development than those of the other countries. This could be due to the service oriented nature of the economy as developments can not protected to a high level through integrating the developed knowledge in technological hardware or through secrecy.

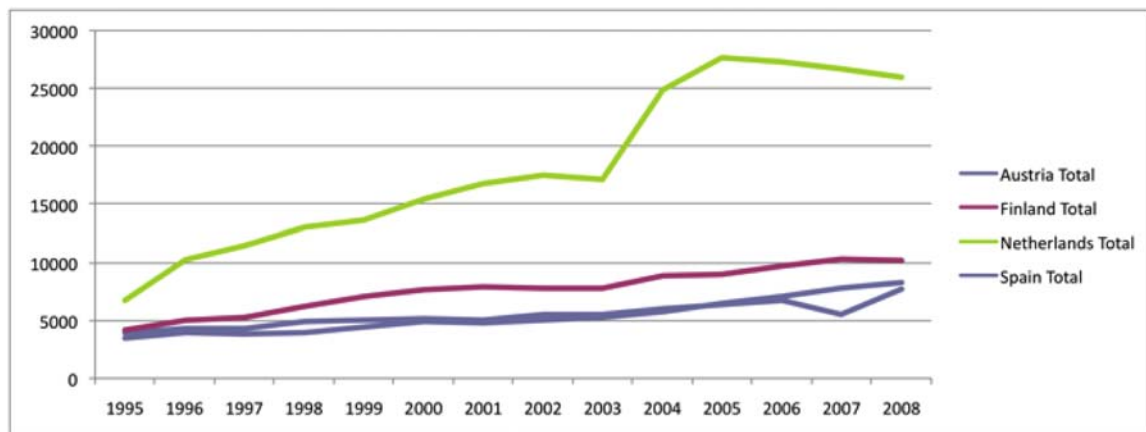


Figure 5: Patent applications per country

Source: WIPO

Table 13: Patent applications per owner type

	Spain	Netherlands	Austria	Finland
Business	53.97 %	90.36 %	77.63 %	93.33 %
Individual	22.73 %	2.77 %	18.49 %	3.87 %
University	14.72 %	2.40 %	3.88 %	0.93 %
Government/Research	8.59 %	4.47 %	0.00 %	1.86 %

Source: WIPO

When assessing the data further we also see that the majority of the patent applications come from business. Spain has the lowest business percentage of patent applications and simultaneously the highest level of university patents. This in combination with the number of scientific articles published in the countries indicates relatively inaccessible knowledge system in Spain. The Dutch and Finnish universities seem to take a more open approach to knowledge production as they publish significantly more papers than they pursue patents.

It has to be noted that the knowledge development in Spain will be substantially bigger than the other countries when we consider output in absolute terms.

Table 14: University output

	University patent applications per million	Scientific articles per million population
Spain	4.36	36.22
Netherlands	6.31	72.96
Austria	4.55	47.55
Finland	3.55	78.64

Source: Eurostat

The standard measure for R&D investments as a percentage of GDP gives a skewed view of the levels and change in R&D growth and indicate that there is little growth in all countries. However, the growth of GDP it self in the respective countries means that R&D investments in absolute terms have grown significantly in the past decade. In the case of the Netherlands – the slowest growing market of the four – we still witness an increase in R&D investments of over €2 billion. This thus indicates strong market growth thus making it an interesting market for new entrants. This is especially the case as we witness relatively little growth of the number of actors in the industry. This indicates that the market saturation is decreasing, making room for possible new entrants. Similarly to the Dutch market, we see that all markets have undergone substantial growth in the past decade, also making those markets attractive form a financial perspective.

However, on the other hand, the barriers to entry make it a less attractive market to enter. The value proposition in the market is based on the development of new knowledge, which requires highly educated and skilled personnel and depending on the market one caters for, high investments in materials and equipment. This is reflected by the data, which shows that more than half of the expenses in the average company are personnel costs.

Further, the access to knowledge is an important factor in this respect. We look at the knowledge output in the countries and especially at the university systems to assess this. This shows us that the Dutch and Finnish systems are the most accessible as they have the tendency to publish papers rather than obtain patents and close off access to the developed knowledge. The Spanish system of new knowledge is relatively the most closed of the four with high levels of university patenting and relatively low levels of scientific papers being published. This market also has the most formalised system of TTOs and protecting university developed knowledge to ensure returns on investment for the universities.

Furthermore, the public funding that RTOs receive allows them to perform market independent research to develop knowledge and their product portfolio at the same time. Even though the figures do not indicate that RTOs perform much basic research this is a critical advantage for them that protects both their position and the market from new entrants.

On the whole we can say that the Dutch and the Finnish case would be most accessible in this respect. However, the markets have gown the most in Spain and Austria and both are most likely to continue this growth. On the whole we can say that this means that the monetary returns are not in line with the size of the barriers in the respective countries.

Threat of substitute products

In Porter’s model the threat of substitute products impedes the return rates that organizations can attain on their products. In this instance return rates are less important than the RTOs’ ability to interact with a large group of actors in the NIS.

The threat of substitute products is measured through the imitability of products and the price performance relative to the substitutes. These factors impede the levels market penetration that the RTOs have within the NIS as market shares will be divided and resource poor organizations will not be reached. With respect to their role and mission this means that they will not be able to efficiently diffuse knowledge throughout the NIS. Thus – especially with respect to the cost aspect of the substitutes – this means that the RTOs are less able to perform the social aspect of their role, helping the laggards and SMEs in their attempts to stay competitive. Furthermore, the threat of substitutes will lead to the commercialization of RTOs, further threatening their ability to perform the social aspect of their roles, as it will lead them away from the resource poor organizations in the NIS.

Imitability and product standardization: Standardized products are easier to imitate which leads to many options. This leads to price becoming the dominating selection factor for the service needed. This also will impede the “reach” that the RTOs have within the system.

Price performance: If the RTOs are too expensive they will not reach the most vulnerable (i.e. laggards and SMEs) in the system, this impedes their ability to perform their role.

Firstly we need to note that during the research it has become evident that the intended indicators for measuring imitability and price performance have been very difficult to attain from the organizations. This is due to a reorganization in the case of Tecnia, and the general unavailability of the data in the other cases. For the sake of completeness and illustration of the effects of the selected indicators they have both been discussed up to this point. We will also note on them further in the discussion and conclusion as they remain to play an essential part in the performance of the RTOs.

The available data shows us that the organizations have a very low level of product standardization. This means that the solutions offered in contracts with third parties are in almost all cases unique, either in knowledge or in solution.

Table 15: Primary contract activities

Activities	
Tecnia	78% R&D&I* projects
TNO	80% of projects defined as R&D, unique or kernel**
Joanneum Research	96% of income is generated through research
VTT	n.a.***

* Spain defines design activities as research, hence R&D&I.
 ** R&D is defined as development of new knowledge; unique is defined as solving unique problems with unique knowledge; kernel is defined as solving new problems with modular knowledge.
 *** Figures on VTT activities are not available.

Source: Annual reports and internal sources

These high levels of unique problem solving means that the organizations are not only very difficult to imitate, they also indicate the high value of the work that the RTOs perform. It thus indicates that the customers aren’t in the position to internalize the research performed by the RTOs or solve the problems they face without external assistance.

Considering relative price performance of the organizations in question we have found that this is also very difficult data to attain. This seems to be information that is not well known within the organizations, mostly due to reorganizations. We thus need to assess the relative price performance using indirect indicators. As indicated universities form the most direct competition to RTOs. As such the most suitable source of information seems to be the universities' need for external funding through third party research. Assessing the percentage of government funding for the top 5 universities in each country we see that funding levels in Spain, Austria and Finland are quite similar. However, funding levels in the Netherlands are substantially lower than in the other countries (see table 15 below).

Table 16: Average levels of government funding at top 5 universities as percentage of total revenue in 2008.

	Average government funding
Spain	69.99%
Netherlands	59.13%
Austria	74.59%
Finland	71.66%

Source: University annual reports

We thus see that the necessity for universities to generate external funding from research is relatively low. In Finland 3 of the 5 assessed universities are even able to carry funds over from previous years, which indicate an excess of funds. In the Netherlands we see that there is more need to generate funds through third party research contracts so than in the other countries, as is reflected in the levels of third party income generated by Dutch universities. We also see that the universities sell research at sub market prices as generally do not make profits from licensing agreements and prefer to licence before patenting (OECD, 2009).

The data indicates that the work performed by RTOs is both difficult to imitate and in demand. On the other hand we also see that there is relatively little pressure for universities to attain high revenues from third sources, putting pressure on the position of the relative price performance of RTOs. This is especially reflected in the Dutch and Spanish situations where universities are actively pursuing interaction with industry through the valorisation of knowledge but fail to attain high rents. However, at this moment the situation does not indicate high pressures on the position of the RTOs either, although all interviewees expect budget cuts in the foreseeable future.

What needs to be taken into account is that the relatively protective position that the RTOs enjoy is used to reach the weak links in the NIS. This means that rents attained from contract research need to be distributed in a manner that organizations from all industries and sizes are able to attain the support and services from the RTOs. At the present time this is not sufficiently the case.

Inputs

As indicated earlier in this instance the inputs is a force that is less related to an organization's ability to control prices and design specifications of supplied parts and products, but more about a RTOs ability to fulfil the role that they are given. This then relates to the ability to access new knowledge developed within the respective NIS, attract talented and highly skilled personnel, and attain the proper levels of funding required too remain independent from industry.

We will thus look at four aspects that we believe summarize the supply side for RTOs; we will assess the levels of government funding, the IP strategies at universities, the quality of the university system, and the popularity of the RTOs among new graduates or the employed. This

will thus tell us the relative (in)dependence of the market, the quality of the personnel that they may attract, and the accessibility of new knowledge at universities.

To start with the funding of the RTOs; we assess the levels of basic government funding, goal oriented funding and funds gained from contract research. Basic funding is described as freely spendable funding from government, this can thus be freely spent as the RTO deems fit. Goal oriented funding is government money that has been given to the RTO to attain predefined targets set by government; commonly these funds are given to the RTOs by ministries who define the targets, these may be very specific or open to interpretation. Contract research is usually performed for industrial partners where the RTO functions as a service company. Table 16 shows the funding structure of the organizations for a three-year period.

Table 17: Funding structure of the four selected RTOs between 2007-2009

		Tecnia	TNO	Joanneum Research	VTT
Basic funding	2007	21%	4.5%	32,5%	33.0%
	2008	21%	4.5%	29.7%	30.4%
	2009	22%	4.9%	28.0%	31.6%
Goal oriented funding	2007	29%	29.3%	23.6%	23.2%
	2008	25%	28.0%	26.1%	25.0%
	2009	26%	30.3%	28.8%	26.7%
Contract research	2007	50%	44.4%	43.9%	29.8%
	2008	54%	45.4%	44.1%	29.8%
	2009	52%	42.2%	43.2%	28.3%

Source: Annual reports

In this table both TNO and VTT revenues do not add up to 100%. This is due to Tecnia and Joanneum Research who do not distinguish between national and international sources of revenue. TNO generates on average 22.3% of their revenue abroad whilst VTT reaches an average of 20.16%. These primarily come from EU sources.

The levels of government funding – the combination of basic and goal oriented funding – mean that the organizations (with the exception of TNO) receive between 45-60% of their total revenue from government sources. They are thus very heavily funded organizations. This allows them to be independent from industry in selecting directions of research, i.e. remain an independent organization. TNO stands out in this respect, although still a heavily funded organization receiving approximately 35% of their revenue from government, they are steered more than the other organizations by government as they are large shareholders and take part in strategic decision-making. On the other hand this also means that the organizations are an extension of government and policy makers as they decide the fate of the RTOs.

The table also shows that VTT is least exposed to market forces and should therefore have the highest level of autonomy from the market, this puts them in a good position to perform long-term risky research and counter sub investing by the industrial sector. They should thus be in the position to drive knowledge development and innovation irrespective of the market.

Thus government funding allows the RTOs to work independent of industry and follow self assigned paths in their research and in the services they offer. The other side of these high levels of support is that governments are in the position to control the RTOs and steer them in their direction and work.

Moving on towards the IP strategies at universities. We have already seen that in all four countries universities hold relatively small patent portfolios (see figure 6) (WIPO database). However, we do see change in this respect. Universities are increasingly trying to gain additional funds from the valorisation of their research through opening up their knowledge base to third parties, including RTOs (Annual reports; WIPO database).

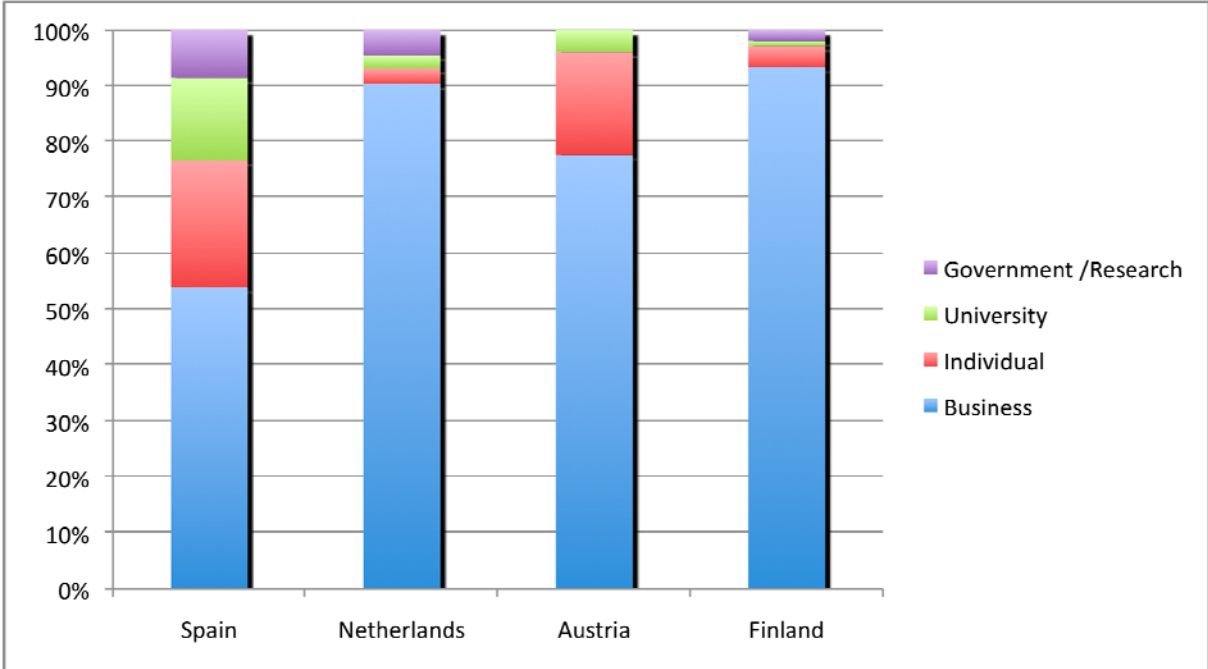


Figure 6: Patents by owner type. Source: WIPO

In Spain this effort is formalized through the development of a nation wide technology transfer office (TTO) network to assist universities in their steps to sell their knowledge. This means that Spanish universities hold the relatively largest percentage of patents among the four selected countries (see figure 6).

The Dutch system lacks a nation wide system as has been implemented in Spain. However, the Dutch universities seem to find their way to the industrial sector and all universities manage their own TTO. Although they hold relatively few patents, they are able to gain almost 25% of their revenue from third parties. This reflects two things; firstly that their knowledge is accessible and relevant and secondly that they actively pursue this source of income.

Looking at Austria we see that they are lacking government held patents but have a relatively large amount of individually held patents. This might be caused by the manner in which patents are applied for or due to local laws. Again we also see relatively few patents held by universities.

Note: These figures lead to an ambiguous conclusion, although the efforts at universities to valorize their knowledge can generally be seen as a positive development as it should help stimulate innovation within industry. On the other hand for RTOs it seems to be a bad thing at first glance as this makes the jobs for RTOs more difficult as competition with universities will increase. However, it can also be seen as an opportunity for the RTOs. Through formalizing their relationship and partnerships with the universities RTOs will be able better access this source of knowledge and skilled employees, whilst universities will be able to profit from the knowledge and skills in valorization of knowledge that the RTOs hold. Considering the right terms of agreement are put in place these developments could lead to a mutually beneficial situation that in the end will benefit industry and economy.

What also stands out is the lack of patents held by Finnish universities. This is also reflected in the revenue streams at the universities, which shows that Finnish universities gain the least from contract research.

As indicated the accessibility to the universities knowledgebase in the respective countries is an important factor to the input of RTOs. When assessing the level of interaction between RTOs and universities through their joint patenting activities we see that such activities are strongly lacking in all four nations. Through a search of the WIPO patent database we see that although the RTOs are patenting, this is rarely done in cooperation with national universities. TNO holds 10; 8 with Dutch universities and 2 with Belgian universities. VTT holds three patents that have been jointly applied for of which only 1 with a Finnish university. Both Tecnalia and Joanneum Research only hold one patent that has joint application with a university. Joanneum Research shares a patent with a Polish university, meaning that no Austrian university is involved in this respect. This low patenting activity does not indicate the total level of RTO-university activity, however it is the best measureable evidence of collaboration results.

The Finnish system stands out as, it has the lowest level of third party research income; yet they receive over €1.8 billion euros in funding of which 55% is provided by non-governmental organizations (ARITAKE-WILD, 2009). Industry is thus highly involved in the university system, however this is not formalized in the same manner as it is done in for instance Spain.

It is thus a relatively open system where the funding is not so much not project based as common practice. For RTOs this means that universities are a constant competitor and due to the manner in which university-industry interaction takes place one that is difficult to compete with.

The next important criterion for assessing is the quality of the respective higher education systems. This will be used as a proxy for both the quality of the research performed within the system as well as the perceived quality of new graduates. To assess the quality of the system we look at three different and internationally recognized ranking systems that rate and rank universities worldwide. We will use the Leiden ranking, the Shanghai ranking and the Times Higher Education ranking. Through using three different rankings we are able to take into account bibliometric measures, size and formation as well as informed peer reviews of universities from around the world.

Table 18: Rankings of national universities

		World top 250 - Leiden ranking	World top 500 - Shanghai ranking	World top 200 - Times Higher Education
ES	Highest position	143	201	142
	Lowest position	226	490	155
	Number of universities listed	5	10	2
NLD	Highest position	60	50	114
	Lowest position	127	416	185
	Number of universities listed	10	12	10
AT	Highest position	189	195	187
	Lowest position	189	494	195
	Number of universities listed	1	7	2
FI	Highest position	92	72	102
	Lowest position	92	470	102
	Number of universities listed	1	6	1

Sources: Leiden ranking, 2007; Shanghai ranking, 2009; Times Higher Education ranking 2010

Here we see that the Dutch system contains the highest ranked universities. Furthermore, the Netherlands the most represented country in the rankings; considering the Netherlands only has 13 universities, these results are especially good.

What is also surprising is the lack of representation of Spanish universities. With a university system that counts over 60 universities this comes somewhat unexpected.

Austria and Finland have seemingly weak tertiary educational systems. They are poorly represented among the top universities in the Leiden and Times Higher Education rankings. In both these rankings a single university represents the countries. They do better in the Shanghai ranking where respectively Austria and Finland are represented by 7 and 6 universities. This puts the countries at the bottom of selected cases.

These rankings contradict the general consensus of the educational systems; especially in the Finnish case, which is known for its high levels of doctorate students. Table 18 shows us the levels of masters and doctorate students in science and technology fields. This clearly shows us that Finland is on top in this instance with 2.55% of the population between 20-29 years old graduating with advanced research qualifications. We also see the lack of science and engineering students in the Netherlands. This has been a long-term problem for the Netherlands, however concerning the strong service oriented economy. We thus generally see that although Spain, Austria and Finland lack internationally high scoring universities, they do see significant levels of highly qualified students graduate in science and technology disciplines. This will make it easier for the RTOs to recruit new employees for both research and consulting services, although judging from the rankings the quality of the new graduates will be lower.

Leiden ranking: the ranking system is fully based on bibliometric data and covers universities with 700+ publications. In this case their size independent indicator based on citations is used.

Shanghai ranking: ranking based on Nobel prizes, number of frequently cited researches, articles in Nature and Science,

Times Higher Education ranking: Peer review by 2500 academic researchers, citation scores, staff to student ratios, international orientation and employer opinion.

Table 19: ISCED levels 5 and 6 students in science and technology fields as % of the population aged 20-29

	Spain	Netherlands	Austria	Finland
2000	1.00%	0.60%	0.74%	1.62%
2001	1.13%	0.64%	0.75%	1.74%
2002	1.19%	0.68%	0.83%	1.76%
2003	1.26%	0.73%	0.84%	1.75%
2004	1.25%	0.79%	0.90%	1.82%
2005	1.19%	0.87%	0.99%	1.84%
2006	1.19%	0.91%	1.10%	1.82%
2007	1.17%	0.90%	1.12%	1.97%
2008	1.22%	0.89%	1.19%	2.55%

Source: Eurostat

So although new graduates are clearly available the RTOs also need to be in the position to attract talented graduates from this pool. We have thus looked at the popularity of the respective organizations among graduates. Earlier research has performed thorough research among new graduates across a broad scope of disciplines to find the most favourable organizations to work for in the respective countries. These results have shown that both TNO⁵ and VTT⁶ are very desirable organizations to work for (see Annex B and D). Tecnalia and Joanneum Research did not reach the top 50 employers in their countries. Both in Spain and in Austria knowledge intensive services make up the top of the rankings, yet they primarily consist of financial and management oriented services.

Overall we can say that all for organizations receive sufficient amounts of funding to ensure that their research orientation will not suffer the consequences of dominant industrial players or government. Further we see that the Dutch higher education system is highly ranked at an international level and that both the Finnish and Austrian systems are lacking most in this respect. We also see that, with the exception of the Spanish higher education system, the educational systems are relatively open and accessible. The data also suggests that the Finnish educational system produces a large number of highly educated people, which puts VTT in a good position to perform high-level research and deliver high quality services. Spain and Austria show very similar results here, although RTOs seem to be a less attractive choice for recent graduates than in the Netherlands and Finland. In this respect the Dutch system stands out negatively due to a relatively low number of science and engineering graduates with advanced research degrees.

In all cases – but especially in the Dutch and the Austrian system – there are opportunities for extended collaboration between universities and RTOs that will be mutually beneficial. These will eventually be beneficial to the economy as a whole. The Finnish system is different in this respect due to the manner in which they interact with industry. Thus, although the university systems are increasingly competing with RTOs for resources from industry there are also opportunities that will satisfy the needs of groups and benefit the economy as a whole.

Power of buyers

The power of buyers is generally seen as a force that impedes an organization's ability to attain high rents. Thus; the stronger the buyer, the better their ability to demand discounts and product specifications. Buyers attain a powerful position when they represent a significant proportion of organization's sales or total customer group.

In the case of an RTO assessing the customer group represents something more important than the organization's ability to attain high rents. Considering their role it is of the utmost importance that RTOs have a large reach. Ideally – with combinations of knowledge in mind – the customer group is also diverse in industry and orientation (orientation = e.g. government, private, etc.).

To assess these aspects for the four selected cases we will look at the customer group size, the composition of the customer groups, the turnover of the respective customer groups and all other relevant data that might be accessed. It has to be noted here this type of data is difficult to attain with secrecy and strategy development in mind.

Table 20 shows the size of the respective customer groups for the RTOs. This shows us that the RTOs have very substantial customer groups.

⁵ See Universum Group website for ranking of [Dutch](#) companies

⁶ See Universum Group website for ranking of [Finnish](#) companies

Table 20: Size of customer groups

	Tecnia	TNO	Joanneum Research	VTT
2007	3235			6500
2008	3800			5730
2009	4059	4160		5700

Source: Annual reports

Besides having substantial customer bases we thus need to look at the distribution of these clients across distinguishable categories. Due to limited access into the customer data at the selected cases we use relatively coarse indicators.

Due to poor accessibility of customer data for outsiders we will move away from previously selected indicators and assess one that is available for all four organizations. The cases where data is available we will use these for the generation of additional insights. We will assess the number of industries in which the RTOs are active. In combination with the funding sources this will generate a good insight into the customer base and the configuration thereof.

From assessing the company structure as a proxy for concise customer data we see that the organizations have similar structures. The companies group their business units or markets according to sector or science base dominating the group.

Table 21: Function based core groups and the sub categories or markets per RTO

	Core groups	Markets
Tecnia	7	19
TNO	5	25
Joanneum Research	5	25
VTT	8	39

Source: Annual reports and websites

Table 22: RTOs and key fields activity

	Tecnia	TNO	JR	VTT
Aeronautics and space				
Building and construction				
Business development, innovation and policy research				
Defence				
Energy and climate				
Environment and marine				
Food and agriculture				
Health and quality of life				
ICT and telecom				
Industrial production, systems and development				
Materials				
Micro- and nanotechnologies and electronics				
Safety and security				
Transport and mobility				

From the tables above we see that the organizations have a similar distribution and a similar number of business units. This means that the organizations have a good distribution across the various local industries and markets. This will allow them not only to mitigate the risk of buyer power; it also allows the RTOs to combine sources of knowledge. Through the wide spread market activities the RTOs develop a broad knowledge base that allows for the formation of novel combinations of knowledge. Furthermore, this distribution in combination with the large customer base allows the RTOs to efficiently diffuse their knowledge and services across the NIS. It makes them a central actor in the system and thus underlines their importance within the NIS.

Not only markets are an important indicator in this instance, the type of customer is also important in assessing the position of the RTOs. The exposure of the RTO to market-based customers also indicates the level of involvement and penetration that the RTOs can attain. We will assess the distribution of the revenue according to major customer groups; private domestic, public and international sources.

Table 23: Tecnia’s revenue sources as percentage of total annual revenue for 2009

Type	Size
Projects under contract	52%
Competitive public	26%
Non-competitive funding	22%

Source: Annual reports

Tecnia attains the highest levels of industry contracts as they make up approximately 52% of the total annual revenue in 2009. This means that they hold a strong industrial focus and are able to be relevant to industry. This increases their involvement in the industrial developments and also their level of industry penetration.

Table 24: TNO’s revenue sources as percentage of total annual revenue

	2006	2007	2008	2009
Private domestic	45	42	42	38
Public domestic	24	23	25	27
Abroad	31	35	33	35

Source: Annual reports

Within TNO 75% of the contracts are filled within one 'kern gebied'. Although this 'kern gebied' consists of several business units, this might have implications for the interaction across the various specialities and the ability to form novel combinations of knowledge. On the other hand the figures in table 24 also show that almost half of the activities are with private domestic organizations, showing a good level of market alignment and penetration. Furthermore, the high levels of international activities, although primarily EU sources, show that TNO’s work is relevant within and outside of the Netherlands.

Table 25: Joanneum Research’s revenue sources as percentage of total annual revenue

	2006/7	2007/8	2008/9
Private domestic	33	31	30
Public domestic	44	47	51
Abroad	23	22	19

Source: Annual reports

In the case of Joanneum Research we see that they are strongly public domestic oriented where they attain most of their contract revenue. This also means that involvement with industry is lower.

Table 26: VTT's revenue sources as percentage of total annual revenue

	2005	2006	2007	2008	2009
Private domestic	30%	29%	30%	30%	28%
Public domestic	13%	14%	25%	27%	26%
Abroad	21%	23%	23%	15%	14%
Basic funding	35%	35%	33%	30%	31%

Source: Annual reports

VTT's customer groups from the domestic private sector are spread out over several customer segments based on industries. These show a good spread with more than half of the groups (6 out of 10) that are evenly sized. International funds primarily come from EU projects.

We see that the construction of the revenue differs across the organizations. This shows that TecNALIA holds the strongest focus on local industry and Joanneum Research has the strongest public focus. We also see that the all four organizations are relatively well represented abroad, although they primarily focus on EU funded projects rather than working with international privately held organizations. The relatively even spread across the various major customer groups allows the organizations relative independence from customers and as such puts them in the position to steer their developments in self selected directions.

TNO customer segmentation

TNO is the only organization for which detailed customer data was accessible. These figures (see table 27) show the size of the various customer groups according to revenue. This shows a common image (REF to lit) of large companies dominating the revenue stream rather than SMEs. Also the ability to reach SMEs through branch organizations seems to be difficult for TNO. These figures thus show a mismatch with the given mission statement in which SMEs play a large role. This is especially noteworthy considering that SMEs form the most innovative group in the Dutch economy.

Table 27: TNO customer segmentation according to revenue for 2008

Type	Size
Foreign companies	15%
Large companies	12%
SMEs	5%
Branche organizations	1%
NGOs	1%
Small advise	1%
Knowledge infrastructure	19%
Governmental organizations	16%
Government funding	37%
TNO	2%

Source: Internal source

The figures also show that TNO is quite far in attaining an international foothold with foreign companies. This is beneficial for the Dutch economy as TNO can track and attain internationally relevant knowledge from foreign economies. However, within RTOs and governments alike the international presence of RTOs is discussed at length due to the large financial investments made by national governments and the spending of these funds to perform internationally

oriented research. Governments are afraid that their investments will yield insufficient returns for the national economy if RTOs get a too strong international focus.

Analysis

The Porter analysis has shown several interesting results for the four cases. In the first instance it of course shows where the threats and opportunities lie for the RTOs. Here the four cases will be discussed independently and the threats and opportunities will be shown schematically.

The following overviews depict the five forces and corresponding the level of threat that comes from them. These levels are given in the form of pluses and minuses ranging from ++ for high levels of threat or competition to – for forces that form very little threat, i.e. that would be areas of opportunity.

Tecnalia

Competitive rivalry

There are relatively many competitors at the national level, however, considering the size of the country the market isn't very saturated. Its important to mention that there is very regionalised system in Spain where in the case of Tecnalia this system gives them some protection from the forces that are at play on the national level. The Basque country is one of the most prosperous regions of Spain. This also means that the investment levels in the region are relatively high. This, in combination with relatively few direct competitors in the region means that Tecnalia enjoys a relatively protected position. The other side of the situation is that the Basque market is of course limited in opportunities and Tecnalia, which means that they need to venture out side into Europe and the rest of Spain.

What is an important factor in the Spanish landscape is the highly organised and active Spanish university system that strives to maximize the income from research performed.

Threat of new entrants

The market in Spain has shown good growth, not only as a percentage of GDP but especially considering investments in absolute terms. In absolute terms (€) Spain has shown the biggest growth. The number of competitors in Spain are also strongly decreasing. Why there is such a large decline in the number of competitors is not clear. Following these statistics we can say that the growing market and relatively few competitors make the Spanish climate quite suitable for new entrants. Although, with so many competitors falling away one has to ask himself the question, why?

Further the Spanish research market is characterized by the relatively strong investment climate where some 25% of turnover was invested in tangible goods in 2003. Finally, as mentioned, the closed knowledge system at universities who actively pursue returns from their knowledge forms a barrier to new entrants.

Threat of substitutes

Tecnalia, like the other RTOs holds a very strong R&D oriented focus in their contract work. They do need to compete with the universities who are, as indicated, very active in this respect. This means that the levels of competition coming from the universities will only increase in the future. The threat of substitution will thus relatively high and is likely to increase.

Power of suppliers

Approximately a half of the funding that Tecnalia receives comes from government. The relatively high levels of government funding at Tecnalia mean that there is some power with government concerning their activities and the expenditure of funds. How the funding structure is built up between local government and national government is not clear, it is thus difficult to

say very much about Tecnia's position with respect to either of them. There is however, a strong movement within Tecnia towards generating funds from research. This will move the power away from government.

As indicated the knowledge system is rather closed. Universities are pursuing income from knowledge and correspondingly they have the lowest level of publications of all four countries.

Power of buyers

Tecnia has a large customer group and it is continuously growing. This is part of their pursuit to increase their contract research. This pursuit takes has lead them to also move towards international customers. They have their customers spread across a variety of markets, however, they have the smallest spread of the four cases.

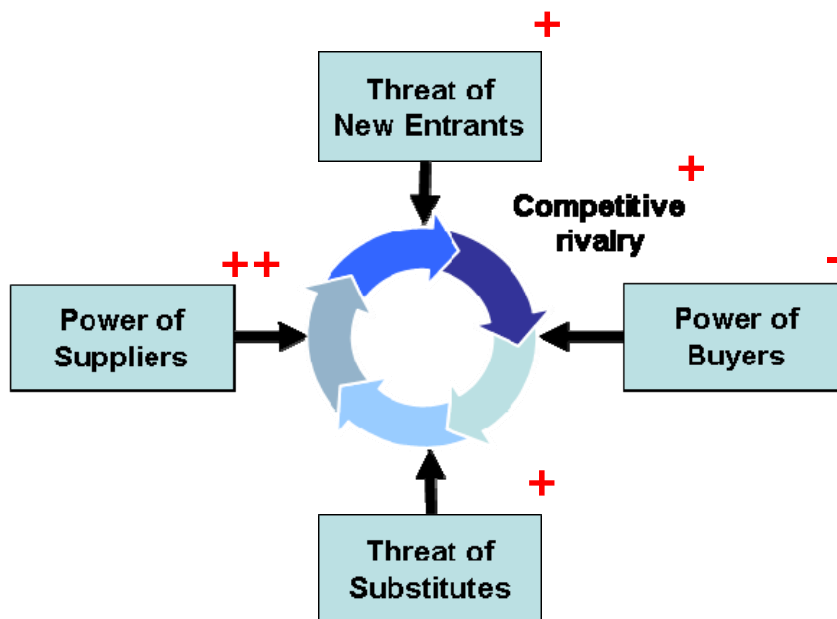


Figure 7: Porters five forces as applicable for Tecnia.

TNO

Competitive rivalry

For TNO we have seen that the competitive rivalry in the national context is high. They're local market has the lowest levels of R&D expenditure and relatively the largest number of competitors. This means that market saturation in their case is the highest of all four cases. This competitive situation in the national market is reflected in TNO's strong international presence.

Further we've seen that TNO receives very little in basic funding from government. This means that they are open to market forces and the competition that comes with the market. However, we've also seen that TNO performs a lot of contract work for government and governmental organizations.

Threat of new entrants

From the data we can see that the threat of new entrants in TNO's case is low. As shown, the competitiveness of the market is high and with the market size not growing relative to the national GDP it is likely to become even higher. This makes the market unattractive to outsiders.

Furthermore, the relatively high levels of patenting indicate a closed and protective market where businesses attempt to gain rents from developed knowledge. This again indicates that the market is unattractive to new entrants.

Threat of substitutes

Although a high percentage of TNO’s contracts are unique problem solving activities, they also have a strong and active university system that they need to compete with. Furthermore, even though the universities are highly financed by the government they strive to maximize their third party income. They also do this at submarket prices, which put them at an advantageous market position with respect to TNO.

This situation means their position as a key player in their knowledge production and diffusion role is threatened by the higher education system in the Netherlands.

Power of suppliers

The case of TNO is a difficult one, although they receive very little in basic funding from government they are still strongly regulated and steered by government. This means that the power at government sources is relatively strong.

As indicated the knowledge system in the Netherlands is quite closed, however, most patenting is done by businesses whereas universities primarily publish their work. Netherlands also ranks highest in the number of publications per million inhabitants, this means that new knowledge should be readily available.

Power of buyers

Looking at the customer side of things we see a different picture. TNO has both a large and well-distributed customer base with a strong international presence. They thus hold a strong position with respect to their buyers.

However, government and governmental organizations form a large part of their income, some 53%, which puts them in a strong bargaining position.

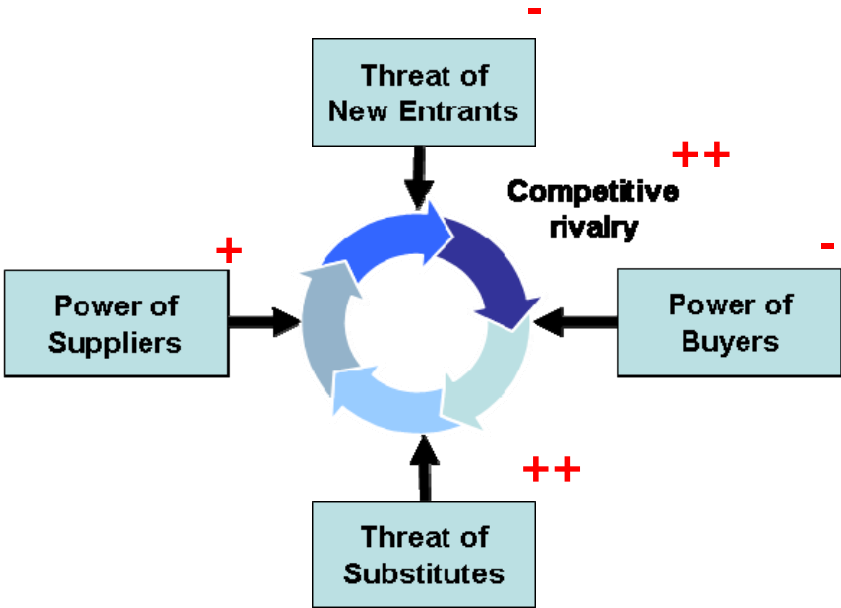


Figure 8: Porters five forces as applicable for TNO.

Joanneum Research

Competitive rivalry

The operating environment in which Joanneum Research finds them selves is characterised by strong growth. The Austrian government has decided to perform a last ditch effort to increase R&D expenditure and attain the Lisbon target. This has lead to the growth on that the Austrian market has seen.

Besides the growth of investments in Austria as a whole, the region of Styria has also grown significantly. In fact, the region of Styria has seen the biggest growth in the country. This is partly due to several big clusters in the region. This means that although investment levels are high, competition is also strong. Joanneum Research thus doesn't enjoy the same protected position that Tecnalia does.

Furthermore, universities in Austria are not very well represented in the patenting activities in the country. Looking at the above we can see that there is some competition but also enough room in the market for all competitors.

Threat of new entrants

As mentioned the market is steadily growing and is in fact the strongest growing market of the four cases. Furthermore, this growth is said to continue in the coming years. The growth in investments has also lead to a strong growth in the number of competitors. In fact, the number of competitors has increased 5 fold.

The research environment in Austria also has relatively high rates of investments in tangible goods and low levels of patenting, as might be expected. Besides the low levels of patenting we have also seen that the number of scientific publications is also not very large.

Overall we can say that the barriers to entry probably don't way up to the gains that the market promises. The threat of new entrants is thus seemingly high.

Threat of substitutes

Joanneum Research has the highest level of R&D activities when considering contract work; in fact some 96% of all contracts is characterized as such. Besides the low levels of patenting at universities, they also don't gain high levels of third party income.

This means that the threat of substitution is not very high as it currently stands so long as universities don't start to move into the market and pursue this third mission.

Power of suppliers

In the case of Joanneum Research high levels of funding and the fact that the Styrian government is officially owner of the organization says enough. Thus high levels of government control are present.

Although Austria has a relatively under represented higher education system, the system produces relatively high numbers of ISCED 5,6 students. This would indicate a good availability of highly educated personnel. However, whether Joanneum Research is in a strong position to attract the top students is difficult to say. It is primarily consulting companies who rank among the most popular companies to work for.

Looking at the output from the higher education system we see that both the number of patents and publications from the country's university system rank relatively high, this also indicates a good availability of new knowledge.

Power of buyers

From Joanneum no data was available concerning the size of the customer group. What we could see is that they have a good spread within their business units and the fields in which they operate. What stands out within Joanneum Research is the strong public domestic orientation. It seems that also in the future large social problems, primarily at the national level, will be the focus for the organization.

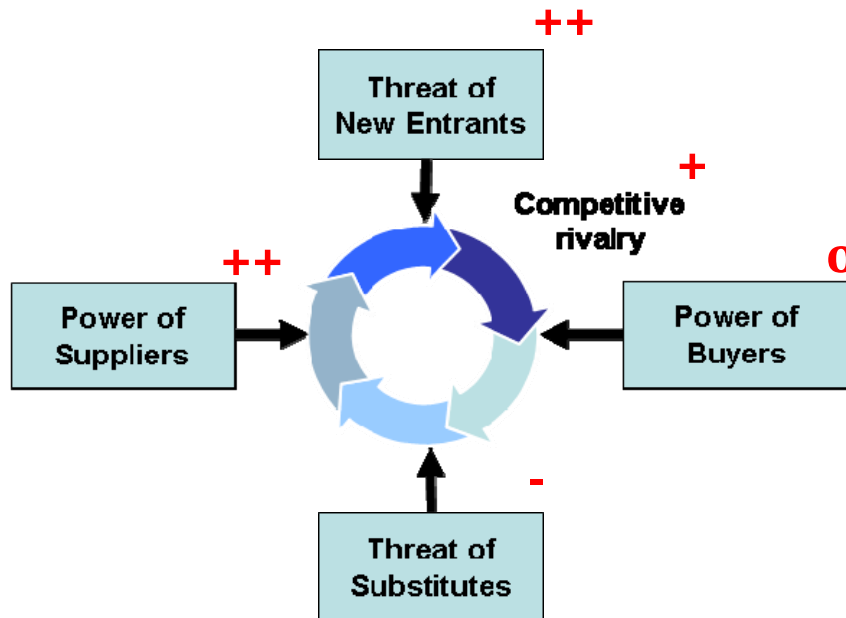


Figure 9: Porters five forces as applicable for Joanneum Research.

VTT

Competitive rivalry

VTT has relatively few competitors compared to the other cases that we've seen. Only 0,06 competitors exist per million euros spent on R&D. This is maybe somewhat unexpected since Finland is the only country to have attained and preceded the Lisbon agreement. There is thus a strong research orientation in the country.

VTT has the highest levels of government funding of all the assessed cases. Correspondingly Finnish universities have the lowest level of third party income. This puts VTT in a relatively protected position.

So although there is a strong research orientation in the country they don't have to deal with the competitive forces that, for example, TNO need to deal with.

Threat of new entrants

With the high levels of R&D investment that Finland has already attained not much growth is expected. However, investment growth is not far behind that of Spain, a country trying to catch up. This, in combination with the slow growth in the number of competitors would mean that the market conditions will increasingly become interesting for outsiders.

Investments in tangible goods are low but the data also shows that the wage adjusted labour productivity is low, this makes for a relatively easily accessible market. The primary barrier for new entrants will then be the level of patenting. With low investments in tangible goods the relatively high levels of patenting might be expected. Almost all patenting is done by businesses.

The Finnish market thus has a good research climate with high levels of investment and relatively few new competitors to compete with.

Threat of substitute products

VTT doesn't publish any data concerning their activities and as such we can't say much about the levels of research work vs. consultancy work. However, considering the activities of the other RTOs that we've discussed above we can say with some certainty that VTT will also primarily be concerned with research oriented projects. This would then of course say that the products are difficult to imitate.

The high levels of funding at universities and the apparent lack of industry – university interaction would also indicate that there is relatively little competition from universities or that is not considered standard practice to perform research activities in a partnership with universities. We have however seen that there is a strong climate of outsourcing research in Finland. This would thus indicate that there are other competitors and that there will be some form of substitutes for VTT.

This would thus indicate that the threat of substitution is present, albeit at relatively low levels.

Power of suppliers

With its high levels of funding government will surely have some say in the activities at VTT. On the other side we have also seen that the knowledge system in Finland is very open with relatively low levels of patenting and very high levels of publishing.

The Finnish university system is however somewhat under represented internationally. What stands out from the Finnish university system is the very high levels of ISCED 5, 6 students that the country has. These statistics, in combination with the knowledge that the organization is very popular among students means that they have a strong position in attaining qualified personnel.

So VTT has to accept that government has some control over the organization in return for the funding they receive. On the other hand the organization has a strong position in the country and has easy access to both knowledge and skilled employees.

Power of buyers

VTT has the largest customer group of the assess RTOs, which continues to grow. They also hold a very strong spread in the number and type of markets in which they operate. As indicated they do however receive a large proportion of their funding from government. Considering their customers they thus have a good spread among the group but they also generate a relatively large proportion of their income from international sources. The spread among the sources of their income is sufficient for buyers not to be a big threat to the organization.

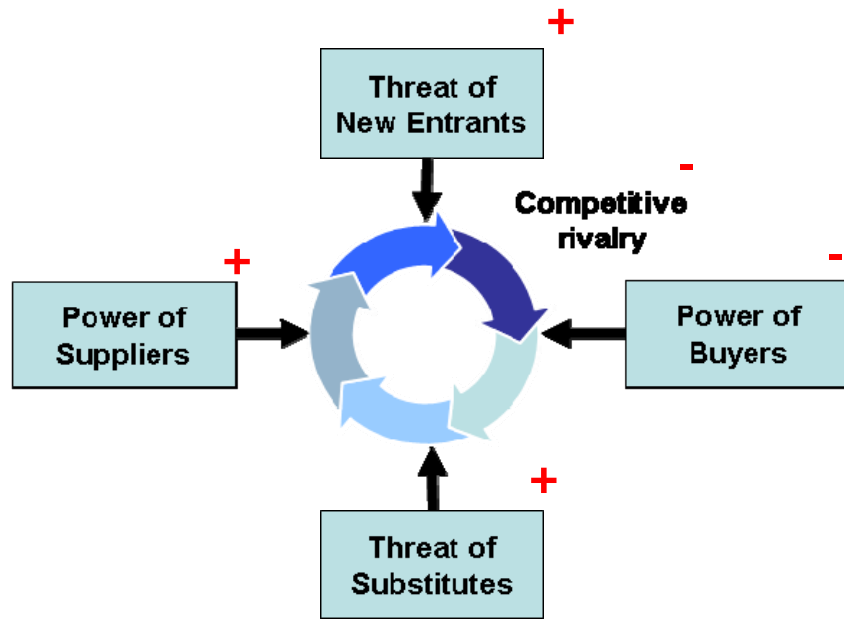


Figure 10: Porters five forces as applicable for VTT.

Discussion and Conclusion

In general we see that the markets have low contestability. Although the markets are growing and the number of competitors is relatively stable, the barriers to entry prevent new entrants to the markets. This means that market positions of the RTOs are relatively stable and increases in competition can only come from internal actors. This increase in competitive rivalry is the case as a result of two changes in the operating environment; 1 universities are increasingly pursuing additional incomes through the valorisation of their research and 2 the legitimization questions and global financial crisis are putting pressure on the government funding on which they rely.

The increasing university activity is best shown in the Spanish case. Here the process of knowledge valorisation between universities and industry is highly formalised and structured through active TTOs at all universities and a national advisory board to assist them. We also see that the high levels of funding for universities in all countries means that there is no pressure to attain high rents from these efforts. This leads to the universities licensing knowledge at sub market prices and as such undermining the competitive position of the RTOs. Although the universities are in a better price position, the flexibility, level of integration with industry and multidisciplinary of the RTOs put them in a similarly advantageous position with respect to industry.

The subsidies that the RTOs receive from various government sources, is a two sided matter. It allows the RTOs to perform long term research and competence building but simultaneously locks the RTOs into a strictly national or regional role. These thus effectively block the RTOs from building an internationally competitive position and attain rents from and knowledge from international sources. With the growing internationalization of research this is a real concern for the RTOs. As of now, the attitude within the respective governments towards international spending of funds “land locks” the RTOs. Until governments recognise the benefits to the NIS from having an internationally leading RTO within their national boundaries, this will remain a problem.

From an innovation system perspective this can also be very advantageous as, internationally operating RTOs can assist in the assimilation of knowledge from outside the NIS into the NIS. As this will allow national organizations compete better at an international level and remain at the fore front of technological developments. However, if the international spending of national funds remains problematic for governments, the RTOs can solve this through commercializing their activities. Although this solves part of the problem, it will not be as beneficial to the knowledge flows between various NIS'. It will, however, help the RTOs to strengthen their position within the market.

From the research we can indicate that the future holds three different generic strategic routes. These possible routes are primarily dictated by the current position that the RTOs hold and the effect of the anticipated changes for them. As can be seen in both literature and the expectancies of the key people within the select organizations, changes in funding and globalization of research are the key trends that will most prominently affect the RTOs.

In general it is expected that the discussions concerning the legitimisation of the RTOs and the large sums of funding they receive will intensify and lead to decreased funding from government sources. Also, it is expected that the developing nations in the Far East and Latin America will increasingly play a crucial role in fulfilling the global appetite for new knowledge. As this shift in power gradually moves away from the western countries and becomes more equally distributed RTOs will need to adapt their role and position accordingly. It is here where the NIS can most benefit from an internationally operating RTO.

This leads to the aforementioned strategic routes:

1. increase legitimization through social involvement;
2. increase commercial orientation;
3. increase the role as system integrator between the three systems of the NIS.

It has to be mentioned that these strategic routes are not mutually exclusive. Of course large organizations can pursue multiple routes, whether they will be able to do this to the required standard or generate the required funds is another question.

For the first option, the social aspect of the RTOs' role needs to be emphasised. This can be achieved through a focus on grand challenges such as energy, environment and public health. The legitimization then needs to lead to the continuation of public funding from a variety of sources. This would also mean that the commercial focus and the level of industrial orientation is decreased and that the government supporting aspects of their role (i.e. policy guiding and implementation) is increased.

The second option, to increase commercialization, means that the RTOs will need to increasingly focus on the industrial system and align their research to the needs within their industry. Considering the internationalization of industrial activities this means that this strategic option also includes a strong international focus. In essence the RTOs will become hubs for international research networks and specialized knowledge centres that rely on the valorisation of knowledge to and for the industrial system of the NIS. This will thus also mean that the government supporting aspect of their current role will decrease and that the focus of their research efforts will be increasingly steered by industry demand. This is also a strategy that has worked well for British RTOs, after being privatised early on after which they have been commercialized and now have a strong industry focus.

The result of commercialization of RTO activities is that less long-term high risk research will be performed within the NIS. Thus the typical market failures stemming from risk avoidance will no longer, or at least to a lesser extent, be prevented by RTOs and government funded research on their part.

The third option, the focus on a system integrator role, requires a stronger focus on knowledge distribution rather than knowledge development. This means that there will be a greater focus on the distribution of knowledge across the systems within the NIS. In this instance additional value can be generated through the integration of international knowledge development into ones own NIS. The difficulty here will be remaining involved internationally; this will require investments, either through strategically funding research projects or through participating as a research partner. Funding will need to come from contract research and consulting services for all actors from all systems within the NIS.

The strong assets that the RTOs currently hold – namely flexibility, strong industry involvement, and multidisciplinary – allow the RTOs to continue to build their competencies and move towards a selected strategic path. It is however crucial to make this move early on as such changes typically take a lot of time and effort to realise.

So, considering the NIS, what do these strategies look like? It is evident that a choice for either of the strategies will lead to a shift in the RTO's position with respect to the systems in the NIS (see figure 1). Here we've established the intermediaries to operate between the industrial system, the education and research system, and the political system.

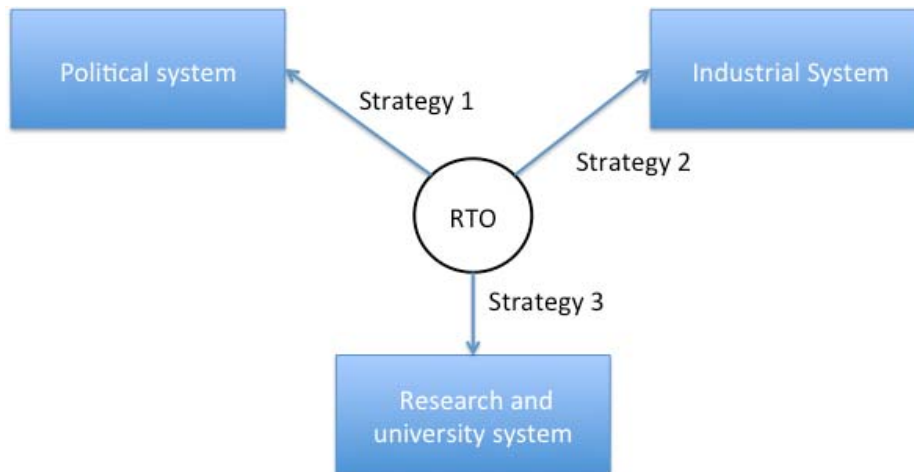


Figure 11: Visualization of the three strategies and the corresponding shifts in RTO position within the NIS.

Considering the five forces and the insights gained at the studied RTOs we can also visualize the position into which the RTOs are currently moving.

The strongest force Tecniaia currently needs to deal with is the power of suppliers, in this instance it is represented by the high levels of government funding and a relative lack of contract research income. Tecniaia is trying to change this by increasing their contract research income. This means a move towards a more commercial orientation, both locally and internationally. They are also expecting funding to decrease in the future and as we have seen the levels of competition with universities is only likely to increase. At the same time Tecniaia takes a prominent role in the development of the regional industries and grander social problems. They thus seem to pursue a dual role, a more commercial focus and simultaneously working on social problems. It has to be said that the international aspect is both paths plays a prominent role.

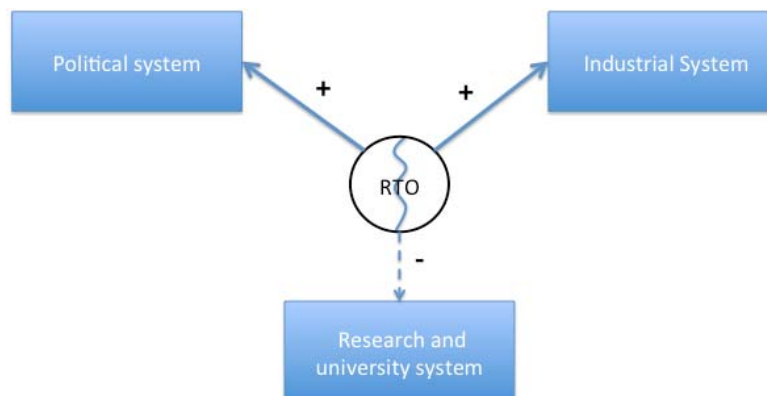


Figure 12: Expected direction of movement of Tecniaia in the NIS.

At TNO we see a similar trend. Of course levels of competitive rivalry are big, especially in the industrial sector as a commercial organization. However, TNO increasingly aims at the valorisation of developed knowledge and the generation of funds from these sources through a variety of methods. At TNO the position of consultant is also increasingly more prominent. This shows an orientation towards the industrial system.

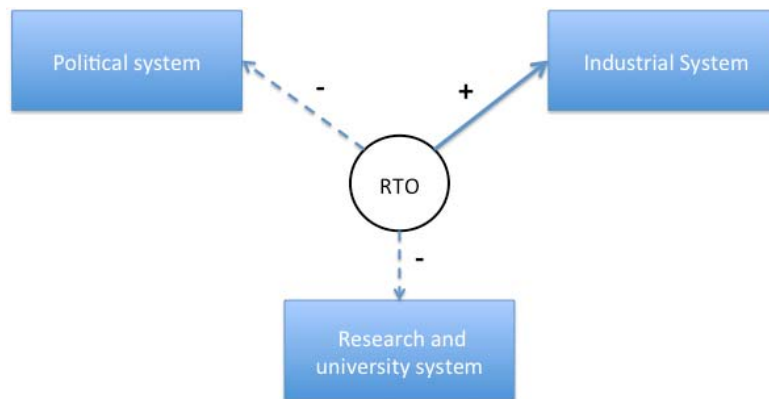


Figure 13: Expected direction of movement of TNO in the NIS.

At Joanneum Research the position is quite clear. Joanneum Research clearly states that they are a government-established organization and will continue to follow this path. This means they will primarily focus on grand social problems and supporting local industries. They will thus follow the political system and attempt to remain where they stand as much as possible.

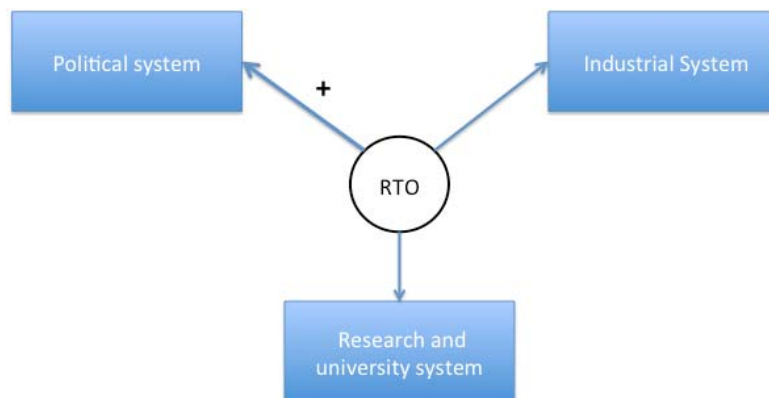


Figure 14: Expected direction of movement if Joanneum Research in the NIS.

VTT, like TNO, has a strong industrial focus. Among their strategic objectives is the establishment of more knowledge intensive joint ventures with industrial organizations. Beyond that they see a strong role laid out for them in the development of international networks to the benefit of national organizations. This thus means that they primarily see them selves as partners of industry and working for industry.

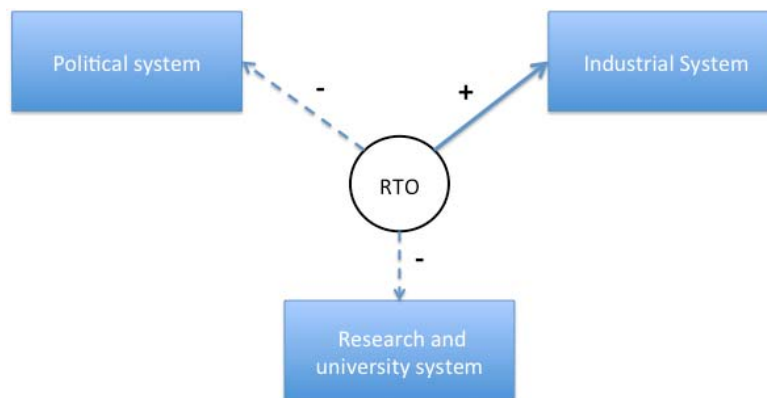


Figure 15: Expected direction of movement if VTT in the NIS.

What is important to note, and which has maybe been understated to this point, is that knowledge development in various forms remain the core competence at all RTOs. Whether they decide to do this on a contract basis and follow the developments in industry or work towards solutions to the social problems in name of governments does not change this.

It is also important to note that these strategies will mean that the current RTO as we know it will cease to exist. This will leave a large gap to fill, as there currently is no other organization with the same competencies and capabilities to perform an intermediary role to this standard and scale. Furthermore, these strategic paths will also affect the laggards and the resource poor in the NIS.

The gap that is left in the NIS' knowledge system will need to be filled as RTOs transform to remain relevant in a changing environment. To fill the gap in knowledge production system it seems that there will be a large role for universities and government research institutions, both nationally and internationally. The role of the RTOs in this respect changes significantly and moves away from the knowledge producer/intermediary to being a system integrator at an international level. This means working in close liaison with universities who will have to perform increasing amounts of applied research.

For RTOs the international aspect seems to be of critical importance as globalization results in the internationalization of research. For the RTOs and their industrial clients to remain up to date the RTOs will be required to integrate international developments into the national context. In cases where RTOs are not able to do so their customers will seek out international partners, meaning that RTOs will miss opportunities and lose customers.

These changes will lead to a more internationally dispersed and networked research area. Moving early will allow universities and RTOs to build strong networks that allow for the building of bridges to strong research areas and economies.

Governments will play a large role in the future developments of the RTOs and their activities within the NIS. Depending on their insights and goals they will adjust the allocation of funds for RTOs with impacts on the strategic options for the RTOs. From a NIS perspective this leads to two general directions for the roles that RTOs play in the knowledge system of the NIS;

1. The RTOs will perform a vital role in the dissemination of knowledge across the NIS;
2. The RTOs will perform a vital function in the development of new knowledge within the NIS through research.

In the first case RTOs will need to seek out new developments and internalize and disseminate them across the NIS, leaving the research to other actors. In the second instance this picture is reversed, RTOs will perform a lot of research and depend on other actors in the NIS to follow international developments.

Irrespective of the future role of RTOs within the NIS the alignment of government policies/goals and RTO strategies is essential to the continuing generation of added value within the NIS.

Furthermore, in general for countries to remain competitive at an international level governments and RTOs alike need to take heed of the internationalizing nature of research and technology and account for this trend in their strategies. The problem for RTOs lies in this case in the lack of insight within local governments who don't allow for international spending of national resources.

As indicated the alignment of mentalities between RTO management and governments will enable RTOs to take vital positions within international knowledge communities to the benefit of actors within the respective NIS. Furthermore, this will help the RTOs grow towards viable strategies that allow them to deliver added value in the future.

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Appendix

Appendix A: Tecnalia, Spain

Competitive rivalry	Threat of new entrants	Substitute products	Power of suppliers	Power of buyers
<p>Competitors</p> <p>Basque 1 major university 166 PROs, government owned 1444 enterprises, all with active TTOs tot. competitors comp./Gmtr. 0.1137130</p> <p>Competition of markets</p> <p>GERD 2008 1.35% of GDP GERD 08 € 14694.78 million GERD 2000-2008: +0.44%</p> <p>BERD 0.74% of GDP BERD 08 € 8654.915 million BERD 2000-2008: +0.25%</p> <p>Basic funding 2007 21% 2008 21% 2009 22%</p> <p>Goal oriented funding 2007 29% 2008 25% 2009 25%</p> <p>Contract R&D 2007 50% 2008 54% 2009 52%</p> <p>Sevilla 19.32 Madrid 12.62 Valencia 16.3 Barcelona 18.3 Average 16.385</p> <p>Spain has a strongly centralised and active network of TTOs at universities.</p> <p>In 2008 universities perform 63% of all basic research and also 27% of GERD (€3332 mtl) was spent at universities.</p> <p>The number of R&D companies has strongly decreased between 2006 and 2007, from 3151 to 1444.</p> <p>BERD is 51.4% of the GERD. Strong business investment culture. Means strong possibility to generate income from contract research.</p>	<p>Industry growth rate</p> <p>% GDP m€ 2001 0.91 6745.303 2002 0.99 7219.139 2003 1.05 8220.755 2004 1.06 8915.045 2005 1.12 9717.417 2006 1.2 10814.41 2007 1.27 13369.67 2008 1.35 14684.78 Difference 0.44 8995.384</p> <p>Year 2000 5191 556.3689 2001 2694 434.9251 2002 2129 294.9105 2003 1936 235.5015 2004 1942 247.2722 2005 1325 130.1767 2006 1501 127.0605 2007 1444 108.0056 Difference -1747</p> <p>Capital requirements As a percentage of the total sector productivity 2003 1.3% 2004 1.8% 2006 -</p> <p>4 country average Human cap. av 54.3% 2003 60% 2004 60% 2006 55.3%</p> <p>4 country average 5.2%</p> <p>IP strategy Country University 3.88 patents per million population Four country av. 36.66 9.14% of patents from unis. WIPO Tecnalia To attain more returns from licencing</p>	<p>Level of product standardization</p> <p>Deviation of projects Tecnalia Quality evaluation 78% Support services 8% 14%</p> <p>Relative price performance</p> <p>Sevilla 69.06% Madrid 68.80% Valencia 83.70% Barcelona 67.51% Granada</p> <p>Gov't fund. 69.06%</p>	<p>Levels of government funding</p> <p>Tecnalia</p> <p>Private Public HEI Foreign</p> <p>2005 46.3 2006 43 2007 4.1 2008 5.7 2009 7</p> <p>2006 42.5 2007 3.9 2008 5.9 2009 21% 2007 29% 2008 25% 2009 25%</p> <p>2007 2007 2008 2008 2009 2009</p> <p>2007 50% 2008 54% 2009 52%</p> <p>Storing movement towards commercialization of research (ReGOTRI).</p> <p>World top 500 Ranking World top 500 Shanghai ranking World top 200 Higher Education World top 200 Higher Education</p> <p>143 226 5 10 2</p> <p>201 490</p> <p>Source Source Source Source Source</p> <p>Popularity among new graduates</p> <p>Tecnalia is not mentioned in any list available on the internet as a popular place to work, at least not at a national level. Top marks go to services companies.</p>	<p>Size of customer group</p> <p>No. of customers 2007 3600 2008 3600 2009 4059</p> <p>Data not available</p> <p>Composition of customer group</p> <p>As percentage of turnover for 2009 Projects under contract 52% Competitive public 28% Non-competitive funding 22%</p> <p>Turnover from customer groups</p> <p>Information And Communication Technologies Industrial Systems and Processes Health and Quality of Life Sustainable Development Innovation and Competitiveness Transport and Mobility</p> <p>19 BUs divided across 7 industries.</p>

For original database look at excel file.

Appendix C: Joanneum Research, Austria

Competitive rivalry	Threat of new entrants	Substitute products	Power of suppliers	Power of buyers																																						
<p>Competitors: Data for 2008 or closest year</p> <p>Steiermarken 5 universities (1 medic, 1 art) 2 Fachhochschulen 17 Kompetenzzentren</p> <p>Nation wide 37 PROs, government owned 559 enterprises 54 universities 9 Fachhochschulen 10 private 46 Kompetenzzentren www.sfg.at</p> <p>tot. comp./GnH 68% comp./GnH 0.09785 em/comp 11.3831</p> <p>Comment Of the universities approx. 0.1% of all research is performed by the 22 public institutes.</p> <p>Consistency of markets GERD 2008 2.67% of GDP GERD 08 € 7558379 million GERD 2005-2008: +0.73% BERD 1.89% of GDP BERD 08 € 5322,005 million BERD 2005-2008: +0.44%</p> <p>Basic funding 2007 96% 2008 24% 2009 23%</p> <p>Goal oriented funding 2007 19% 2008 23% 2009 25%</p> <p>Contract R&D 2007 56% 2008 55% 2009 54%</p> <p>2009 Two yr av. KF Graz 19.7 TU Wien 17.46 Wien 11.53 3.86 TU Osnabrueck 3.59 TU Braunschweig 2.84 TU Dresden 2.04 TU Chemnitz 1.33 Average 14.084 12.31 13.137</p> <p>Comments Slovia is a strongly clustered economy that has been new products approx. 1/3 of all high tech products that come from Austria. Research companies have been involved from the get go. Source</p> <p>In 2007 23.8% of GERD (€1.637bn) was spent on research at universities. They form the backbone of basic research and the state expects them to increase interactions with companies.</p> <p>R&D is on the up and up, the number of companies active in the sector has increased from 559 in 2005 to 684 in 2007, from 100 to 559 enterprises.</p>	<p>Industry growth rate</p> <table border="1"> <tr> <th>% GDP</th> <th>m€</th> </tr> <tr> <td>2000</td> <td>1.94 4026.059</td> </tr> <tr> <td>2001</td> <td>2.14 4633.341</td> </tr> <tr> <td>2002</td> <td>2.14 4633.341</td> </tr> <tr> <td>2003</td> <td>2.26 5246.533</td> </tr> <tr> <td>2004</td> <td>2.26 5246.533</td> </tr> <tr> <td>2005</td> <td>2.45 5967.831</td> </tr> <tr> <td>2006</td> <td>2.47 5967.831</td> </tr> <tr> <td>2007</td> <td>2.67 5967.831</td> </tr> <tr> <td>2008</td> <td>2.67 5967.831</td> </tr> <tr> <td>Difference</td> <td>0.73 3532.32</td> </tr> </table> <p>Year Enterprise en/bn/m€ 2000 200 50.01456 2001 220 50.01456 2002 515 109.9642 2003 477 94.51847 2004 487 92.57027 2005 513 95.9422 2006 513 79.4422 2007 559 80.98827</p> <p>Capital requirements Tang. goods 2003 20% Human cap. 2004 15% 4 country average 2008 - 13% 50.3% 49.3% 75% 55.3%</p> <p>IP strategy Country 33.87 patents per million population Four country av. 36.66 47.55 scientific publications per mln pop. Four country average, 46.94 University Joanneum Research</p> <p>Comment High human capital costs in 2006 are due to a relatively very low total production in the sector in that year.</p>	% GDP	m€	2000	1.94 4026.059	2001	2.14 4633.341	2002	2.14 4633.341	2003	2.26 5246.533	2004	2.26 5246.533	2005	2.45 5967.831	2006	2.47 5967.831	2007	2.67 5967.831	2008	2.67 5967.831	Difference	0.73 3532.32	<p>Level of product standardization</p> <p>Research 2006/7 2007/8 2008/9 Licence agreements 3.857039 2.708542 2.503044 Conference fees 0.482932 0.485983 0.150915 Others 1.192166 0.183553 0.319166 Total 100 100 100</p> <p>Calculated from annual reports</p> <p>Relative price performance Karl-Franzens-Unt. Graz 80.11% Universitat Wien 81.25% Universitat Innsbruck 79.52% TU Graz 64.28%</p> <p>Comments To make the relative price performance we need to look at the need for universities to gain revenue from tertiary research, this can be assessed by looking at the level of financing.</p>	<p>Levels of (government) funding</p> <p>Private 2005 2006 2007 2008 2009 Public 45.7 48.4 48.7 46.3 37.2 HE 36.2 36.5 36.5 36.5 36.5 Foreign 17.7 18.4 17.9 16.1 16.1</p> <p>Joanneum Research Basic funding 2007 8,403 2008 7,750 2009 7,690 Goal oriented funding 2007 6,121 2008 6,816 2009 7,698 Contract R&D 2007 11,965 2008 11,504 2009 11,558</p> <p>IP strategies at universities Universities traditionally have two missions, teaching and research. Universities are expected to interact more with companies in Austria. Universities thus form the (basic) research backbone in the country. The government works under the motto that knowledge = competitiveness and innovation, this knowledge needs to be transferred to employees (teaching) and come from research (university R&D).</p> <table border="1"> <tr> <th>Highest position</th> <th>World top 250 Leiden Ranking</th> <th>World top 500 Shanghai ranking</th> <th>World top 200 Higher Education</th> </tr> <tr> <td>189</td> <td>189</td> <td>195</td> <td>187</td> </tr> <tr> <th>Lowest position</th> <td>189</td> <td>494</td> <td>195</td> </tr> <tr> <th>Number of universities listed</th> <td>1</td> <td>7</td> <td>2</td> </tr> </table> <p>Popularity among new graduates Joanneum Research is not mentioned in any best employer or favorite company to work for list among the favorite companies in the top 100 list (top 100 list based on IT) based on survey based and consulting companies score high. Source</p>	Highest position	World top 250 Leiden Ranking	World top 500 Shanghai ranking	World top 200 Higher Education	189	189	195	187	Lowest position	189	494	195	Number of universities listed	1	7	2	<p>Size of customer group 2007 No. of customers 2008 2009</p> <p>Composition of customer group Data not available</p> <p>Turnover from customer groups As part of turnover. Private domestic 2006/7 2007/8 2008/9 Public domestic 33 31 Abroad 44 47 51 25 22</p> <p>Business unit/markets Materials Health Education Resources Policies</p>
% GDP	m€																																									
2000	1.94 4026.059																																									
2001	2.14 4633.341																																									
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189	189	195	187																																							
Lowest position	189	494	195																																							
Number of universities listed	1	7	2																																							

For original database look at excel file.

Appendix D: VTT, Finland

Competitive rivalry	Threat of new entrants	Substitute products	Levels of government funding	Power of suppliers	Power of buyers
<p>Competitors: Data for 2008 of countries/year</p> <p>18 PROs, government owned 17 universities 28 polytechnics 428* 0.062/142384 emicom, 16.09207</p> <p>tot. comp. comp./6mth</p> <p>Contestability of markets</p> <p>GERD 2008 3.73% of GDP BERD 09 € 6887408 million GERD 2006-2008 0.35%</p> <p>GERD 2008 2.77% GDP BERD 09 € 5114777 million BERD 2006-2008 0.40%</p> <p>2004 30.92% 2005 34.78% 2006 35.15% 2007 34.48% 2008 34.8% 2009 31.61%</p> <p>2004 21.41% 2005 21.77% 2006 22.89% 2007 23.21% 2008 25.04% 2009 26.69%</p> <p>2004 30.78% 2005 28.91% 2006 29.84% 2007 29.84% 2008 29.79% 2009 28.29%</p> <p>2008 Two 11.78 2009 Two 11.78 11.83 13.55 12.69 6.16 6.57 6.365 10.23 11.02 10.625 Average 8.562 8.6025 8.53225</p> <p>VTT generates a lot of funds from international sources. On average 20.16% of their revenue comes from foreign sources. These are primarily EU sources.</p>	<p>Industry growth rate</p> <p>% GDP 2000 3.32 4.621374 2001 3.32 4.621374 2002 3.32 4.621374 2003 3.44 5.00231 2004 3.46 5.24336 2005 3.48 5.24336 2006 3.48 5.764376 2007 3.48 6.253.63 2008 3.73 6.887408 2009 0.38 2.861723</p> <p>Year 2000 54,0294 2001 54,0294 2002 52,3218 2003 50,37183 2004 51,51531 2005 61,74324 2006 61,74324 2007 62,8435</p> <p>ent./labic 2000 239 2001 240 2002 240 2003 305 2004 325 2005 339 2006 393 2007 428</p> <p>Difference 154</p> <p>8% 9% 4% 13% av 50.2% 47% 51.3% 49% 52% 53.3%</p> <p>Capital requirements</p> <p>Tang. goods 2003 4% 2004 4% 2006 13%</p> <p>4 country average</p> <p>Human cap. 2003 48% 2004 47% 2006 49% 2006 52%</p> <p>4 country average</p> <p>45-25 patents per million population Four country average: 36.66</p> <p>76.64 scientific publications per mln pop. Four country average: 46.34</p> <p>University VTT</p> <p>As part of their new strategy they intend to increase business revenue. This means that they will increase the valorisation of research through various methods including licensing and spinoffs.</p>	<p>Data not available</p> <p>University of Helsinki 76.15% Tempera university of t 51.26% Jyväskylä University 74.20% University of Turku 76.91%</p> <p>Comments: Universities of Helsinki, Jyväskylä and Tempere precede years. This indicates that the universities make profits and do not require all of the funding.</p>	<p>Private Public HEI Foreign Basic funding</p> <p>2005 25.7 2006 25.3 2007 24.1 2008 22.68% 2009 23.21%</p> <p>2004 30.92% 2005 34.78% 2006 35.15% 2007 34.48% 2008 34.8% 2009 31.61%</p> <p>2004 24.14% 2005 24.48% 2006 22.68% 2007 23.21% 2008 25.04% 2009 26.69%</p> <p>2004 30.78% 2005 29.81% 2006 29.84% 2007 29.84% 2008 29.79% 2009 28.29%</p> <p>Universities receive €1.8bn in funding, 65% comes from the state (€1.18bn) and 35% from other sources (€700m) yet on average the top 5 universities only receive €8.9m from third party research projects, the lowest of all four countries.</p> <p>World top 500 Shanghai ranking World top 200 Times Higher Education</p>	<p>Private Public Abroad Basic funding</p> <p>2005 30 2006 29 2007 30 2008 30 2009 28</p> <p>Private domestic 13 Public domestic 21 Abroad 23 Basic funding 35</p> <p>The customer groups from the domestic private sector are spread across several customer segments, based on the size of the customer groups. The largest customer group is from half of the groups (6 out of 10) that are evenly sized.</p> <p>Biotechnology, pharmaceutical and food industries Electronics Energy Forest industry Information and vehicles Precision and instrumentation Real estate and construction Service and logistics</p> <p>38 subgroups spread across 8 Business categories.</p>	
<p>Comments</p> <p>VTT generates a lot of funds from international sources. On average 20.16% of their revenue comes from foreign sources. These are primarily EU sources.</p>	<p>IP strategies at universities</p> <p>World top 250 Leiden Ranking World top 500 Shanghai ranking World top 200 Times Higher Education</p> <p>92 72 102</p> <p>92 470</p> <p>4 6 1</p> <p>Popularity among new graduates VTT is rated 3 most popular among business and law and is rated 1 among engineers. Among students: Business 62 Eng/Nat sc. 1 Law IT 5</p>	<p>Business units/markets</p> <p>Biotechnology, pharmaceutical and food industries Electronics Energy Forest industry Information and vehicles Precision and instrumentation Real estate and construction Service and logistics</p> <p>38 subgroups spread across 8 Business categories.</p>			

For original database look at excel file.