Economic Footprint of 9 European RTOs in 2015-2016

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Prepared for:

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The core mission of Research and Technology Organisations (RTOs) is to harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness with high impact for society. RTOs' technologies cover all scientific fields and their work ranges from basic research to the development of new products and services. RTOs thus take a unique position in the deployment process from science to innovation. They closely cooperate with industries, large and small, as well as a wide array of public actors. With their open-innovation business model, one of the core missions of RTOs is to transfer research and technology to the market with high impact for society.

In addition, their activities also leave a so-called 'economic footprint' in society – an impact that is much less known and documented. The focus of this study is to specifically highlight the economic footprint of RTOs' activities, based on information from 9 European RTOs, members of the European Association of Research and Technology Organisations (EARTO). Data was gathered from the following RTOs: AIT (AT), CEA (FR), DTI (DK), Fraunhofer (DE), imec (BE), SINTEF (NO), TECNALIA (ES), TNO (NL) and VTT (FI). This group of RTOs represents a mix of smaller and larger organisations across Europe and when comparing with sector statistics collected in 2010[1], they together stand for over one third of the revenue of all European RTOs.

In the analysis, we focus on two types of activities that are expected to generate a strong economic impact:
- **the economic leverage of the RTOs' core activities through spending and employment;**
- **the economic leverage of the knowledge transfer through contract research, spin-offs and outflow of staff.**

Although we are well aware of the fact that the total economic footprint of RTOs goes beyond the above-mentioned effects, we have consciously chosen for a conservative estimation of the economic footprint, to avoid double-counting (and thus overestimations). The analysis results in objective and robust observations on the economic effect of RTOs on the European economy – results that can be quoted as a lower boundary.

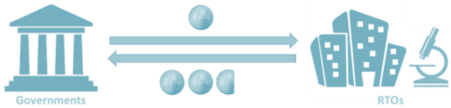
As a result of our analysis, we find that:

- **A total of 284,000 jobs (HC) are created in the European economy that can be linked to the activities of the 9 RTOs included in this footprint, corresponding to a total turnover of 35.8 billion euro and a total value added of 16.8 billion euro. The total fiscal return adds up to 6.7 billion euro (core activities, contract research, spin-off activities), of which 2.6 billion euro stems from the RTOs' core activities.**
  - **Core Activities:** Over 125,000 HC jobs (111,000 FTE) in Europe stem from the core activities of the 9 RTOs, corresponding to a total additional turnover of 15.8 billion euro and a value added of around 7.4 billion euro each year (direct value added is defined as direct revenue, including the operational grant, minus the cost of goods sold). It also leads to 2.6 billion euro of fiscal and parafiscal return to governments.
  - **Collaborative Contract Research:** Almost 2.5 billion euro worth of contracts each year (of which 2.0 billion euro from Europe) result in an annual technological value creation of 3.9 billion euro (directly). This in turn translates into an additional 140,000 jobs, an annual turnover of 17.6 billion euro, and an added value of 8.3 billion euro in the European economy. It also leads to 3.6 billion euro of fiscal and parafiscal return to governments.
  - **Spin-off Activities:** 387 spin-offs created by 7 RTOs result in 18,800 jobs, 2.4 billion euro turnover and 1.1 billion euro value added in the European economy in 2016. This led to 0.5 billion euro of fiscal and parafiscal return to governments in 2016. RTOs' spin-offs are active during on average 7.74 years. 83% of the RTOs' spin-offs survive the first five years of activity.

[1] Technopolis (2010). Impacts of European RTOs, A Study of Social and Economic Impacts of Research and Technology Organisations. A Report to EARTO.

- **For each job in the RTOs, another 4 jobs are created elsewhere in the European economy (on top of the 1 direct job in the RTO)** either at the suppliers of the RTOs and further upstream, or in the broader economy thanks to the economic activity of the employees of both the RTOs and their suppliers, and thanks to the effects of knowledge transfer through contract research and spin-offs.

- The operational grants received by RTOs, are earned back by national governments through fiscal return mechanisms. **For each euro invested in the form of operational grants, almost 3 euro flow back to the national governments[2].** In other words, 270% of the amount spent on operational grants for RTOs returns to governments through fiscal revenues.



This is a lower boundary to the total economic leverage effect, which would take into account all other types of impact (technological, social, tourism, human capital development, etc.).

The figure below summarises the key results from our economic footprint study of 9 RTOs in Europe (with HC=head counts and B€=billion euro).

	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Direct	54,191	7.193	3.503
Indirect	60,656	7.363	3.361
Induced	10,385	1.223	0.563
Total core	125,231	15.779	7.427
Fiscal return core (B€)	1.834	0.261	0.541

= 2.6 BILLION EURO FISCAL RETURN CORE ACTIVITIES

	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Contract research	139,767	17.610	8.289
Spin-off activities	18,800	2.369	1.115
Total	283,798	35.758	16.831

= 6.7 BILLION EURO FISCAL RETURN TOTAL CORE ACTIVITIES, CONTRACT RESEARCH, AND SPIN-OFF ACTIVITIES

2 Applying the multiplier of 3.4 instead of 1.98, like in the BiGGAR Economics study on LERU universities, would result in a total fiscal leverage of 3.8 in 2016.

As mentioned before, the 9 RTOs of the study stand for over one third of the sector in Europe when compared to sector statistics collected in 2010[3], estimating a total revenue of European RTOs of between 18.5 and 23.0 billion euro. When extrapolating[4] the findings for the 9 RTOs to the entire RTO sector in Europe based on these same statistics, we find a total employment creation of between 322,000 and 400,000 jobs in Europe that are generated through the core activities of European RTOs. Including also the effects from contracts and spin-offs, we find an impressive total of between 730,000 and 907,000 jobs in Europe that are related to (a selection of) activities of the European RTOs.

This quantification of the economic footprint of RTOs thus clearly demonstrates RTOs' value for the economy and society in Europe.

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3 Technopolis (2010). Impacts of European RTOs, A Study of Social and Economic Impacts of Research and Technology Organisations. A Report to EARTO.

4 Thus assuming that the 9 RTOs in the sample are on average representative for the total population of RTOs.

INTRODUCTION

As an international non-profit association, EARTO represents the interests of 350 RTOs in the European Union and FP-associated countries.

EARTO's mission is:

- *"to promote and defend the interests of RTOs in Europe by reinforcing their profile and position as a key player in the minds of EU decision-makers and by seeking to ensure that European R&D and innovation programmes are best attuned to their interests;*
- *to provide added-value services to EARTO members to help them to improve their operational practices and business performance;*
- *as well as to provide them with information and advice to help them make the best use of European R&D and innovation programme funding opportunities."*

RTOs are considered important technology transfer agents in the national innovation systems. In 2005, the EURAB concluded[5] that *"Research and Technology Organizations (RTOs) are distinctive, mission-oriented R&D organisations which perform key functions in European innovation systems and which exhibit characteristic strengths."* EARTO defines the RTOs as organisations with the *"core mission to harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness."*[6] They thus distinguish themselves from universities whose predominant activity is education, and from enterprises, whose predominant activity is the production and sales of goods and services.

RTOs have a distinctive role in research collaboration with industry, and in particular with small and medium enterprises[7]. Also in regional research and innovation, and in smart specialisation, RTOs are driving and/or steering actors. They *"occupy nodal positions within innovation eco-systems, bringing together key players across the whole innovation chain […]"*.[8] In this sense, their contribution to the realisation of the European Research Area (ERA) is acknowledged[9].

To support EARTO in its mission to reinforce the profile of RTOs in an EU R&I policy environment where data on RTOs from official EU sources is unfortunately lacking, IDEA Consult has estimated the economic footprint of 9 of its RTO members. The first version of RTOs' Economic Footprint was based on data from 2013-2014 and was published in 2015[10]. This second upgraded version focusses on data from 2015-2016, and the dimensions covered are largely the same. Additional data and methodologies allow for a more detailed insight, for even more realistic results.

The methodology to measure the economic effect of the RTOs' day-to-day activities is based on the classic input-output approach, combined with micro-data input from the RTOs on their purchases (upstream effects).

- The advantage is that **direct economic effects** of the RTOs are exact and that the quantification of the **indirect effects** (at the suppliers of the RTOs and further upstream) is based on the RTO-specific data rather than on sector averages. Both elements benefit the accuracy of our results.

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5 European Research Advisory Board (EURAB) Final Report, Research and Technology Organisations (RTOs) and ERA: https://ec.europa.eu/research/eurab/pdf/eurab_05_037_wg4fr_dec2005_en.pdf

6 Website EARTO: http://www.earto.eu/about-rtos.html

7 See for example Albors-Garrigós J., Rincon-Diaz C. A. & Igartua-Lopez J.I. (2014). Research technology organisations as leaders of R&D collaboration with SMEs: role, barriers and facilitators, Technology Analysis & Strategic Management, 26(1), 37-53.

8 Website EARTO: http://www.earto.eu/about-rtos.html

9 European Research Advisory Board (EURAB) Final Report, Research and Technology Organisations (RTOs) and ERA: https://ec.europa.eu/research/eurab/pdf/eurab_05_037_wg4fr_dec2005_en.pdf

10 See "Economic Footprint of 9 RTO's" (2015), IDEA Consult. http://www.earto.eu/fileadmin/content/02_Events/EARTO_Economic_Footprint_Study/EARTO_Economic_Footprint_Report_-_final.pdf

- In addition to the direct and indirect economic effect, also **induced impact** (the effect of additional direct and indirect employment leading to extra consumption in the local economy) and **fiscal return** (the return for the governments via fiscal flows originating from direct, indirect and induced impacts) are calculated.
- Particularly interesting are the **leverage effects** we see arising from the economic footprint results: what is the additional employment in the European economy that can be related to one person employed at an RTO? If grants are received, how many euros flow back to governments for each euro they invest in the (daily operation of) RTOs?
- New compared to the 2013-2014 study is that we highlight the **effects of specific RTOs' investments in technology infrastructures** in the period 2015-2016. The analysis for these infrastructures are included as case studies in this report.

We further complement this economic footprint assessment with a number of indicators on downstream effects: the scientific and technological activities of the RTOs. For this report, we focus on three forms of knowledge transfer and knowledge conversion that typically have a strong economic impact as well:

- **Outflow of staff**: RTOs transfer highly-educated staff to the private sector along with the valuable knowledge and know-how acquired by working within the RTOs, strongly contributing to the availability and absorption of high-value knowledge by companies and their related industries. Outflow of staff was also included in the 2013-2014 study, but this section is now updated in more detail and with more and better-quality data.
- **Contract research**: RTOs carry out contract research in collaboration with their industrial partners, from large companies to SMEs, supporting them to bring technology to the market and increase their competitiveness while creating high impact for society. Additional to the 2013-2014 economic footprint assessment, we now complement the assessment of the economic impact of contract research through application of a technology multiplier effect (as in the 2013-2014 study) with an additional input-output approach measuring the (monetary) downward effects. The latter is a lower boundary and benchmark to the first.
- **Spin-off creation**. RTOs nurture and create deep-tech start-ups with great life expectancy and low rate of failure. RTOs' spin-offs have great chances of scaling-up in the deep-tech area, creating new industrial champions in Europe and a high number of high-quality jobs. Additional to the 2013-2014 economic footprint assessment, we have added an analysis of RTOs' spin-offs' survival rate compared to the average start-up company in Europe.

The quantification of these economic effects is an important value added in the demonstration of the RTOs' value for the economy and society in Europe.

In the underlying report, we present the methodology and results of the economic footprint of the 9 European RTOs. We first define the scope and outline the methodological framework of the economic footprint in Part 1. Next, we guide the reader through the methodology for the economic footprint (Part 2) and that for the economic valuation of scientific/technological activities (Part 3). In these parts of the report, we also present the detailed results of each step. In Part 4, we compare the results to existing studies and data as a benchmark and in Part 5 we synthesise the results and formulate our conclusions.

As we explain in Part 1 on the scope of this study, we are aware that we do not measure the full impact of RTOs in Europe – which would be scientific and technological in the first place. Instead we focus on the footprint which their activities generate throughout the European economy. To fully grasp the meaning of the results, it is interesting to situate and compare them with results from other existing footprint and impact studies in the field (mainly for universities, and occasionally for individual RTOs). In many cases, however, the methodology or parameters applied are responsible for different outcomes and it is important to understand these to the full extent before considering the existing material as a reference or benchmark. We will guide the reader as much as possible in the comparison of our results with these existing studies, throughout the report and summarised in Part 4.

PART 1: Framework and Scope

1/ Objectives

Despite the general recognition of the relevance and importance of RTOs for the scientific community, companies and society at large, the impact of the RTOs' activities in the European economy or the economic value of technological spillovers to European industry, had not been mapped before 2015. The "Economic Footprint of 9 European Research and Technology Organisations (RTOs) in 2013-2014" report[11] showed this impact for the first time. This new report aims to update the economic footprint assessment with 2015-2016 figures, refine it with more detailed data and shed light on a selected number of impacts that were not included in the 2013-2014 report yet.

Economic impacts are generally defined as the effects of an event, organisation, policy, etc. on the economy in a specific area or region. An economic impact analysis measures the change in economic activity in case an 'event' occurs, compared to the situation where it does not occur (counterfactual). In this study, we measure the economic effects of the RTOs activities in the European Union, compared to a situation where the RTOs would not exist[12]. Our economic footprint model is cost-based and measures output effects as the total increase in revenues in the economy, based on the costs or supplier invoices of the RTOs.

We account for:

- The economic leverage effects that RTOs generate via their day-to-day activities and their purchases of goods and services in the European economy, with additionally three examples of impact through infrastructure projects;
- The economic leverage effects of RTOs as 'senders' of knowledge, in particular through outflow of staff, contract research and spin-off creation. For contract research, we extend the scope compared to the 2013-2014 economic footprint study and include also collaborative contract research next to bilateral contract research.

New compared to the 2013-2014 study are the following analyses:

- Analysis of the effects of specific infrastructures constructed by three RTOs in the period 2015-2016 included as cases in this report.
- Benchmark of the contract research analysis by means of an additional input-output approach measuring the downward effects.
- Analysis of the survival rate of the RTOs' spin-offs.
- Analysis of outflow of staff. This was also included in the 2013-2014 study but it is now updated with more detailed data.

2/ Framework

2.1 Dimensions of impact

In the underlying study, it is a methodological choice not to try to cover the full spectrum of dimensions of impact, but rather to focus on a detailed analysis of the above mentioned activities with a strong economic impact. Nevertheless, to situate this economic footprint analysis in the right context, this section sheds light on other types of impacts and effects that can be expected from RTOs but are not measured here.

Important to mention in this respect, is that 1) an RTO's mission is not necessarily economic but rather scientific/technological so the analysis grasps only a specific dimension of their impact and; 2) many more

11 See "Economic Footprint of 9 RTO's" (2015), IDEA Consult. http://www.earto.eu/fileadmin/content/02_Events/EARTO_Economic_Footprint_Study/EARTO_Economic_Footprint_Report_-_final.pdf

12 In this, we do not take into account the operational grants that would be otherwise saved if the RTO would not exist.

dimensions of scientific and societal impact are being realised in the RTOs that one could (try to) translate into economic value, such as cooperation, training, conferences and events, etc.

Without meaning to be exhaustive, Figure 1 below gives an overview of the outputs and impacts that can be expected in relation to the role and objectives of the RTOs and their inputs (labour, supplies, R&D expenditures, social environment)[13]. Many are indeed related to their technological mission, and in particular to the transfer and conversion of knowledge: to have a technological impact in Europe, the results of research are further transferred to relevant knowledge receivers. These receivers gain more in-depth knowledge and apply or modify the knowledge to the specific needs of the economic or social framework, region or company. The following phases are distinguished in the process from research to innovation/commercialisation:

1) **Knowledge creation**: knowledge base and know-how built up over the lifetime of the RTO.
2) **Knowledge transformation and knowledge transfer**: transformation and transfer of knowledge through a variety of channels such as research collaborations with both academia and industry, publication, lectures, training, etc.
3) **Knowledge conversion**: reaching a diversity of knowledge receivers, who take up the knowledge and further apply it. For the receivers, the knowledge has a particular value as it entails the potential for innovation in the production process or product design.

Next to the primarily scientific/technological impact of RTOs, the following are also dimensions of the total impact of an RTO:

- Catalytic impact: The presence of RTOs in Europe is an important element in the location and collaboration decisions of many enterprises. Also the role of RTOs in the international research landscape and the overall ecosystem can be part of a catalytic impact assessment. The attractiveness and specialisation of a region in a specific field, combined with the technological and scientific cooperation of RTOs with both universities and industry, further supports regional (smart) specialisation.
- Human capital impact: Through employment, training and interaction with higher education, RTOs are expected to have a positive impact on the development of research capacity in Europe. Also the mobility of RTOs' personnel to other sectors in the economy, and in particular to industry, is considered a strong contribution to the European knowledge economy.
- Social impact: The social impact refers to the role that an RTO plays in supporting and informing the society at large through education, communication, interaction with the broader public, but also by addressing the societal challenges through research.
- Tourist impact: RTOs organise events, trainings, conferences that attract local but also international visitors to their region, who in turn consume in hotels, restaurants, transport, etc. in the region.
- Economic impact: Through its day-to-day activities, RTOs -as any other organisation- generate employment, value added and turnover. They buy from suppliers in the local (EU) economy, generating also additional turnover at these suppliers, and at these suppliers' suppliers and so on. The activities of RTOs thus also have a purely economic effect.

A typical characteristic of these different types of impact, is that they are in constant interaction with each other and consequently create a dynamic process. For example, an excellent reputation in R&D (technological effect) is reflected in the revenues from contract research (economic effect) and will stimulate further collaboration of European industrial and academic partners with the RTO and possibly international investments in the proximity of the RTO (catalytic effect). The presence of foreign top companies (catalytic effect) in turn gives a positive impulse to the knowledge creation process within the RTO (technological effect).

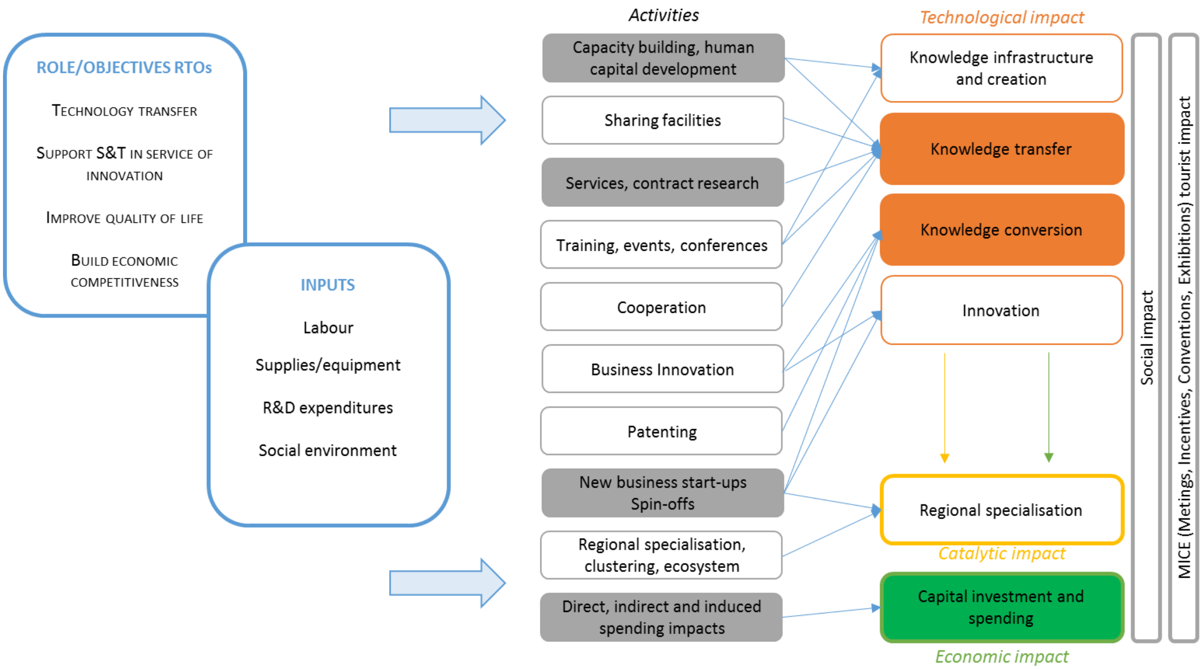
In the underlying study, we will measure the economic footprint for the 9 European RTOs related to those activities in the filled boxes in Figure 1: human capital development (employment, transfer of heads), contract research, spin-offs and spending impacts (total and three infrastructure projects). Furthermore, the footprint concentrates on the economic effects of spending and on the economic effects of knowledge transfer and conversion through a selected number of channels. The focus of this study is thus not on trying to identify the full impact, which would be primarily scientific and/or technological. The focus is on demonstrating the economic value of RTOs in the European economy – a dimension much less known. Compared to the 2013-2014 economic footprint study, the dimensions covered are largely the same, but additional data and methodologies allow for a more detailed insight in each of these dimensions.

[13] Based on previous work by IDEA Consult and a review of existing studies.

This choice was also a pragmatic one, in the first place to reduce the data requirements put upon individual RTOs. But also it is known that the further one moves away from traditional quantitative methods, the more results depend on hypotheses and assumptions and the less robust results turn out to be.

Therefore, our rather 'conservative' approach has the advantage that it avoids overestimations and results in objective and robust observations on the economic effect of RTOs on the European economy – results that can be quoted as a lower boundary and replicated.

Figure 1: Logic frame of expected outputs and impacts of RTOs



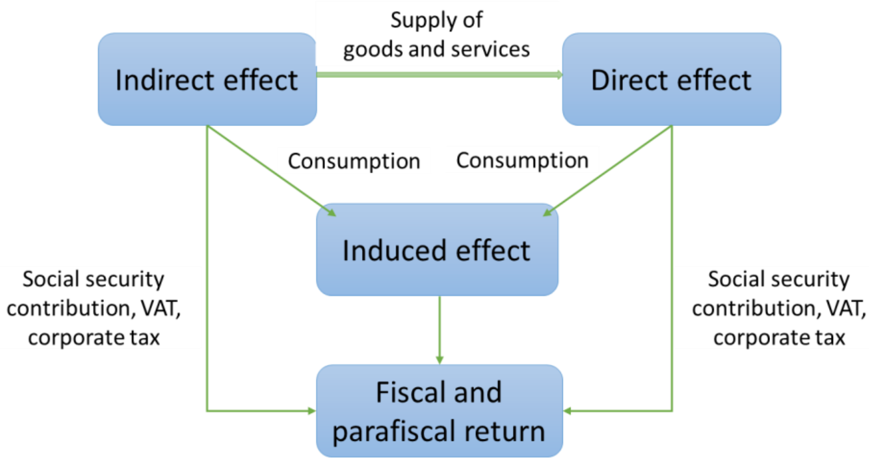
Source: IDEA Consult

2.2 Economic impact framework

As explained before, an economic impact analysis measures the change in economic activity in a specific region in case an 'event' occurs, compared to the situation where it does not occur (counterfactual). In this study, we measure the economic effects of the RTOs activities in the European Union, compared to a situation where the RTOs would not exist[14]. Our economic footprint model is cost-based and measures output effects as the total increase in revenues in the economy, based on the costs or supplier invoices of the RTOs. The framework is described in the following paragraphs and shown in Figure 2, the methodology is explained step-by-step in Part 2 of this report.

[14] In this, we do not take into account the operational grants that would be otherwise saved if the RTO would not exist.

Figure 2: Analytical framework for the economic impact assessment



Source: IDEA Consult

- Via its day-to-day activities, an RTO generates employment and economic added value within Europe. Often, this economic impact is only measured by means of the **direct effect** of the research activities: the employment, value added and output at the organisation itself.

Yet, the total economic impact goes beyond this direct effect. Through upstream relations (with suppliers) and downstream relations (with client-users), an RTO creates an additional economic effect:

- The organisation buys goods and services from EU companies in a series of other industries. This in turn leads to additional employment and additional demand of these EU companies upstream. This expanding impact of an RTO on the economy is what we call its **indirect economic effect**.
- The **induced economic impact** is created through the directly and indirectly created employment. These employees receive a wage higher than the social benefits at unemployment. This additional income is partly spent in the European economy through consumption of goods and services. This spending generates additional upstream turnover and employment at the suppliers' side.
- Each of the above dynamics leads to a form of **fiscal and parafiscal return towards the respective governments** of EU countries where the RTO generates economic effects: the additional employment (direct, indirect and induced) leads to additional social security contributions in different EU countries; the additional production and turnover leads to additional VAT and corporate taxes. We value each of these effects and calculate the multiplier effect of the government grants in the RTOs with respect to this total return.
- Finally, the **technological spillover effects** of the RTO also create an economic leverage effect with its knowledge receivers through the valorisation of the technological knowledge into commercially viable activities. We will include two specific forms of knowledge transfer that typically have a substantial economic effect: contract research and the creation of spin-offs.

3/ Scope

3.1 Sample of RTOs

Nine of EARTO's member RTOs have participated in this study. Data was gathered from the following RTOs: AIT, CEA, DTI, Fraunhofer, imec, SINTEF, TECNALIA, TNO and VTT (cf. Table 1). This group of RTOs represents a mix of smaller and larger organisations across Europe and when comparing with statistics collected in 2010[15], they together stand for over one third of the revenue of all European RTOs. Annex 1 further provides a short description of each RTO's main activities.

Table 1: RTOs in the scope of the study

AIT	Austria	Austrian Institute of Technology
CEA	France	French Alternative Energies and Atomic Energy Commission
DTI	Denmark	Danish Technological Institute
Fraunhofer	Germany	Gesellschaft zur Förderung der angewandten Forschung
imec	Belgium	Interuniversitair Micro-Elektronica Centrum
SINTEF	Norway	Stiftelsen SINTEF
TECNALIA	Spain	Fundación Tecnalia Research and Innovation
TNO	The Netherlands	Netherlands Organization for Applied Scientific Research
VTT	Finland	Technical Research Centre of Finland

3.2 Data coverage and quality

The data were collected by the 9 RTOs in the period July-October 2017. Annex 2 gives an overview of the data requests and availability at the different RTOs.

All RTOs managed to deliver the requested data - if sometimes in a more aggregated form. Only value added and life cycle information on spin-offs are each missing in two cases and investment shares are missing in one case. For the other indicators, this allowed us to work with the full-scale coverage of the 9 RTOs throughout the analysis.

Where data were more aggregated or not available, we have used a simple extrapolation in order to come to the required level of detail. Examples are extrapolations based on the remaining RTOs' aggregated data (e.g. for collaboration contract data) or based on information available in another year or unit (e.g. spin-off employment information in head count or FTE or purchase data for which the sector distribution is only available for national suppliers but not for international suppliers), etc. The number of extrapolations was limited due to a better accuracy of the primary data (cf. infra). More detail on data availability, extrapolations and hypotheses made in the calculations are provided per indicator in the specific sections.

Overall, data quality has improved compared to the first economic footprint study 2013-2014. RTOs have learned from the first experience to set up systematic monitoring and gather accurate data. Therefore, more RTOs were able to provide detailed information on the sector distribution for the purchase data. As an addition, the sector distribution for collaboration contract data was included in the update, also with a very high level of accuracy. The data regarding spin-offs improved as well, with more spin-offs included and more accurate estimates of the number

[15] Technopolis (2010). Impacts of European RTOS, A Study of Social and Economic Impacts of Research and Technology Organisations. A Report to EARTO.

of FTEs per spin-off being available in most of the RTOs. In a number of RTOs, the calculation method for revenues was improved compared to the previous study in order to better reflect annual report data and reality.

Next to the increased accuracy of the available data, the following evolutions were identified to have an impact on the data, and in particular on the direct revenues and grants:

- Compared to the 2013-2014 study, one RTO was no longer included while another RTO was included for the first time. The newly included RTO has a similar order of magnitude but still a slightly lower direct effect than the one that is no longer included.
- The merger of one RTO (included in the first economic footprint) with another RTO (not included in the first economic footprint) in 2015 leads to an increase with the scale of this second RTO;
- The corporisation of one RTO in 2015, meaning that while this RTO used to be state-owned and did not receive a separate grant, it is now a limited liability company which is attributed a separate grant.
- A number of RTOs reported a decline of their revenues or employment due to increased budgetary pressure in their home countries.

Both the increased data quality and the identified evolutions have an effect on the results and on their consistency with the first economic footprint study. As most 2015-2016 results cannot be considered fully consistent with the 2013-2014 results, this report primarily focuses on the 2015-2016 results. Where relevant comparisons can be made with the 2013-2014 study, the evolutions are summarised in Annex 3.

3.3 Points of attention with respect to this footprint study

Important when reading the results is to keep in mind the activities that are included or excluded from the analysis:

1. The analysis focuses on the **economic footprint of the core activities** of the RTOs. A list of the coverage and 'definition' of each RTO is provided in section 3 of Part 1 and in Annex 1.
2. Three types of technological activities are included as an illustration of how this type of knowledge transfer activities generates economic value for the receivers:
   a. **Outflow of staff** from the RTOs: the outflow of highly-qualified staff towards industry contributes strongly to the availability and absorption of highly-valued knowledge enterprises and their related industries. Many of the outflowing employees/researchers go to industry, not rarely taking up positions with high levels of responsibility (management, product development, strategic business development, etc.). As such, very well-educated people flow from the RTOs to industry, with a high degree of knowhow.

   b. **Contract research**: these contracts between the RTO and an individual organisation reflect the value that knowledge or technology have for the organisation (willingness to pay) and we analyse how this value further translates into economic effects. The 2015-2016 economic footprint includes also collaborative contract research, next to bilateral contract research.

   c. The **spin-off activities** of the RTOs. On the one hand, these spin-offs thank their existence to the founding RTO, so their effect is partly attributable to it. On the other hand, they have evolved since their creation and their current impact (in terms of employment, output and value added) is not only and entirely attributable to the RTOs anymore. This impact is influenced by a combination of other factors (e.g. management of the spin-offs, their collaborations with third parties, financial structures, etc.). We therefore cannot simply add the impact of the spin-offs to the footprint of the RTOs' core activities. The economic impact of the spin-offs is thus calculated and analysed, but separately from the RTOs' core activities and as an illustration of the importance of knowledge conversion from an economic point of view.

      In addition to this analysis, a new analysis is added in this update of the economic footprint regarding the survival rate of spin-offs of RTOs. This is an indication of the strength in terms of commercialisation opportunities of RTO (collaborative) research.

In geographical terms, this study focuses on the footprint of the RTOs in the **EU28 and Norway** (hereafter equally called 'Europe', unless specified differently). Most parameters are only available at EU28 level. In this case, we have applied the same parameter for Norway as for the rest of the EU, assuming that the Norwegian economy and actors have similar patterns as the EU28. Other points of attention are:

1. The direct effect is concentrated in the home countries of the RTOs.
2. The first order indirect effect is measured by means of incoming invoices from all European countries to the RTOs.
3. The higher order indirect effect, at the suppliers of the suppliers, is calculated at an aggregated EU level. This means that the aggregated purchases in Europe (EU28 and Norway) are used as input for the model and the result is the aggregated higher order effect in Europe. Inter-EU flows are accounted for in this model, but imports and exports outside Europe are not.
4. The fiscal and parafiscal return concerns the tax flows to all national governments in Europe from the additional direct, indirect and induced impact in their country.

For further methodological details, we refer to Parts 2 and 3.

PART 2: Economic footprint of the organisations

Based on the economic impact framework presented in section 2.2 of Part 1, we now calculate the direct, indirect and induced effects of the 9 RTOs in Europe based on upstream input-output analysis (first to third section). For each type of impact, first the methodology is outlined and then the results are discussed. The fourth section shows how this economic impact generates fiscal returns to national governments and the fifth section adds up the economic effects where relevant to give the full picture of the upstream economic footprint. In the sixth section, 3 cases of infrastructure projects are elaborated to show the specific impact – as part of the total results – of such projects for the European economy.

1/ Direct economic effect

1.1 Methodology

The direct economic effect is measured at the level of the RTOs. It is based on data delivered by the RTOs, combined with information from the institutes' websites and annual reports. The following data have been used:

- Employment: number of full-time equivalents (FTE) and head counts (HC) on the payroll;
- Employment: number of researchers on the payroll;
- Revenue;
- Value added.

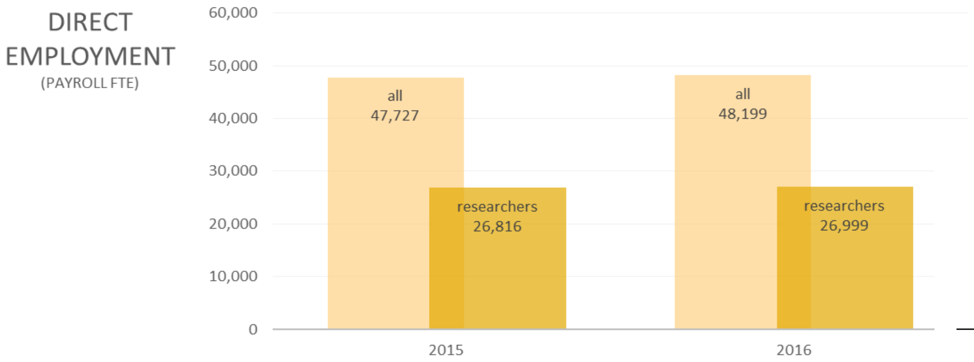
All data are available for the 9 RTOs, except for value added which is available for only 7 RTOs. The total 'value added' indicator is therefore extrapolated, based on the available data of 7 RTOs. Relative indicators based on value added (e.g. value added per FTE) are calculated on the basis of these 7 RTOs only. For instance, to calculate the value added per FTE we divide the sum of the value added of the 7 RTOs by the sum of employment (FTE) in these same 7 RTOs.

1.2 Results

Direct economic footprint: The 9 RTOs employ almost 54,200 knowledge workers (HC), 56% working as researchers. In 2016, they generate a total revenue of 7.2 billion euro, and they have generated a total direct value added of around 3.5 billion euro.

The direct economic effect of an RTO is defined by its in-house activities: the people it employs and the turnover and added value it creates as an organisation. An RTO has a particular profile in this respect: the majority of the staff is highly-educated and/or works as researcher. Their mission is first to develop scientific and technological activities, not to develop an economic activity as such. Generating a direct economic effect is a derivative of the scientific and technological activities. 8 out of the 9 RTOs in the study receive a public grant for operations to support their core activities.

- **Direct employment of almost 54,200 HC knowledge workers (or 48,200 FTE) in 2016.**



DIRECT EMPLOYMENT

(PAYROLL HC)

2015	**53,443**
2016	**54,191**

Source: IDEA Consult based on RTO data

The 9 EARTO members jointly create employment for nearly 54,200 people (HC – head count) in Europe[16] in 2016. This corresponds to around 48,200 full time equivalents (FTE). 56% (i.e. 27,000 FTE) work as researchers at these RTOs (2016).

- **Direct revenue worth 7.2 billion euro per year (2016), including grants.**

DIRECT REVENUE

(INCLUDING OPERATIONAL GRANTS; BILLION EURO)

2015	**7.018**
2016	**7.193**

Source: IDEA Consult based on RTO data

Each year, the 9 RTOs generate a total revenue of between 7 and 8 billion euro. This includes the operational grants that the RTOs receive (in total between 3.5 and 3.8 billion euro per year). Excluding the operational grants, the 9 RTOs generate a revenue of around 3.4 billion euro per year.

- **Total direct value added amounts to 3.5 billion euro per year (2016).**

DIRECT VALUE ADDED

(BILLION EURO)

2015	**3.637**
2016	**3.503**

Together, the RTOs are estimated to have generated a total direct value added of around 3.5 billion euro in 2016[17].

DIRECT VALUE ADDED PER EMPLOYEE

(INCLUDING OPERATIONAL GRANTS; EURO PER FTE)

2015	**76,200**
2016	**72,700**

Source: IDEA Consult based on RTO data (based on n=7)

Employees in the RTOs (FTE) created on average between 73,000 and 76,000 euro value added (including grants) in 2015-2016. This compares to an average value added per FTE in the research sector of between 57,000 euro (according to Eurostat) and 70,000 euro (according to the input-output tables).

[16] 8 RTOs are located in the EU28, one in Norway. All effects thus take place in the EU28 and/or Norway, to which for reasons of simplicity we refer as 'Europe'.

[17] This estimation applies an extrapolation of the value added per FTE as it is observed in the 7 RTOs where value added is known, to the 2 RTOs where only information on FTE is available.

2/ Indirect economic effect

The direct economic effect of the RTOs mainly focuses on the income side and employment within the RTOs. In order to generate revenue, goods and services are purchased, investments are made and wages are paid and (partly) spent. All these activities in turn create employment in other sectors. Employment created at the suppliers (and their suppliers) as a result of purchases of the RTOs is called *indirect* employment. Employment resulting from the consumption of wages is *induced* effect (see Part 2, section 3).

To estimate the indirect economic effect, we first calculate the output[18], value added and the number of full-time jobs created by the RTOs at their own suppliers and service providers in Europe. These are the *first order* economic effects, measured by means of incoming invoices from all European countries to the RTOs. Next, we estimate the *higher order* economic effects, i.e. output, value added and employment further upstream in the value chain at the suppliers of the RTO-suppliers and even further upstream in the chain.

2.1 Methodology

2.1.1 First order indirect economic effect

Incoming invoices of the RTOs are at the basis of the first order indirect effects calculations. The main advantage of using this type of information compared to national input-output-tables is that more specific multipliers for the concerned RTOs can be calculated. In other words, we know how the purchases made by the RTOs are distributed across sectors, and hence need not to rely on purchase patterns for the NACE sector 72 'Scientific research and development' as a whole, which is an aggregate of all companies and organisations that are active in this sector. Although input-output analyses are basically estimates at a sectoral / meso level, it has to be indicated that the accuracy can be significantly improved by capturing the RTO specific outlays, and therefore estimate at least the first round indirect effects in a precise manner.

The purchase data thus reflect the turnover realised at the first tier suppliers of the RTOs. In order to derive the value added and employment associated to this turnover, EU sectoral averages for the ratios "turnover over value added" as well as "turnover over employment" were used.

An important remark is that the first order indirect effects are based on the products and services invoiced to the RTOs directly. The use of taxi's, restaurants or hotels that are linked to the RTO's activities (congresses, training, etc.) but are not paid for by the RTOs, are not part of this analysis. The latter are related to the tourist effect of RTOs, which is not in the scope of this study (cf. section 2 in Part 1).

- Data

All nine RTOs have provided IDEA with a list of purchases aggregated by NACE sector and destination country, based on invoice data. For one RTO, the sector distribution was not available for the international purchase data and the sector distribution of the national data was applied. For one other RTO, no cross-distribution for sector and country was available and the single distributions were crossed assuming that the sector distribution is the same in each country where the RTO has suppliers.

- Hypotheses for the analysis

The use of EU sectoral averages to translate the first order turnover into employment and value added constitutes an approximation. In practice some EU countries (home countries in the first place) receive a higher share of the purchases of the RTOs compared to their share in the EU economy, and vice versa.

2.1.2 Higher order indirect economic impact

The expenditures of the RTOs at their suppliers, lead these suppliers to increase their demand at their own suppliers. Consequently, the suppliers of the RTOs in turn create additional production and employment at their suppliers. Ideally, a similar exercise could thus be done for each of these suppliers, based on their incoming invoices in order

18 I.e. the share of turnover at the suppliers that is attributable to the RTOs invoices.

to calculate very accurately the higher order economic effect. In practice, however, feasibility of this approach decreases with each order of impact.

To calculate the effect further upstream, we therefore use the latest input-output tables available at Eurostat. In order to calculate the higher order indirect effect we introduce the RTO's expenditures as a demand shock in the EU input-output table and derive the corresponding output, employment and value added effects. Based on the estimations of the higher order indirect turnover, we subsequently compute the higher order indirect employment and value added, using the sector ratios identified before (Eurostat).

Since we focus on the 'domestic' effects in the EU, import and export outside the European Union are not taken into account. However, cross-border purchases patterns within the European Union are taken into account in calculating the economic impact.

- Data

The starting point is the data on purchases of RTOs at their various suppliers (the first order indirect effect). Subsequently, through the information contained in the input-output tables, the ultimate indirect effects, capturing the effects of spending for suppliers in various rounds can be modelled.

2.1.3 Total indirect economic effect

- Methodology

The first order indirect effects refer to the immediate relations with the RTO's suppliers. To calculate the first order indirect effect, we took into account only those invoices that effectively bring about additional turnover and employment in the European economies.

The higher order effects relate to the purchases that the first tier suppliers of the RTOs make at their suppliers. In order to calculate the total indirect economic effect, the first and higher order effects are added up.

2.2 Results

Indirect economic effect of RTO purchases: employment creation of 60,700 HC jobs in the European economy in 2016, indirect turnover worth around 7.4 billion euro per year, and indirect value added creation of around 3.4 billion euro per year.

To support their activities, RTOs buy goods and services from companies in a series of other industries. In 2016, purchases from the RTOs with European companies amounted to around 3.9 billion euro per year. This in turn leads to additional employment and additional demand of these companies upstream. This expanding effect on the economy is what we call the indirect economic effect.

- **Indirect employment of 60,700 jobs (HC) in 2016.**

INDIRECT EMPLOYMENT EFFECT

(FTE and HC)

	1° order		higher order		TOTAL	
	FTE	HC	FTE	HC	FTE	HC
2015	28,215	31,594	23,983	26,855	52,198	58,449
2016	29,211	32,843	24,737	27,813	53,948	60,656

Source: IDEA Consult based on RTO data

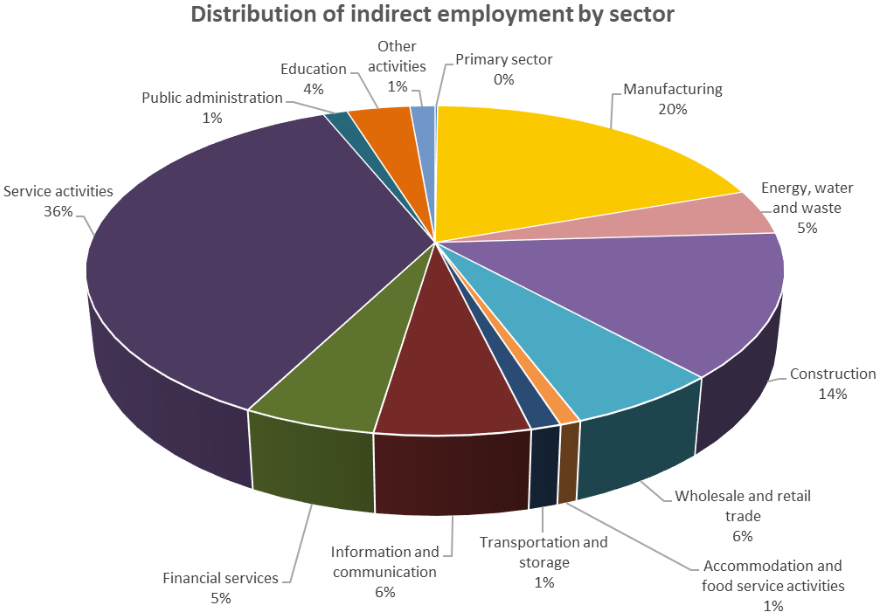
In 2016, the total indirect employment created in the European economy through the purchases of the RTOs amounted to around 60,700 jobs (HC, equivalent to around 54,000 FTE).

More than half of the indirect employment creation happened at the direct suppliers of the RTOs (1° order indirect employment effect). Over 29,200 FTE or 32,800 HC positions have been created there thanks to the purchases of the RTOs. Another 24,700 FTE or 27,800 HC positions have been created further upstream in the value chain, with the suppliers of the RTOs' suppliers (higher order indirect employment effect).

As RTOs rely on a broad range of suppliers of goods and services, their activities result in the creation of employment across many different sectors. The three main benefitting sectors are the business service sector (36%, i.e. about 19,600 FTEs or 22,000 HC in 2016) which consists of many specialised organisations that support the research activities of the RTOs, the manufacturing sector (19%, i.e. about 10,500 FTEs or 11,800 HC) supplying primarily high-tech research equipment, and the construction sector (14%, i.e. about 7,600 FTEs or 8,600 HC) taking care of the RTOs' needs for research facilities.

INDIRECT EMPLOYMENT CREATION PER SECTOR

(FTE, 2016)



Source: IDEA Consult based on RTO data

▸ **Indirect turnover worth around 7.4 billion euro per year (2016).**

INDIRECT TURNOVER

(BILLION EURO)

	1° order	higher order	TOTAL
2015	**3.731**	**3.394**	**7.125**
2016	**3.867**	**3.496**	**7.363**

Source: IDEA Consult based on RTO data

RTOs purchase goods and services from suppliers, who then in their turn buy goods and services from their own suppliers, and so on. This way, in consecutive rounds of spending, a total turnover of around 7.4 billion euro is generated in the European economy each year. Similar to employment, around half of this indirect turnover is created at the direct suppliers of the RTOs. The other half is created further up in the value chain.

- **Indirect value added creation of around 3.4 billion euro per year (2016).**

INDIRECT VALUE ADDED

(BILLION EURO)

	1° order	higher order	TOTAL
2015	**1.703**	**1.530**	**3.234**
2016	**1.780**	**1.581**	**3.361**

Source: IDEA Consult based on RTO data

In total, the value added created throughout the economy as a result of the purchases of goods and services by the RTOs amount to about 3.4 billion euro per year, of which around 1.8 billion is created at the direct suppliers of the RTOs.

To benchmark the indirect effects, these figures can be compared to existing studies. For this, we refer to Part 4 of this report.

3/ Induced economic effect

3.1 Methodology

The RTOs' activities generate income for their employees (direct effect), for the additional employees at their suppliers (first order indirect effect) and further upstream in the supply chain (higher order indirect effect). The spending of this additional income in the economy provides a third type of economic effect: the 'induced effect'.

The total *additional* wage expenses of the households, minus the amount of VAT[19], for their part create additional output in several sectors. As we have no insights in how these wages are spent precisely, we estimate the induced value added and induced employment based on economy-wide average ratios of value added over turnover and employment over turnover. An alternative method is using a closed model of the EU input-output table. However the results have not been found reliable, since import leaks, expenditures of households outside the EU, and savings are not incorporated, and therefore tend to overestimate the real impact. Our approach can be considered as a conservative estimate, indicating the minimum border of potential effects.

It is important to recall that we compare the situation 'as is' with the situation that the RTOs would not be active. We thereby assume that employees (direct and indirect) would be unemployed if the RTOs did not exist. The additional impact of an RTO is thus the difference between employment and unemployment of the direct and indirect employees. In this situation, we assume that the unemployed would receive an unemployment benefit, so that their income would not decrease to 0. Many other impact studies in the field do assume that the unemployed have zero income, which leads to an overestimation of the additional effects of the RTOs. For example, the study of the Economic Contribution of the LERU Universities by BiGGAR Economics (2015, update 2017) does not mention a correction for unemployment benefits. On top, we do not account for the unemployment benefit itself: this is a cost for the government if the RTOs would not be active, which is omitted in the situation where RTOs do exist and generate additional employment in the European economy.

- Data

As starting point, the figures on direct and indirect employment were used. These were multiplied with average net wages[20] in the different sectors in the EU where the RTOs create direct and indirect employment. Subsequently, these were multiplied with average wage-spending quota[21] (= how much of an income is actually spent by a household). Next, the fraction of income that is spent outside the EU was subtracted in order to arrive at net spending in the EU economy induced by the RTO's activities[22].

However, not all of these expenses can be attributed to RTO-activities: only the part that results from the difference between the average unemployment compensation[23] and the average net wage of the direct and indirect employment can be considered as an induced impact of the RTOs. Therefore the average unemployment compensation was also subtracted from the average net wages.

- Hypotheses for the analysis

The use of EU averages for all parameters in the calculation of the net spending by the RTOs' and suppliers' employees, is an approximation given the rather unequal geographical spread of the RTOs covered in our study in Europe, and given the fact that also a Norwegian RTO is included in this study.

We also make the assumption that all employees (direct and indirect) would be unemployed if the RTOs would not be active.

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19 Taxation trends in the European Union (2017), DG for Taxation and Customs Union and Eurostat.

20 Eurostat data per sector for the EU28.

21 Eurostat data. The average domestic wage-spending quotum is the percentage of the wage income of a household that is on average spent on the purchase of goods and services from the domestic market (thus not imported).

22 Eurostat data on final consumption expenditures in the EU and abroad.

23 Eurostat data for the EU28.

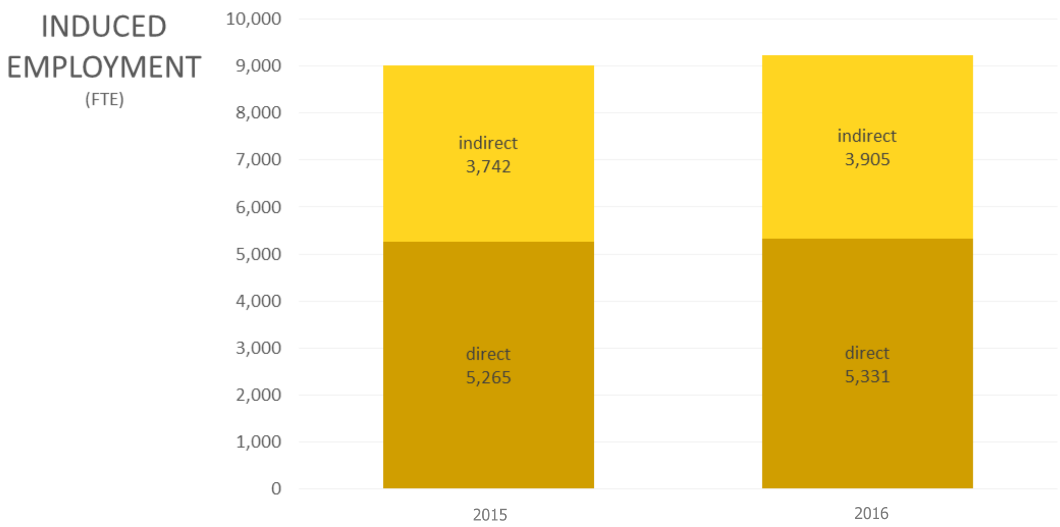
3.2 Results

Induced economic effect: Consumption of 1.2 billion euro per year in the broader economy, with an induced employment of around 10,400 jobs (HC) and an induced value added creation of around 0.6 billion euro per year.

The induced economic effect is created through the RTOs' directly and indirectly created employment. These direct and indirect employed people now receive a wage which is higher than an unemployment benefit. They spend part of their additional income in the European economy through consumption of goods and services, and in turn this spending generates additional turnover and value added in the European economy.

We remark that the results of other impact studies often do not account for an unemployment benefit but rather assume a zero income as alternative to working at the RTO, leading to an overestimation of the additional induced effects. We can therefore not compare the results with other benchmarks or studies.

- **Induced employment of around 10,400 jobs (or 9,200 FTE) in 2016.**



Source: IDEA Consult based on RTO data

The employment generated at the 9 RTOs directly and indirectly at their suppliers, results in additional household expenditures in the European economy, which in turn create new employment and value added. In 2016, an additional 10,400 HC jobs (equivalent to 9,200 FTE positions) existed in Europe as a result of this consumption. 58% of this induced employment is generated by the household expenditures of the employees of the RTOs (around 5,300 FTE or 6,000 HC), while the remaining 42% (around 3,900 FTE or 4,400 HC) is generated by the indirect employees linked to the RTOs' purchases.

- **Induced turnover creation worth over 1.2 billion euro per year.**

INDUCED TURNOVER

(BILLION EURO)

2015	**1.191**
2016	**1.223**

Source: IDEA Consult based on RTO data

The turnover generated at companies who benefit from the extra[24] household expenditures from the direct and indirect employees linked to the RTOs, amounts to more than 1.2 billion euro annually.

- **Induced value added creation of around 0.6 billion euro per year.**

INDUCED VALUE ADDED

(BILLION EURO)

2015	**0.544**
2016	**0.563**

Source: IDEA Consult based on RTO data

The corresponding value added generated by these companies is around 0.6 billion euro annually.

[24] I.e. on top of what would be consumed if these person were unemployed and received unemployed benefits.

4/ Fiscal and parafiscal return to national governments in Europe

Based on the direct, indirect and induced effect, one can estimate the fiscal and parafiscal return to the national governments in Europe. This fiscal and parafiscal return is mainly generated through the following channels:

- the additional employment (social security contributions, wage tax);
- the additional output (corporate tax);
- the additional value added (VAT).

The estimation of the fiscal and parafiscal return is based on direct, indirect and induced effect on the employment, output and value added, as outlined in the previous chapters.

We have collected the following financial parameters, necessary to estimate the fiscal and parafiscal return in Europe:

- gross wages and labour tax rates[25] - these were already used for the calculation of induced effects;
- sectoral profitability rates[26] and corporate tax rates[27];
- VAT rates[28].

The average tax rate for the EU28 was applied each time.

4.1 Methodology

4.1.1 Labour taxes

Data on the average implicit tax rate (ITR) on labour for the EU was used[29], which includes the various social security contributions (of both employers and employees) as well as personal income tax. This ITR was applied to gross wages paid by RTOs and suppliers, which was obtained from Eurostat (NACE 2 sectoral level).

In the assessment of fiscal and parafiscal return due to additional employment, we do not account for the potential reduction in unemployment benefits when additional people are employed compared to unemployed.

- Hypotheses for the analysis

As was already indicated earlier, and as also applies to the corporate tax and VAT estimations discussed further on, the use of EU averages is an approximation in the sense that only a subset of EU countries is represented through the nine RTOs (among which Norway), and that the countries where most economic effect takes place may have different average parameter values than the EU28 as a whole.

4.1.2 Corporate tax (turnover)

Next to the additional employment, a second source of government income comprises the fiscal and parafiscal return from the corporate tax on the additionally created turnover. For each sector, we convert the increase in turnover (direct, indirect and induced turnover creation per country) to profits (using data on gross profitability per sector) and impose the average EU corporate tax rate on these profits. For the RTOs (the direct effect) as well as sectors NACE 84 'Public administration and defence services; compulsory social security services' and NACE 85 'Education services', a zero profit rate was maintained in line with the mission of the RTOs and of most organisations falling under these two NACE codes.

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25 Taxation trends in the European Union (2017), EC Taxation and customs union & Eurostat, data for 2015.

26 Eurostat business statistics.

27 Taxation trends in the European Union (2017), EC Taxation and customs union & Eurostat: data for 2016.

28 Taxation trends in the European Union (2017), EC Taxation and customs union & Eurostat: data for 2016.

29 Taxation trends in the European Union (2017), EC Taxation and customs union & Eurostat, data for 2015.

▶ Hypotheses for the analysis

As noted earlier, the use of EU average tax rates is an approximation as only a subset of EU countries is covered, who may not have the same average rates as the EU as a whole.

4.1.3 VAT (value added)

A third pillar of the fiscal and parafiscal return to the government is the amount of additional VAT revenues. These VAT revenues are estimated by applying the EU average VAT-rates on the additional value added creation in the EU (calculated as the sum of direct, indirect and induced impact).

▶ Hypotheses for the analysis

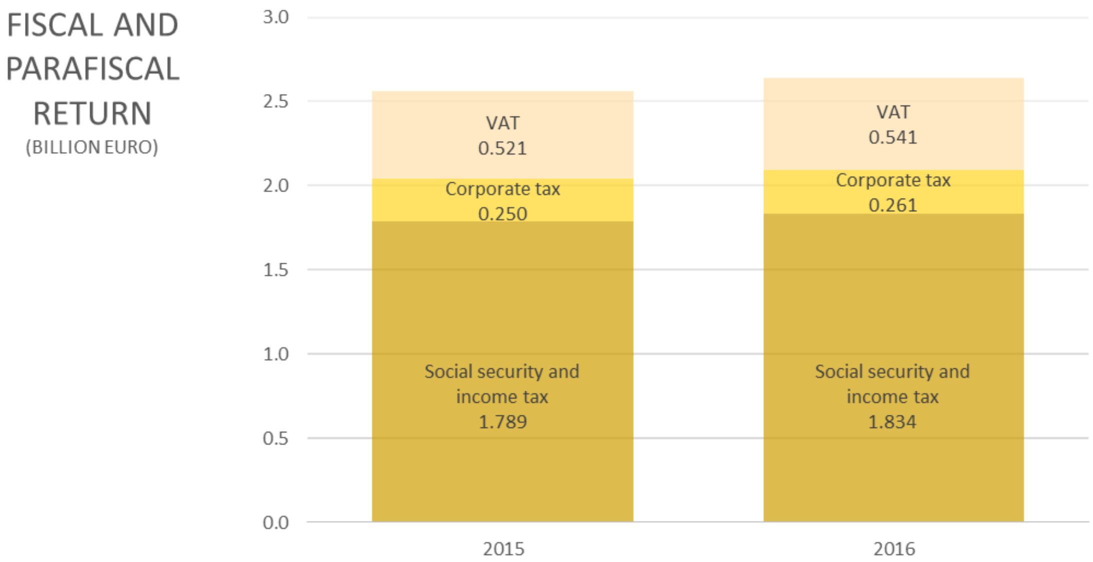
Also here, the use of EU average tax rates is an approximation as only a subset of EU countries is covered, which may not have the same average rates as the EU as a whole.

4.2 Results

Fiscal and parafiscal effect: around 2.6 billion euro flow-back to national governments each year, including 1.8 billion euro through social security and income taxes, 0.3 billion euro through corporate taxes, and 0.5 billion euro through value added taxes (VAT). Only looking at the economic footprint of the core activities of RTOs (without taking into account the impact of their technological activities), almost 100% of government funding for civil research activities at the RTOs (through the operational grants) returns to national governments through fiscal and parafiscal flows in 2016.

The direct, indirect and induced dynamics in terms of employment, turnover and value added each lead to a form of fiscal and parafiscal flow-back towards the respective governments of the European countries where the RTOs generate economic effects. Below, we value each of these effects and calculate the multiplier effect of the government grants in the RTOs with respect to this total flow-back.

▶ **Total fiscal and parafiscal return for national governments of 2.6 billion euro per year.**



Source: IDEA Consult based on RTO data

The direct as well as indirect and induced economic activities generated by the RTOs, generate major fiscal and parafiscal revenues to European governments, amounting to 2.6 billion euro in 2016. These revenues come from social security and income taxes, VAT and corporate taxes paid by the RTOs, their suppliers across the value chain and through the induced effect.

The main component of these revenues are the taxes levied on the income of employees whose job is directly or indirectly linked to the RTOs (social security contributions and income taxes).

- **Total return for national governments generated through social security and income taxes: 1.8 billion euro per year.**

SOCIAL SECURITY AND INCOME TAXES

(BILLION EURO)

	Direct	Indirect	Induced	TOTAL
2015	0.928	0.740	0.121	1.789
2016	0.940	0.770	0.125	1.834

Source: IDEA Consult based on RTO data

In total, 1.8 billion euro of fiscal return is generated each year through social security and income taxes (70% of the total fiscal return). Of this, 0.9 billion euro or 51% are paid by the employees of the RTOs (direct effect), another 0.8 billion euro or 42% by the employees of the suppliers in the value chain (indirect effect) and around 0.1 billion euro or 7% comes from employment that was created through extra household expenditures of the direct and indirect employees (induced effect).

The second, relatively minor component of the fiscal revenues are corporate income tax revenues collected from companies that supply the RTOs (indirect effect) or its employees (induced effect) with goods and services. This third component amounts to around 0.3 billion euro per year (10% of the total fiscal return). We assume that the RTOs themselves do not pay any corporate income tax, so the direct corporate income taxes equal 0. The corporate income taxes through the indirect effect amount to 0.2 billion euro (86%) and through the induced effect to 0,040 billion euro (14%).

- **Total return for national governments generated through corporate income taxes: 0.3 billion euro per year.**

CORPORATE INCOME TAXES

(BILLION EURO)

	Direct	Indirect	Induced	TOTAL
2015	0	0.213	0.037	0.250
2016	0	0.223	0.038	0.261

Source: IDEA Consult based on RTO data

The third source of fiscal revenue is the value added tax (VAT) that stems from the purchase of goods and services by companies and households.

- **Total return for national governments generated through value added taxes (VAT): 0.5 billion euro per year.**

VALUE ADDED TAXES

(BILLION EURO)

	Direct	Indirect	Induced	TOTAL
2015	0	0.404	0.117	0.521
2016	0	0.420	0.121	0.541

Source: IDEA Consult based on RTO data

The fiscal return from VAT amounts to 0.5 billion euro per year (21% of the total fiscal return). The VAT at the level of the RTOs (direct effect) is limited due to the fact that the operational grants are excluded. In 2015 and 2016, the value added does not exceed the operational grants so no value added is accounted for in the fiscal return. Most of the VAT revenues are realised through the suppliers in the value chain (indirect effect): 0.4 billion euro or 78%. The induced effect results in a VAT effect of 0.1 billon euro or 22% of the total VAT effect.

- **Leverage effect: Only looking at the economic footprint of the core activities of RTOs (without taking into account the impact of their technological activities), for each euro of government funding for civil research activities at the RTOs (through the operational grants), about 1 euro returns to national governments through fiscal and parafiscal flows in 2016.**

LEVERAGE EFFECT

(FISCAL RETURN PER EURO OPERATIONAL GRANT)

Focusing on civil research activities	
2015	**0.86**
2016	**0.93**

Source: IDEA Consult based on RTO data

The grants that the RTOs receive from national governments, trigger economic activity at both the RTOs as well as indirectly at their suppliers. As a result, a financial flow-back is generated for the national governments in Europe.

We have calculated two types of fiscal multipliers: one based on the total activities of all RTOs as a benchmark, and one excluding substantial defence activities by CEA[30;31]. Defence-related activities are generally of a different nature, in the sense that the government subsidies devoted to them are very different from other types of R&D activities and the subsidies allocated to them. For the so-called ‘civil’ research activities a government grant is often provided with the expectation that a leverage is created by attracting funding from third and/or private partners, while the defence-related activities are expected to more strongly rely on public funding by the governments. For reasons of representativeness of the results we therefore prefer the more specific multiplier, excluding the defence research activities. The fiscal leverage including all activities is equal to 0.69 in 2016, the fiscal leverage focusing on civil activities is 0.93[32].

According to this specific fiscal multiplier with focus on the civil research activities of the 9 RTOs, the return equals the initial grants and the leverage effect is around 1. In other words, 93% of the amount spent on operational grants for RTOs returns to governments through fiscal revenues.

30 CEA is not the only RTO with dedicated defence R&D activities, but the order of magnitude of their activities in this field is substantially higher than that of the other RTOs. Therefore, it was asked to report the data separately for the civil and defence activities so that this distinction could be taken into account in the analyses. This way, we can provide a benchmark for both the total and the more specific multiplier.

31 In the calculation of the specific fiscal multiplier focusing on civil research activities, the defence-related activities are excluded from all figures in the nominator (fiscal return on the direct, indirect and induced effects) and denominator (grants).

32 This multiplier is calculated based on the fiscal returns excluding defence research activities = 2.08 billion euro and operational grants excluding defence research activities = 2.24 billion euro in 2016.

5/ Adding up the economic effects of the organisations

5.1 Methodology

In order to obtain a complete picture of the economic footprint of the RTOs, the results from the previous four chapters (direct, indirect and induced impact, together with fiscal return) are combined. However, not all results from these different elements can be simply aggregated. In the following table, we present which parts can be added up in a methodologically sound manner.

Figure 3: Overview and add-up of the different economic impact elements

Direct	Indirect	Induced	Fiscal and parafiscal return
Employment (in FTE)	Employment (in FTE)	Employment (in FTE)	Wage tax and social security contributions (in €)
Turnover (in €)	Turnover (in €)	Turnover (in €)	+ Corporate tax (in €) +
Value added (in €)	Value added (in €)	Value added (in €)	VAT revenues (in €) = Total return (in €)

Source: IDEA Consult

We can add up the employment that is created as a consequence of the direct, indirect and induced effect (horizontal sense). The same can be done for the realised turnover and value added creation. We can however not add employment, output and value added (vertical sense), as these refer to the same effect only in other terms. Summing them would thus imply duplications. The different elements of the fiscal and parafiscal return to the national governments, generated by the total output, employment and value added creation can be added up as they represent real fiscal flows (last column of Figure 3).

5.2 Results

Total economic impact of core activities: The core activities of the 9 RTOs have an impact on 125,000 HC jobs in Europe in 2016, 15.8 billion euro turnover and 7.4 billion euro value added. For each job in a European RTO, 1.3 additional jobs are generated in the European economy in 2016 thanks to RTOs' core activities.

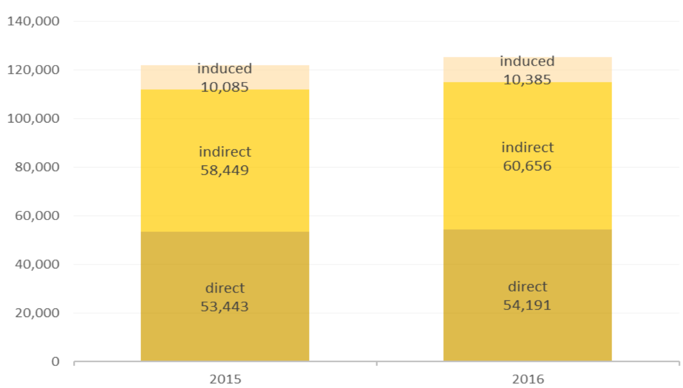
Aggregating the individual economic effects created by the 9 RTOs (direct, indirect and induced), results in an estimate of the total effect of the 9 RTOs' activities in the economy.

- **Total employment creation of 125,000 HC jobs (or 111,000 FTE) from RTOs' core activities in 2016.**

TOTAL EMPLOYMENT (HC)

(TOTAL HC)

2015	**121,978**
2016	**125,231**



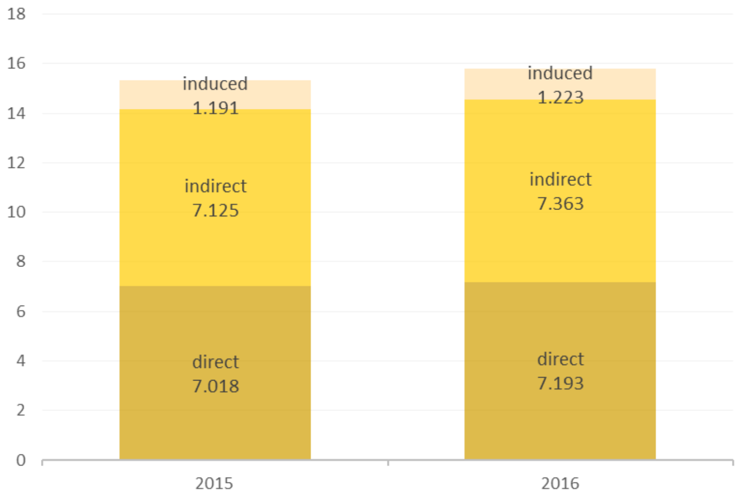
Source: IDEA Consult based on RTO data

Taking together the employment that is generated directly at the 9 RTOs, indirectly at the suppliers of the RTOs as well as the employment induced by the consumption purchases of these first two categories, the total employment created/generated amounts to over 125,000 jobs in 2016. A large share of this employment is generated directly at the RTOs (43%). Indirect employment also represents 48% of total employment, while induced employment accounts for 8% of the total.

- **Total revenue of 15.8 billion euro from RTOs' core activities in 2016.**

TOTAL TURNOVER
(BILLION EURO)

(BILLION EURO)	
2015	**15.334**
2016	**15.779**



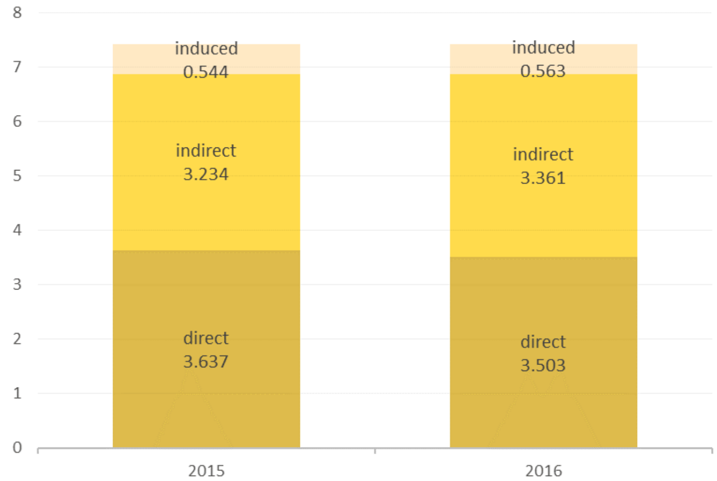
Source: IDEA Consult based on RTO data

Similarly, direct, indirect and induced effects add up to a total turnover effect of around 15.8 billion euro each year.

- **Total value added of 7.4 billion euro from RTOs' core activities in 2016.**

TOTAL VALUE ADDED
(BILLION EURO, INCLUDING GRANT)

(BILLION EURO, INCLUDING OPERATIONAL GRANT)	
2015	**7.415**
2016	**7.427**



Source: IDEA Consult based on RTO data

The total (direct + indirect + induced) effect of the 9 European RTOs translates into 3.6 billion euro of value added creation in Europe each year (excluding the operational grants).

- **In total for the 9 RTOs' core activities in 2016:**

	EMPLOYMENT (HC)	REVENU/TURNOVER (B€)	VALUE ADDED (B€)
Direct	54,191	7.193	3.503
Indirect	60,656	7,.363	3.361
Induced	10,385	1,223	0.563
Total core	125,231	15.779	7.427
Fiscal return core (B€)	1.834	0.261	0.541

= 2.6 BILLION EURO FISCAL RETURN CORE ACTIVITIES

- **Leverage effect: For each job in a European RTO, 1.3 additional jobs are generated in the European economy in 2016.**

EMPLOYMENT MULTIPLIER

(DIRECT + INDIRECT + INDUCED EMPLOYMENT / DIRECT EMPLOYMENT)

2015	**2.28**
2016	**2.31**

Source: IDEA Consult based on RTO data

As illustrated before, the economic footprint of the RTOs is not limited to their direct employment. Through indirect and induced effects, the total impact of the RTOs in terms of employment more than doubles. We find an employment multiplier of 2.3 for the core activities of the RTOs. Per direct job at an RTO, 2.3 jobs are thus linked to the core activities of the RTO (of which 1 direct job). This also means that for each employee working in an RTO, an additional 1.3 jobs are being created elsewhere in the economy (on top of the one direct job in the RTO).

6/ Economic footprint of three technology infrastructure projects

One of RTOs' core mission is to house, manage and provide access to their excellent technology infrastructures. They are the backbone of dynamic R&I ecosystems and play a crucial role for any innovative technology to reach the necessary maturation level, create prototypes, enable upscaling and validate new solutions that can enter the market. Industry relies on RTOs to access such technology infrastructures, as they very often cannot afford the investments and skills needed to operate them. The following case studies analyse the economic effect of three RTOs' investments in specific technology infrastructure projects in 2015-2016.

6.1 Methodology

Three RTOs that invested in one or more specific technology infrastructures in 2015-2016 were able to provide data regarding the related expenditures. The purchases done for building these infrastructures are included in the analysis of the economic footprint and are thus part of the results presented above. They are highlighted in this separate section in order to generate insights in the order of magnitude and specific characteristics of these specific and non-recurrent projects and of their effects.

For infrastructure, the same methodology is applied as for the total economic footprint of the organisations[33]. That means that the purchases for infrastructure are regarded as the first order indirect economic effects. In order to derive the value added and employment associated to this turnover, EU sectoral averages for the ratios "turnover over value added" as well as "turnover over employment" were used. In order to calculate the higher order indirect effect we introduce the RTO's expenditures as a demand shock in the EU input-output table and derive the corresponding output, employment and value added effects.

Also the methodology to calculate the induced effects, i.e. the effects of additional spending in the economy through additional employment and thus individual income of employees, is calculated in the same way and with the same parameters as for the total economic footprint for the organisations. The total additional wage expenses of the households, minus the amount of VAT, for their part create additional output in several sectors.

Finally, for the fiscal and parafiscal return to national governments in Europe, we - again according to the same methodology and applying the same parameters - calculate labour taxes through the additional employment, corporate taxes through the additional turnover and VAT through the additional value added (indirect and induced).

- Data

Three RTOs that invested in one or more specific technology infrastructure projects in 2015-2016 were able to provide information on earmarked expenditures. The data were provided in the same format and as part of the total purchase data per NACE2 sector.

- Hypotheses for the analysis

Given that the same methodology is applied as for the economic footprint of the organisations, also the hypotheses made are the same. In sum, the use of EU level parameters implies an assumption that EU countries are comparable and that purchases are distributed across Europe while in practice there is generally a higher concentration in the RTOs' home countries. In the analysis of induced effects, we make the assumption that all employees (indirect) would be unemployed if the RTOs would not be active.

6.2 Results

In total, the RTOs indicate that around 20% of their aggregate expenditures (upstream purchases) are related to investments. The expenditures for these investments are included in the analysis of the economic footprint and thus in the results presented above, but they are highlighted in this separate section through three specific cases in order to generate insights in the order of magnitude and characteristics of these specific projects and of their effects.

The three investment projects are:

- CEA: Jules Horowitz research Reactor (JHR)
- Imec: New clean room
- DTI: Combined technology infrastructure projects

33 Note that no direct effects are taken into account separately for the infrastructure projects.

6.2.1 CEA: Jules Horowitz research Reactor (JHR)

The Jules Horowitz research Reactor (JHR) is an infrastructure project conducted by the CEA Nuclear Energy Division. The 100MW nuclear reactor an answer to a key technological and scientific challenge: testing fuel and material behaviour under irradiation in support of current and future nuclear reactors. JHR, currently under construction at CEA Cadarache site, will represent in Europe a unique experimenting tool available to nuclear power industry, research institutes, nuclear regulatory authorities and their technical supports. It will also ensure the production of radioelements for nuclear medicine and non-nuclear industry.

The project started in 2002 with the basic design and will be completed by the end of the decade. The installation of the metal reactor dome took place in December 2013 and the pouring of the concrete dome in January 2015, both important milestones of the reactor construction process.

The JHR project is an international project, with in the consortium both industry partners and the European Commission, as well as research institutes in Belgium, Czech Republic, Finland, India, Israel, Sweden and the UK. The CEA is the owner, nuclear operator and contracting authority for the reactor, but in exchange of their financial participation, JHR consortium members will benefit from guaranteed access to experimental capacities of the facility to carry out their own research on material behaviour under irradiation.

An overview of the economic effects resulting from the construction of this infrastructure for one year (2016), is given in the figure below (with HC = head count and M€ = million euro). The numbers are very similar for 2015 data, given that the investments were of a similar range in both years.

CEA	Employment (HC)	Revenu/Turnover (M€)	Value added (M€)
Direct	NA	NA	NA
Indirect	1,152	129.723	59.032
Induced	89	9.426	4.278
Total	1,241	139.149	63.310
Fiscal return (M€)	15.284	4.400	8.299

= 27.982 MILLION EURO FISCAL RETURN CORE ACTIVITIES

- **The total economic effect of this 66 million euro investment by CEA in 2016 corresponds to 1,241 HC jobs, a turnover of almost 140 million euro and a value added of around 63 million euro.**

The investments in the JHR infrastructure by CEA add up to 66.8 million euro in 2015 and 66.4 million euro in 2016. This investment in 2016 generates 1,152 indirect jobs (HC) at the suppliers and further upstream and another 89 jobs (HC) through induced consumption effects. 130 million euro indirect and 9 million induced turnover is created, as well as 59 million euro of indirect value added and 4 million euro of induced value added.

Also in 2015, the effects add up to 1,252 HC jobs (1,118 FTE), a turnover of almost 141 million euro and a value added of 63 million euro.

- **The total fiscal return of the infrastructure project JHR by CEA adds up to 28 million euro in 2016.**

Both in 2015 and 2016, the total fiscal return amounts to 28 million euro. For both years together, this means that around 56 million euro of fiscal returns were generated in Europe. Given that the start of activities was in 2002 with the design of the infrastructure, and construction/finishing is still ongoing, the total effects of the entire infrastructure project are expected to be a multiple of this figure.

6.2.2 imec: clean room

In 2012, the decision was made to build a new clean room in Leuven, Belgium. The new cleanroom opened in March 2016 and is a state-of-the-art technology infrastructure that will be used to develop and produce ultra-small chips. It is built for the larger, higher and heavier equipment that is increasingly needed for the 300mm wafers, but is at the same time fully compatible with the 450mm wafers to which the semiconductor industry is evolving. This unique infrastructure will thus allow imec to keep its global leading position as a nanoelectronics R&D centre serving the entire semiconductor ecosystem, including foundries, IDMs, fabless and fablite companies, equipment and material suppliers, etc.

The cleanroom's structure consists of a 'waffle table', a 90 centimetre thick concrete slab that is completely separate from the outer walls. The structure rests on 831 concrete piles, placed 18 metres deep in the ground to make it totally vibration-free. The waffle table is further perforated with 3,300 holes to allow for constant air circulation, so that the clean room would also remain perfectly dust-free. The new facility thus extends the existing cleanrooms.

The cleanroom was constructed by M+W, an internationally renowned contractor of large-scale high-tech infrastructure. The construction was completed in 20 months. The new cleanroom comprises a total investment of more than 1 billion euro (100 million euro for the building and 900 million euro for the equipment) - of which 100 million euro funding from the Flemish Government and more than 900 million euro investments from more than 90 industrial partners from the semiconductor industry.

An overview of the economic effects resulting from the construction of this infrastructure for one year (2016), is given in the figure below. No figures were available for 2015.

IMEC	EMPLOYMENT (HC)	REVENU/TURNOVER (M€)	VALUE ADDED (M€)
Direct	NA	NA	NA
Indirect	398	43.145	18.115
Induced	27	2.603	1.062
Total	424	45.748	19.176
Fiscal return (M€)	4.556	1.151	2.493

= 8.200 MILLION EURO FISCAL RETURN CORE ACTIVITIES

- **The total economic effect of this 20 million euro investment by imec in 2016 corresponds to 424 HC jobs, a turnover of almost 46 million euro and a value added of around 20 million euro.**

The investments by imec in 2016 add up to around 20 million euro. This investment generates 398 indirect jobs (HC) at the suppliers and further upstream and another 27 jobs (HC) through induced consumption effects. 43 million euro indirect and 2.6 million induced turnover is created, as well as 18 million euro of indirect value added and 1 million euro of induced value added. Given that also in previous years (larger) investments were made in this clean room infrastructure, the total impact is expected to be a multiple of this.

- **The total fiscal return of the infrastructure investments by imec adds up to 8.2 million euro in 2016.**

6.2.3 DTI: Combined technology infrastructure projects

The Danish Technological Institute (DTI) aims to provide unique facilities that allow their customers to test technologies without having to make costly investments first. In 2015 DTI invested 4 million euro in buildings and property and equipment, with around 2 million euro that can be linked directly to technology infrastructure projects:

- In 2014 DTI built a new domicile to DMRI (Danish Meat Research Institute) of 6600 square meters. In 2015 this building was finalized with new state of the art research facilities, thus consolidating DMRI's position as Denmark's leading food center.
- Furthermore, in 2015 DTI upgraded its laboratory facilities for advanced packaging development. This will provide much better opportunities for supporting Danish enterprises in their development of new packaging. Moreover, the furniture testing facilities have been improved with renovation of the rooms and investments in new test machinery, making the laboratory one of the most modern laboratories in Europe.
- The Institute's largest investment in 2016 is the purchase of an ion accelerator from Danfysik A/S. The ion accelerator will, besides assisting in the development of new surface coatings, be used to produce the unique low-friction coating IBAD-DLC. It makes it possible to shape packaging for canned goods without harming the protective polymer layer that is on top of the metal to prevent direct contact between metal from the can and, for example, highly corrosive foods. Furthermore, the accelerator will be used for the production of the special chromium nitride Super-Slip (CrN-SS) coating that reduces the distortion effects in connection with injection moulding significantly. This coating has, among other things, made it possible for the company Winther Mould Technology A/S to develop a fully automatic injection moulding production platform that can increase productivity by up to 50% without compromising on quality. The ion accelerator opens up for entirely new perspectives and development options for Danish industry. The importance of it was recently highlighted in Innovationfonden's new material push at the end of 2016, where they specifically chose to grant DKK 21 million to a large Danish-Swiss project called "SUPER-MOULDS." The project will develop new coatings to improve the efficiency of injection moulding in order to ensure increased competitiveness in high-wage countries like Denmark and Switzerland.
- The Institute has also in 2016 established a new dry concrete laboratory where it is now possible to carry out pilot productions of very dry concrete that needs to be vibrated and pressed into shape. With the equipment one can, for example, make a full-scale test of recipes and develop new types of concrete based on the materials used. Beyond this, the equipment can also be used to develop and document products for climate change adaptations, such as, for example, permeable cobblestones that allow water to pass through them.

An overview of the economic effects resulting from the construction of this kind of infrastructure for one year (2016), is given in the figure below. The numbers are very similar for 2015 data, given that the investments were of a similar range in both years.

DTI	EMPLOYMENT (HC)	REVENU/TURNOVER (M€)	VALUE ADDED (M€)
Direct	NA	NA	NA
Indirect	35	3.923	1.647
Induced	2	0.254	0.104
Total	37	4.177	1.751
Fiscal return (M€)	0.428	0.108	0.228

= 0.764 MILLION EURO FISCAL RETURN CORE ACTIVITIES

- **The total economic effect of this 2 million euro investment by DTI in 2016 corresponds to 37 HC jobs, a turnover of 4.2 million euro and a value added of 1.8 million euro.**

The investments in technology infrastructures by DTI add up to 2.0 million euro in 2015 and 1.9 million euro in 2016. This investment in 2016 generates 35 indirect jobs (HC) at the suppliers and further upstream and another 2 jobs (HC) through induced consumption effects. 3.9 million euro indirect and 0.3 million induced turnover is created, as well as 1.6 million euro of indirect value added and 0.1 million euro of induced value added.

This economic effect of DTI's investments in the creation and upgrade of technology infrastructures only accounts for the year 2016. Similarly in 2015, the effects add up to 38 HC jobs (34 FTE), a turnover of 4.3 million euro and a value added of 1.8 million euro.

- **The total fiscal return of the infrastructure project by DTI adds up to 0.8 million euro in 2016.**

Both in 2015 and 2016, the total fiscal return amounts to almost 0.8 million euro. For both years together, this means that around 1.5 million euro of fiscal returns were generated in Europe.

PART 3: Economic footprint of a selection of scientific/ technological activities

The technological spillover effects of the RTOs also create an economic leverage effect with its knowledge receivers through the valorisation of the technological knowledge into commercially viable activities. Knowledge transformation and transfer at an RTO includes many aspects: its industry intimacy and cooperation strategy, sharing research and technological facilities, staff outflow, scientific transfers through publications, presentations, mandates in universities, PhD or master supervision, academic cooperation, professional education and training etc.

In this study, the focus is put on only three specific forms of knowledge transfer that typically have a substantial economic effect: outflow of staff, contract research and the creation of spin-offs. All three have an important economic impact and illustrate that also the scientific and technological activities have positive economic effects on the European economy – even if it is not their prime objective. The focus of this study is thus not on trying to identify the full impact, which would be primarily scientific and/or technological. The focus is on demonstrating the economic value of RTOs in the European economy – a much less known dimension.

1/ Knowledge transfer: human capital and outflow of staff

The number and share of researchers working in the RTO is a good indication of the knowledge input and absorptive capacity in the RTO. When these researchers with a unique combination of knowledge and knowhow leave the RTO to work in another environment, in particular in private industry, they take their knowledge and knowhow with them to apply in their new position. The outflow of highly-qualified staff towards industry contributes strongly to the availability and absorption of highly-valued knowledge enterprises and their related industries. Many of the outflowing employees/researchers go to industry, not rarely taking up positions with high levels of responsibility (management, product development, strategic business development, etc.). As such, very well-educated people flow from the RTOs to industry and their number is an indicator of an important form of knowledge transfer from the RTOs.

1.1 Methodology

One, and perhaps the most important input factor of an RTO is its human research capital. In section 1.2, we already reported on the direct employment in the 9 RTOs. We now also identify the number of researchers among these employees. The number of researchers is measured directly at the RTOs.

In addition, the outflow of staff is measured. In the previous study, the exits of RTO employees to other organisations or sectors were only included as rough estimates. For this update study, more detailed information is gathered at the RTOs to analyse these effects.

- Data

Employment: number of full-time equivalents and head counts on the payroll of the RTO; number of researchers. All data are available directly from all 9 RTOs.

Outflow of staff: In most RTOs, only aggregate data on the outflow of staff is available, without further specification of the number of researchers and/or the destination sector. The number of researchers in the outflow is only known in three RTOs. Four RTOs distinguish the outflow to private industry and also four RTOs distinguish the international flows. Overall, there is a large variation across RTOs in the data and data quality. It is therefore necessary to interpret the results with care.

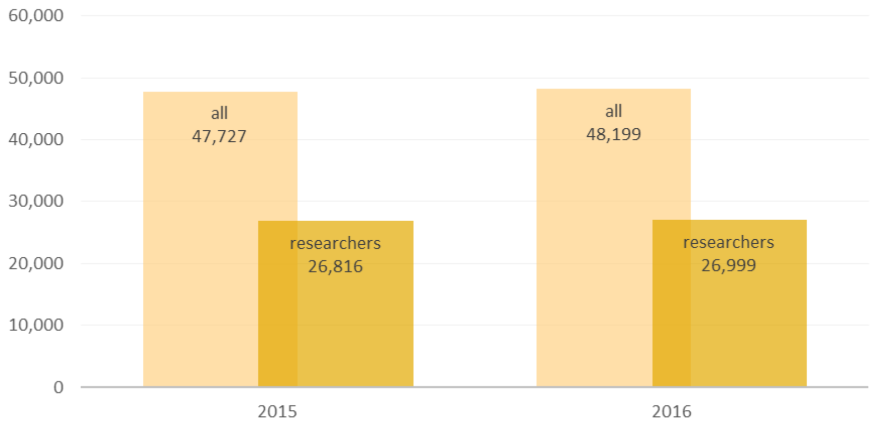
- Hypotheses for the analysis

The analysis requires no prior hypotheses. When extrapolation is carried out to estimate the total effect of all RTOs based on information of only a number of them, we assume that the ratios of outflow to private industry and/or abroad are similar in all RTOs.

1.2 Results

- **Direct employment of almost 54,200 HC knowledge workers in 2016, of whom around 30,400 HC researchers.**

DIRECT EMPLOYMENT
(PAYROLL FTE)



(PAYROLL HC)	
2015	**53,443**
2016	**54,191**

Source: IDEA Consult based on RTO data

- **Transfer of between 7,300 and 7,500 well-educated and experienced employees to private industry in Europe each year. Around half of this outflow of staff moves to private industry in Europe. Around 10% of this outflow of staff moves to another country.**

Even though the results are to be interpreted with care, as stated above, it is clear from this first assessment that the mobility effect is substantial: together, the 9 RTOs estimate that between 7,300 and 7,500 employees move from the RTO to another position in one year. That is 14% of the total staff each year.

In the 4 RTOs with information on the destination sector, around half of the outflow is estimated to go to private companies – though with large variation between the RTOs. A rough extrapolation for the 9 RTOs in the sample thus results in estimations of between 2,700 and 3,500 exits each year to private companies. These are all moving within the home country or Europe.

In the 4 RTOs with information on the destination region, around 90% of the outflow is estimated to stay within the country of the RTO. A rough extrapolation for the 9 RTOs in the sample thus results in estimations of between 6,700 and 6,900 exits each year to another position within the home country.

2/ Knowledge transfer: collaborative contract research

Knowledge transformation and transfer at an RTO includes many aspects: its industry intimacy and cooperation strategy, sharing research and technological facilities, staff outflow, scientific transfers through publications, presentations, mandates in universities, PhD or master supervision, academic cooperation, education and training etc.

In this study, we focus on the aspect of collaborative contract research to illustrate the importance of this kind of knowledge transfer flows also from an economic point of view. Where 50 years ago, RTOs depended more on government budgets and pursued a mainly scientific mission, today RTOs are increasingly working on research or development for and with firms and are able to leverage their knowledge to attract private funding through contract research[34]. The interaction between public research institutes on the one hand and (local) industry on the other hand, adds substantially to the innovative performance and economic development of a region or country. The total scale of contract research in an RTO is an indication of the importance of this targeted knowledge transfer to industry. The total amount of the collaborative contracts is also a proxy for the value that this knowledge transfer has for an individual company.

RTOs apply their knowledge and use their infrastructures in a broad range of research projects. One type of projects are competitively funded public research projects, often in cooperation with other research and industrial partners. In addition, RTOs also regularly work on specific research topics together with individual (public or private) organisations in bilateral or multilateral contract research. Both types of projects have an encouraging effect on knowledge transfer.

2.1 Methodology

2.1.1 Publicly funded research projects

Publicly funded research projects is measured directly at the RTOs. The total scale of the funding is an indication of the importance of this kind of research, and a reflection of the research efforts delivered to these projects. It is based on data delivered by the RTOs.

- Data
  - Total amount of government funded research per year
  - Divided by type of projects: national or subnational, European (Horizon 2020, ESA, other EU), and other international

Data are available for all 9 RTOs for 2015-2016.

- Hypotheses for the analysis

The analysis requires no prior hypotheses.

2.1.2 Collaborative contract research

Collaborative contract research is measured directly at the RTOs. Like with the publicly funded research, the total scale of the contracts is an indication of the importance of this kind of research. Further, the price a company or organisation is willing to pay for the research reflects the value of the knowledge for the receiver. This indicator is based on data delivered by the RTOs.

We remark that VAT from contract research is not included here, because this was taken into account in the direct effects of the RTOs and their total value added reported there (cf. section 1.2 of Part2). Including it again here would mean counting the effect twice.

- Data
  - Total amount of contract research per year
  - Distributed by country of receiver and by sector of receiver (NACE2)

[34] http://www.earto.eu/fileadmin/content/05b_Membership/RTOs_and_the_Evolving_European_Research_Area_WhitePaperFinal.pdf

Data on collaborative research contracts are available for all 9 RTOs. Only in one case no sector distribution could be provided and in one other case a more aggregate sector distribution was provided.

- Hypotheses for the analysis

In the one case where the sector distribution of the collaborative research contracts was not available, we have used a simple extrapolation based on the remaining RTOs' aggregated data in order to come to the required level of detail. The main assumption made in this extrapolation, is that European RTOs have similar patterns concerning the international or intersectoral cooperation in contracts. In the case where data were available at a more aggregate sector level, the amount was distributed equally over the corresponding subsectors.

2.1.3 Value of knowledge transfer through contract research

The assessment of the value of knowledge transfer is a complex matter, given the implicitness of 'knowledge'. Two elements are of particular importance:

- The 'diffusion' and transfer of knowhow / technology needs first to be measured
- the 'value' of this diffusion is to be assessable

The **measurement of the diffusion** and its value implies the point of view of the knowledge user. This user needs to appropriate a value to the transferred knowledge. We refer briefly to three different methodologies for measuring diffusion (Peeters, 1998):

- *Technology flows measured by patent data* through the use of technology flow matrices based on patent classifications according to industry/sector of origin and adoption which are used in order to identify R&D flows. Patents are considered to be carriers of technological knowledge in this methodology.
- *Surveys of the use of new technologies:* these surveys measure the rate of adoption of new technologies and provide a 'picture' of the technologies that industries use in a particular point in time.
- *Technology flows on the basis of input-output (I-O) matrices* based on transactions across sectors for intermediate and investment goods. The goods are considered to be reflecting the R&D efforts.

In this study, we focus on contract research as form of knowledge diffusion and the contract amounts as value appropriated to the transferred knowledge by the users.

Also for **measuring the value of knowledge transfer**, a number of methodologies are available. Yet, most commonly, the empirical literature refers to a method based on the input-output method and using the 'technology multiplier'. This method is applied by Papaconstantinou et al. (1996) for 10 OECD countries and further refined, extended and updated by Knell (2008) for 25 European countries and the United States and Japan[35]. These studies are based on OECD data (input-output database and ANBERD database).

The **technology multiplier** indicates the relation between total technology intensity and R&D intensity. In other words, the relation between the total embodied R&D and the intramural R&D, taking into account the direct and indirect technology diffusion in the region. **The most recent estimation for the technology multiplier in the Euro zone is 1.98.** This means that for each euro of intramural R&D expenditures in the Euro zone, 1.98 euro of embodied technology is created.

We use the above-mentioned technology multiplier to assess the value of the knowledge transfer of the RTOs through contract research. We apply the technology multiplier of the EU to all contracts as an average value for all countries involved (mainly the home countries of the RTOs but also other EU countries are receivers) and add up the effects into a total economic value creation through technology transfer by RTOs.

This multiplier methodology is developed at the level of countries, not institutions. Applying this multiplier to the technology transfer of an RTO therefore leads to results that need to be interpreted as illustrations rather than facts. For this study, we have therefore additionally validated the multiplier value with benchmarks in existing literature, in a workshop with RTOs and in an interview with an external expert, Magnus Gulbrandsen (Professor at the TIK Center for Technology, Innovation and Culture, Norway). This way, the available general information is combined with RTO specific information from studies that the RTOs have carried out themselves or, in a more qualitative approach, from examples, cases, and general perception of the RTOs. The conclusion of this process

[35] Knell (2008) is based on the methodology described in Papaconstantinou et al. (1996) but additionally accounts for potential duplications as described in Hauknes and Knell (2006). The study is in other words a refinement of the methodology of Papaconstantinou et al. (1996).

was that the use of the value 1.98 remains justified and is considered a 'careful' estimate (cf. summary note in Annex 4).

- Data

We start from the contract research revenues of the RTOs. These revenues are an indication of the willingness to pay of enterprises for access to the R&D of the RTOs. In line with the results of Knell (2008) we apply the multiplier of 1.98 for the EU to calculate the value of the technology transfer through contract research. We benchmark the results with an analysis of the downstream interactions in input-output tables.

- Hypotheses for the analysis

Three assumptions are important to bear in mind:

- The fact that the multiplier is developed at country level and that applying it at institutional level gives results that are to be considered an illustration rather than a fact.
- The multiplier is not regularly updated (also due to the delays in availability of input-output tables) so applying it assumes that we do not expect large changes in the multiplier over time, in particular in recent years.
- The use of one technology multiplier for the entire EU, while the main receivers are located in the home countries of the RTOs (Belgium, Denmark, Finland, France, Germany, The Netherlands, Norway, Spain, Sweden) and thus concentrated in Western and Northern Europe. In most of these countries one might expect a higher technology multiplier thanks to a higher technology intensity.

2.1.4 Economic impact of the technological knowledge transfer

Knowledge transfer has an important economic value for the receiver. Furthermore, it generates in turn additional economic effects by the filtering through of direct effects to suppliers and consumers (upstream). Estimating these economic effects demonstrates the importance of the technological knowledge transfer also from an economic point of view.

In our framework, the value of the technology transfer corresponds to the direct value added created by the contract research. This direct value added is then further translated into turnover and employment and finally into estimations of the indirect and induced effects. For this, the specific economic ratios calculated for the RTOs in the detailed economic analysis are applied:

- Direct turnover knowledge transfer = direct value added knowledge transfer * (direct revenue RTOs/direct value added RTOs)
- Direct FTE knowledge transfer = direct value added knowledge transfer * (direct FTE RTOs/direct value added RTOs)
- For the three units (employment, turnover and value added):
    - Indirect effect knowledge transfer = direct effect knowledge transfer * (indirect effect RTOs/direct effect RTOs)
    - Induced effect knowledge transfer = (direct+indirect) effect knowledge transfer * [induced effect RTOs/(direct+indirect) effect RTOs]

The effects based on this approach are further triangulated with an analysis of downstream interactions according to the input-output tables[36]. The results of this analysis thus benchmark the results of the technology multiplier based on Knell (2008).

- Data

The estimation of the value of contract research is available from the previous step. To calculate the direct turnover and value added, and to estimate the indirect and induced impact, the specific economic ratios of the RTOs are applied (cf. supra).

[36] Note that the input-output analysis captures only the monetary value of the research contracts; therefore not 1) the discounted present value of future potential unknown income streams that are due to the knowledge produced, 2) the scientific value, 3) environmental value, 4) societal benefits.

- Hypotheses for the analysis

By applying the RTO specific ratios we assume that the effects of knowledge transfer have similar upwards spillover effects as the RTO core activities. We thus assume that the purchasing pattern of the receivers of the knowledge transfer and the profile of their employees (average wage and spending) are similar to the purchasing pattern and the profile of employees at the RTO.

For the implementation of the downstream input-output calculations, the underlying hypothesis is one of an economy with an excess demand (supply shortage): whatever one sells will be bought. While this is a strong hypothesis for most of the sectors, for R&D this hypothesis is quite plausible – in particular since production is nowadays strongly knowledge & technology driven.

2.1.5 Fiscal return of the technological knowledge transfer

To calculate the fiscal return through the economic impact of the technological knowledge transfer, each type of impact is translated to its specific fiscal return, i.e. turnover to corporate taxes, value added to VAT, employment to social security contributions and wage taxes. For this, the specific fiscal return ratios calculated for the RTOs are applied:

- Fiscal return from turnover knowledge transfer = turnover knowledge transfer * (fiscal return from turnover RTOs/total turnover RTOs)
- Fiscal return from value added knowledge transfer = value added knowledge transfer * (fiscal return from value added RTOs/total value added RTOs)
- Fiscal return from employment knowledge transfer = employment knowledge transfer * (fiscal return from employment RTOs/total employment RTOs)

- Data

The estimation of the economic effects of contract research is available from the previous step. To calculate the fiscal return stemming from each type of impact, the specific ratios of the RTOs are applied (cf. supra).

- Hypotheses for the analysis

By applying the RTO specific ratios we assume that the effects of knowledge transfer have similar fiscal returns mechanisms as the RTO core activities.

2.2 Results

Publicly funded research: 1.6 billion euro each year, including 72% from national and regional funding programmes, 21% from EU funding programmes (including Framework Programmes), and 7% from other international programmes.

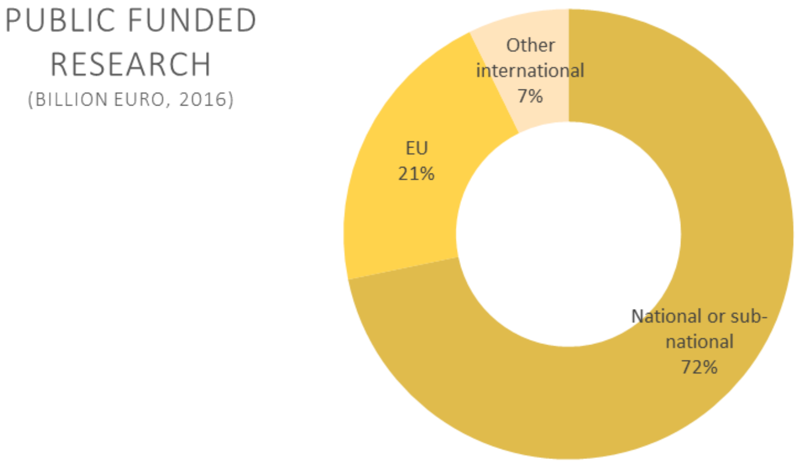
Knowledge transfer through contract research: almost 2.5 billion euro worth of contracts each year (of which 2.0 billion euro from Europe) result in an annual technological value creation of 3.9 billion euro (directly). This in turn translates into an additional 140,000 jobs, an annual turnover of 17.6 billion euro, and an added value of 8.3 billion euro in the European economy. It also leads to 3.6 billion fiscal and parafiscal revenue to governments.

The European RTOs apply their knowledge and infrastructure in a broad range of research projects. One type of projects are public research projects, often in cooperation with other research and industrial partners. But RTOs also regularly work on specific research topics together with individual (public or private) organisations bilaterally or in collaborative settings. Both types of projects have in common that they have an encouraging effect on knowledge transfer. The RTOs thus have a scientific/technological impact on the partners they cooperate with by sharing and applying their knowledge in a common research project.

In the case of the contracts, the value of the contract is a proxy for the willingness to pay for the knowledge by the receiving partner. By applying the technology multiplier to this value, the total technological impact of the RTOs on the technological research community through contracts is quantified. Based on this value, also the economic impact and fiscal return of these activities in the broader economy is estimated.

2.2.1 Publicly funded research projects

- **Over 1.6 billion euro per year of publicly funded research activities.**



Source: IDEA Consult based on RTO data

Thanks to their scientific focus and available resources (staff, infrastructure), the 9 RTOs attract each year an impressive volume of around 1.6 billion euro of public funds for research[37]. The majority, around 72%, stems from national (or subnational) sources. Around 21% is funded through European projects - of which 94% comes via the R&D Framework Programmes and Horizon 2020.

This confirms the observation that EARTO members are especially active in the European R&D Framework Programmes. Based on eCorda data of September 2017, EARTO calculated that its members combined 4,318 participations in Horizon 2020 and received 2.3 billion euro EC contribution (8%). They were part of 43% of the projects in terms of EC contribution, and played the role of project coordinator of 821 projects. Besides, 62% of the funding spent in pillar II – Industrial Leadership and 51% of those of Pillar III – Societal Challenges was given to projects with EARTO members involved, showing their strong involvement in collaborative research at EU level.

The cooperation of public and private actors in publicly funded research projects brings about additional private investments for R&D. We did not collect the data in this study to calculate this effect for the entire sample of RTOs, but an example of one RTO gives a sense of magnitude of this leverage effect. This RTO estimated in its annual report that in 2013, for each euro granted to the RTO, another 3.4 euro was spent by its partners (industry or research institutes) in the project.

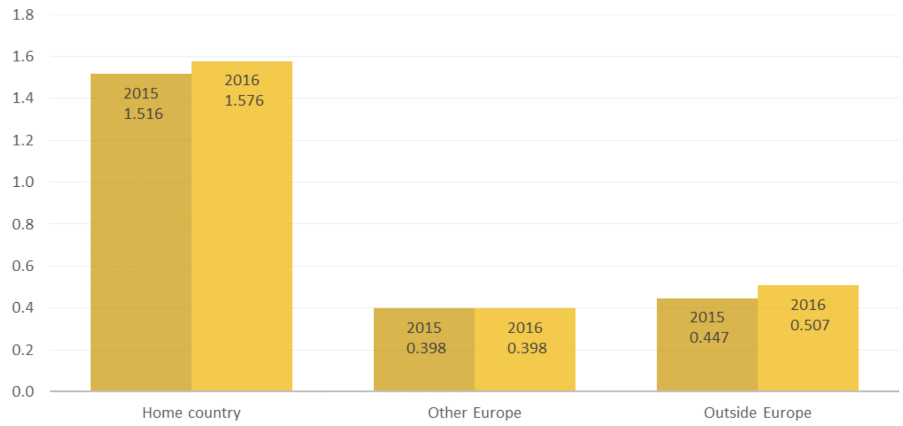
[37] Due to the application of a stricter definition by one of the RTOs compared to the 2013-2014 economic footprint, the figures cannot be compared over time and we only report the 2015-2016 values.

2.2.2 *Collaborative contract research*

- **Almost 2.5 billion euro turnover in collaborative contract research per year, of which almost 2.0 billion in Europe.**

BILATERAL CONTRACT RESEARCH

(BILLION EURO)



(BILLION EURO)

2015	**2.361**
2016	**2.481**

Source: IDEA Consult based on RTO data[38]

In 2016, the 9 RTOs participated in contracts with a total amount of around 2.5 billion euro. 64% correspond to partners located in the home country of the RTO and another 16% from collaboration contracts with partners in other European countries.

40% of the budget from contract research in Europe stems from the manufacturing sector, 25% from the service activities sector, 5% from wholesale and retail trade and another 5% from the ICT sector. Around 12% stems from the public and education sector.

These contracts correspond to a direct knowledge transfer to the contract partner, which is of great scientific/technological interest to them. Their willingness to pay, approximated by the amount of the contract, can be considered a concrete estimate of the value for the receiving partner.

2.2.3 *Value of knowledge transfer through contract research*

- **Collaborative contract research: Technological value of 3.9 billion euro per year.**

TECHNOLOGICAL VALUE OF CONTRACT RESEARCH

(BILLION EURO)

2015	**3.789**
2016	**3.909**

Source: IDEA Consult based on RTO data[39] and Knell (2008)

Besides estimating the knowledge transfer in contract research through the total contract amounts, one can also measure the economic value of this knowledge transfer for the receiving organisation. As outlined in the methodological section, the empirical literature refers to a method based on the input-output tables and using the 'technology multiplier'[40]. The technology multiplier indicates the relationship between total technology intensity and R&D intensity. In other words, the relationship between the total embodied R&D and the intramural R&D, taking into account the direct and indirect technology diffusion in the region.

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39 Note that in the 2013-2014 economic footprint study, only bilateral contract research was taken into account. For the 2015-2016 study, also collaborative research with more than one partner contributing is taken into account.

40 This method is applied by Papaconstantinou et al. (1996) for 10 OECD countries and further refined, extended and updated by Knell (2008) for 25 European countries and the United States and Japan. These studies are based on OECD data (input-output database and ANBERD database).

The most recent estimation for the technology multiplier in the Euro zone is 1.98 (Knell, 2008[41]). This means that for each euro of intramural R&D expenditures in the Euro zone, 1.98 euro of embodied technology is created.

For this study, we have therefore validated the multiplier value with benchmarks in existing literature, in a workshop with RTOs and in an interview with an external expert, Magnus Gulbrandsen (Professor at the TIK Center for Technology, Innovation and Culture, Norway). The conclusion of this process was that the use of the value 1.98 remains justified (cf. summary note in Annex 4). In what follows, we use the above mentioned technology multiplier to present an illustration of the value of the knowledge transfer of the 9 European RTOs through contract research[42].

To estimate the value of the knowledge transfer to European partners, we start from the contract research revenues of the 9 RTOs in the EU28 and Norway, which amount to almost 2.0 billion euro each year. These revenues are an indication of the willingness to pay of European enterprises for access to the R&D of the RTOs. In line with the results of Knell (2008) we apply the multiplier of 1.98 for the EU to calculate the value of the technology transfer through contract research. In 2016, the value of the RTOs' global technology transfer through contract research in Europe is then estimated around 3.9 billion euro.

The technology multiplier is based on a robust methodology and values are relatively constant over time. In other studies we also see multipliers based on the return on investment principle, based on expert opinions or previous studies on business interaction with academia. The values for these multipliers are diverse and make comparison difficult. Many of the values we find in literature are higher than the technology multiplier estimated in Knell (2008). An example is the multiplier used in the report by BiGGAR Economics for LERU on the economic contribution of 21 LERU universities (2015, update 2017)[43]. This was based on a previous evaluation of the Interface programme through Scottish Universities (2013), and found to be comparable to the value observed by PriceWaterhouseCoopers[44] in their study for the Department of Business, Enterprise & Regulatory Reform (2009). The first study found that the direct return to investment for businesses to participate in the programme was 360%. The latter found that interventions in 'Science, R&D and innovation infrastructure' returned a cumulative GVA of 340% of the cost of the project at the businesses. While the 2015 BiGGAR study applied the value of 360%, the 2017 update applied the benchmark of 340%.

2.2.4 Economic impact of the technological knowledge transfer

The value attributed to the knowledge transfer via contract research was demonstrated in the previous part. Applying the RTO specific economic rates, this value added is translated to estimate the economic importance of the contract research. This means that we translate the value of the knowledge transfer to turnover and employment according to the specific economic ratios that are calculated for the 9 RTOs[45].

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[40] This method is applied by Papaconstantinou et al. (1996) for 10 OECD countries and further refined, extended and updated by Knell (2008) for 25 European countries and the United States and Japan. These studies are based on OECD data (input-output database and ANBERD database).

[41] The delay in the data applied (data of 2000 in the 2008 study for example) is caused by the limited frequency (5-annually in most cases) and the delay in publishing of the input-output tables. Because input-output data are relatively constant over time, the value of the multiplier also is.

[42] This multiplier methodology is developed at the level of countries, not institutions. Applying this multiplier to the technology transfer of an institution like imec therefore leads to results that need to be interpreted as illustrations rather than facts.

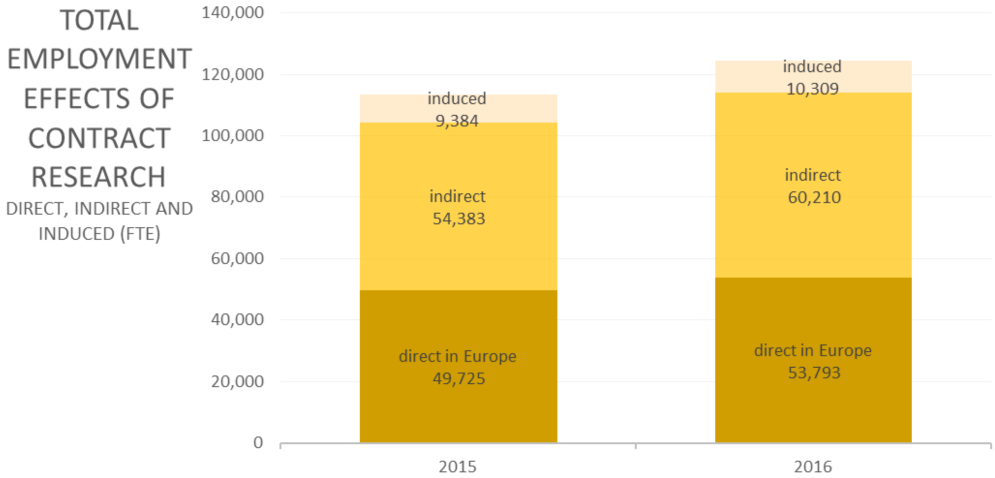
[43] BiGGAR Economics (2015). Economic Contribution of the LERU Universities.

BiGGAR Economics (2017). The Economic Contribution of the LERU Universities in 2016.

[44] PriceWaterhouseCoopers, Impact of RDA spending – National report – Volume 1 – Main Report, March 2009, DBERR.

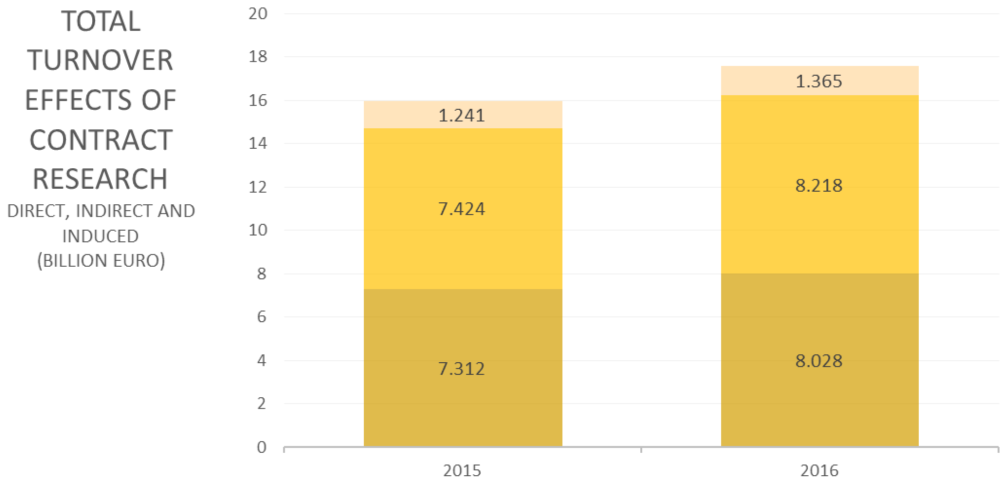
[45] For example, the total value that is created directly by knowledge transfer is multiplied by the ratio "direct revenue over direct value added" to calculate the direct turnover of knowledge transfer from the RTOs. This direct turnover is in turn multiplied by the ratio "indirect turnover over direct revenue" to calculate the indirect turnover of the knowledge transfer from the RTOs. The induced turnover is then calculated as the "direct+indirect turnover" multiplied by the ratio "induced turnover over direct+indirect turnover".

- **The total employment (direct, indirect and induced) that is created by means of knowledge transfer through contract research is estimated at around 140,000 additional HC jobs.**



Applying in the previous step the multiplier of 3.4 instead of 1.98 would result in values almost twice as high: a total employment creation (direct, indirect and induced) of around 213,000 FTEs.

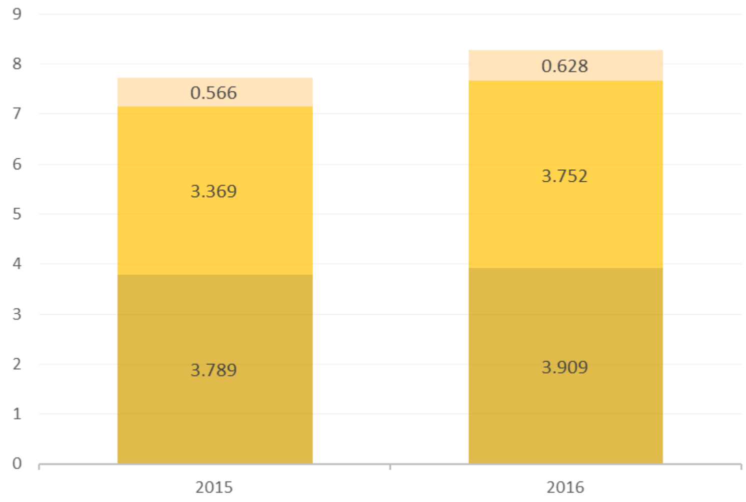
- **The total turnover (direct, indirect and induced) that is created by means of knowledge transfer through contract research is estimated at around 17.6 billion euro.**



Applying in the previous step the multiplier of 3.4 instead of 1.98 would result in values almost twice as high: a total turnover (direct, indirect and induced) of around 30.2 billion euro.

- **The total value added (direct, indirect and induced) that is created by means of knowledge transfer through contract research is estimated at around 8.3 billion euro in 2016.**

TOTAL VALUE ADDED EFFECTS OF CONTRACT RESEARCH
DIRECT, INDIRECT AND INDUCED (BILLION EURO)



Applying in the previous step the multiplier of 3.4 instead of 1.98 would result in values almost twice as high: a total value added (direct, indirect and induced) of 14.2 billion euro in 2016.

Source: IDEA Consult based on RTO data

2.2.5 Fiscal return of the technological knowledge transfer

- **Fiscal and parafiscal impact: close to 3.6 billion euro flow-back to national governments through bilateral and collaborative contract research each year.**

Also the economic effects of the contract research of the RTOs lead to fiscal and parafiscal flow-back towards the respective governments of the European countries where the RTOs generate economic effects. The total fiscal return of contract research in the 9 RTOs amounts to almost 3.6 billion euro in 2016.

The main component of these revenues are labour taxes: 2.0 billion euro. Another 1.1 billion euro stems from the value added creation at the receivers and upstream in their value chain. The corporate tax generates around 0.4 billion euro of fiscal return.

FISCAL AND PARAFISCAL RETURN OF CONTRACT RESEARCH
(BILLION EURO)

Applying in the previous steps the multiplier of 3.4 instead of 1.98 for the estimation of value added from contract research, would result here in a total fiscal return of 6.1 billion euro in 2016.

Source: IDEA Consult based on RTO data

2.2.6 Adding up the economic effects of the RTOs' contract research

- **In total for the 9 RTOs' collaborative contract research activities in 2016:**

	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Direct	60,481	8.028	3.909
Indirect	67,696	8.218	3.752
Induced	11,590	1.365	0.628
Contract research	139,767	17.610	8.289
Fiscal return core (B€)	2.047	0.384	1.143

= 3.6 BILLION EURO FISCAL RETURN CONTRACT RESEARCH

2.2.7 Benchmark with analysis of downstream interactions in input-output tables

As explained in the methodological section 2.1.4 in Part 2 of this report, the downstream interactions can also be analysed through input-output tables. This analysis provides additional insights in the results of technological knowledge transfer in economic terms. However, it is important to take note of the fact that the input-output analysis captures only the monetary value of the research contracts; therefore not 1) the discounted present value of future potential, yet unknown, income streams that are due to the knowledge produced, 2) the scientific value, 3) environmental value, 4) societal benefits. It is therefore considered a lower boundary to the real effects. The analysis in the previous sections captures at least part of the technological and scientific impact through the technology multiplier and as such will be higher than the results based on the monetary flows in the input-output analysis.

Given the almost 2.0 billion euro of contracts in Europe, the downstream interactions through input-output tables results in an input multiplier of 1.96 for the 9 RTOs. This means that for each euro sold or contracted by the RTOs, another 0.96 euro can be sold by other sectors. In total, this implies an additional output of 1.8 billion euro in the European economy in 2016 (indirect) – on top of the almost 2.0 billion of contract research at the RTOs (direct). In other words, with the research services of the RTOs the economy is able to generate another 1.8 billion euro turnover in the EU. However, the total of 3.8 billion euro is low compared to the value for turnover found in the analysis based on the technology multiplier. As is explained above, the IO analysis captures only the monetary streams and not scientific or other impacts on contracts and sales, and does not take into account the discounted value of future potential output streams that may stem from the RTOs research findings[46].

[46] Assessing the latter is beyond the scope of this project and warrants a separate study given the wide range of potential outcomes and the difficulty tot race the contribution to a specific research output since building knowledge, discoveries, and innovations usually consists of combinations of know-how and research results, often in incremental manner.

3/ Knowledge conversion: Spin-offs

Knowledge conversion refers to the process of converting scientific and technological knowledge to a format that allows for further commercialisation and a wider diffusion within society.

The knowledge conversion process consists of three different phases:

- market intelligence
- go-to-market policy
- implementation

Once a number of potential areas for commercialisation have been explored (market intelligence phase), it is necessary to develop a clear vision on how the potential fields of knowledge application can be translated into specific products (go-to-market policy phase). The creation of spin-offs can be one option to translate technological knowledge into prototypes and marketable products. Also patents can be an efficient instrument. Finally, the integration of different forms of knowledge and the adoption of newly developed products can be enhanced by frequent interaction with stakeholders and the wider society. The implementation phase allows for the research projects to be evaluated within a specific context and stimulates the integration of new knowledge into the existing knowledge base.

In this study, we focus on spin-off creation to illustrate the importance of this kind of knowledge conversion flows also from an economic point of view. With their open-innovation business model, one of the core missions of RTOs is to transfer research and technology to the market with high impact for society. RTOs have many ways of doing so, one of which being the incubation, creation and development of spin-off companies: deep-tech start-ups. RTOs' spin-offs are based on RTOs' unique and differentiated knowledge and technology, often protected with strong IP or incorporated through human capital. They are an important instrument to translate their RTOs' R&I activities into commercial or industrial applications and leverage the economic added value of this knowledge. In this sense, RTOs are venture builders, they accelerate the incubation of business opportunities converting innovative technological assets into investment-ready deals capable of generating value for society. Several RTOs have an implicit or explicit spin-off strategy.

In addition to this a new analysis is added in this update of the economic footprint regarding the survival rate of spin-offs of RTOs. This is an indication of the strength in terms of commercialisation opportunities of RTOs' (collaborative) research.

3.1 Methodology

3.1.1 Technological impact of spin-offs

The number and size (in terms of FTE) of spin-off companies are reported as indication of the scale of knowledge conversion through this channel. The life cycle is reported as an indication of the strength in terms of commercialisation opportunities of RTOs' (collaborative) research. Both types of indicators are based on data delivered by the RTOs.

- Data

The input data for this indicator is a list of spin-off companies from each RTO that are still active or were active at some point during the period 2015-2016, and their number of employees. Spin-offs are defined as those companies with direct links to the RTO, based on knowledge/technology of the RTO. This also means that for instance the exit of people who start their own company or licencing to entrepreneurs, etc. are excluded here.

Two RTOs report that they do not work with spin-offs on a formal basis as it does not fit their statute or vision. The seven other RTOs all reported data on employment in the spin-offs, however, data on FTE were not always available. In two cases, the head count figures were transposed into FTE by applying the FTE/HC rate of the RTOs, thus assuming that this rate is similar in the spin-offs. In some cases, data for one of the two years was available only. If the spin-off was indicated to be active in the other year as well, the number of FTE was taken equal in that year as in the other year. One RTO applied an average number for all spin-offs, based on information available for a limited group of its spin-offs.

Overall, coverage of information has improved due to consistent monitoring by the RTOs. But for 56 out of 387 spin-off companies, employment data were not available in 2015 nor 2016 (coverage of 86%), their FTE values were set to zero. The limitation that information on FTEs is not available for all spin-offs in all years, results in the fact that the indicators are to be considered lower boundaries to the real effect. However, the overall effects are closer to the real value compared to the 2013-2014 economic footprint thanks to the better coverage: more spin-offs included and for the reported spin-offs there is a coverage of 86% versus 84% in terms of employment data availability. The increase in results can thus be attributed to both higher data quality and real evolutions reported by the RTOs, such as a merger (now including the spin-offs of the two merged RTOs, instead of one in the previous study), substantial growth in a number of spin-offs, the creation of new spin-offs, etc.

New compared to the 2013-2014 study is that also data on the life cycle of the spin-offs is collected by the RTOs. Five RTOs (of seven that work with spin-offs) provided a list of spin-off companies over a longer period of time, with their start-up year, current status and end year.

- Hypotheses for the analysis

Where data were not available for one year, we have used the numbers for the other year – conditional upon the spin-off being active in that year as well. This assumes that the employment in spin-off companies is more or less stable between 2015 and 2016, which is a reasonable assumption to make. As mentioned, in two cases the head count figures were transposed into FTE by applying the FTE/HC rate of the RTOs, thus assuming that this rate is similar in the spin-offs.

3.1.2 Economic impact of spin-offs

Spin-offs not only have an important potential value added in terms of translating basic research into commercial applications. They also create new jobs and have a positive impact on economic growth, just like any other new company. This aspect is considered in the economic impact assessment of the spin-offs.

As mentioned before, we cannot simply add the impact of the spin-offs to the footprint of the RTOs (the founding organisation). For, not all accomplishments of these spin-offs can be attributed to the RTO. On the other hand, these spin-offs would not have existed without it. Therefore we calculate their economic impact as an indication of the importance of this kind of knowledge conversion processes for the European economy.

To calculate the economic impact of the spin-offs (direct, indirect and induced) we use the same method as for the calculation of the economic impact of the RTOs core activities. Only, less data are available than for the RTOs so we apply the specific economic ratios found in the detailed calculations for the RTOs:
- Direct turnover spin-offs = direct FTE spin-offs * (direct revenue RTOs/direct FTE RTOs)
- Direct value added spin-offs = direct FTE spin-offs * (direct value added RTOs/direct FTE RTOs)
- For the three units (employment, turnover and value added):
  - Indirect effect spin-offs = direct effect spin-offs * (indirect effect RTOs/direct effect RTOs)
  - Induced effect spin-offs = (direct+indirect) effect spin-offs * [induced effect RTOs/(direct+indirect) effect RTOs]

- Data

For the spin-offs, only the direct employed FTE are available. To calculate the direct turnover and value added, and to estimate the indirect and induced impact, the specific economic ratios of the RTOs are applied (cf. supra).

- Hypotheses for the analysis

By applying the RTO specific ratios of turnover/FTE and value added/FTE in the direct economic impact assessment, we assume that the spin-off has a similar activity profile as the RTO. Also, by applying the RTO rates of indirect and induced impact compared to direct impact, we assume that the purchasing pattern of the spin-offs and the profile of the spin-off employees (average wage and spending) are the same as the purchasing pattern and the profile of employees at the RTO. We remark that the economic effects of spin-offs cannot be fully attributed to the RTOs that supported their start-up.

3.1.3 Fiscal return of the spin-offs

To calculate the fiscal return of the spin-offs, each type of impact is translated to its specific fiscal return, i.e. turnover to corporate taxes, value added to VAT, employment to social security contributions and wage taxes. For this, the specific fiscal return ratios calculated for the RTOs are applied:

- Fiscal return from turnover knowledge transfer = turnover knowledge transfer * (fiscal return from turnover RTOs/total turnover RTOs)

- Fiscal return from value added knowledge transfer = value added knowledge transfer * (fiscal return from value added RTOs/total value added RTOs)

- Fiscal return from employment knowledge transfer = employment knowledge transfer * (fiscal return from employment RTOs/total employment RTOs)

- Data

The estimation of the economic impacts of spin-offs is available from the previous step. To calculate the fiscal return stemming from each type of impact, the specific ratios of the RTOs are applied (cf. supra).

- Hypotheses for the analysis

By applying the RTO specific ratios we assume that the effects of knowledge transfer have similar fiscal returns as the RTO core activities. We remark that the fiscal returns of spin-offs cannot be fully attributed to the RTOs that supported their start-up.

3.2 Results

Economic impact of spin-off creation: 387 spin-offs created by 7 RTOs result in around 18,800 jobs HC, 2.4 billion euro turnover, 1.1 billion euro value added in the European economy in 2016. This led to 0.5 billion euro fiscal and parafiscal return to governments in 2016. RTOs' spin-offs are active during on average 7.74 years. 83% of the RTOs' spin-offs survive the first five years of activity.

3.2.1 Economic impact of the spin-offs

The creation of spin-offs is an important way for research intensive organisations to translate their scientific research into commercial or industrial applications and leverage the economic added value of this knowledge. Also, the human capital moving from the 'founding' organisation to the spin-off contributes to the availability and dispersion of highly qualified knowledge and skills to the local economy and related industries. Several RTOs have an implicit or explicit spin-off strategy, while others indicate they prefer other strategies to share their knowledge. In what follows, we estimate the economic impact of spin-off creation by the RTOs.

- **Spin-off activities generated 18,800 jobs HC in 2016: 8,100 HC (or 7,200 FTE) direct and another 10,700 HC (or 9,500 FTE) of indirect and induced full-time jobs in Europe in 2016.**

EMPLOYMENT GENERATED BY SPIN OFFS

(HC / FTE)

	Direct	Indirect	Induced	TOTAL
2015	7,595 / 6,783	8,306 / 7,418	1,433 / 1,280	17,334 / 15,481
2016	8,135 / 7,236	9,106 / 8,099	1,559 / 1,387	18,800 / 16,721

Source: IDEA Consult based on RTO data[47]

The scientific activities of 7 RTOs in this study have led to the creation of many valuable spin-off activities over the years. 387 of their spin-off companies are still active today[48] and employ around 8,100 HC or 7,200 FTE in Europe in 2016. 95% of the spin-off and employment creation is concentrated in the RTOs' respective home countries. The spin-offs' activities additionally generate around 9,100 HC (8,100 FTE) indirect positions in the European economy, as well as another 1,600 HC (1,400 FTE) induced positions.

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47 The overall effects are closer to the real value compared to the 2013-2014 economic footprint thanks to the better coverage: more spin-offs included and for the reported spin-offs there is a coverage of 88% versus 84% in terms of employment data availability. The increase in results can thus be attributed to both higher data quality and real evolutions reported by the RTOs, such as a merger (now including the spin-offs of the two merged RTOs, instead of one in the previous study), substantial growth in a number of spin-offs, the creation of new spin-offs, etc.

48 For data feasibility reasons, only spin-offs still active in 2015 and 2016 are included.

- **Spin-off activities generated 17.6 billion euro turnover in 2016 in the European economy.**

TURNOVER GENERATED BY SPIN OFFS

(billion euro)

	Direct	Indirect	Induced	TOTAL
2015	**0.997**	**1.013**	**0.169**	**2.179**
2016	**1.080**	**1.105**	**0.184**	**2.369**

Source: IDEA Consult based on RTO data

Under the assumption that the spin-offs have a similar turnover per capita as the RTOs, the spin-offs' direct activities are good for an annual additional turnover of over 1 billion euro in Europe in 2016. The spin-offs' activities generate around 1.1 billion euro of turnover at the spin-offs' suppliers each year, and an induced turnover of 0.2 billion euro is estimated in 2016.

- **Spin-off activities generated 1.1 billion euro value added in 2016 in the European economy.**

VALUE ADDED GENERATED BY SPIN OFFS

(billion euro)

	Direct	Indirect	Induced	TOTAL
2015	**0.517**	**0.460**	**0.077**	**1.054**
2016	**0.526**	**0.505**	**0.085**	**1.115**

Source: IDEA Consult based on RTO data

Under the assumption that the spin-offs have a similar value added per capita as the RTOs, the spin-offs direct activities are good for an annual additional value added of more than 0.5 billion euro in Europe in 2016. An additional indirect and induced value added of around 0.6 billion euro in 2016 in the European economy is linked to the spin-off activities of 7 European RTOs.

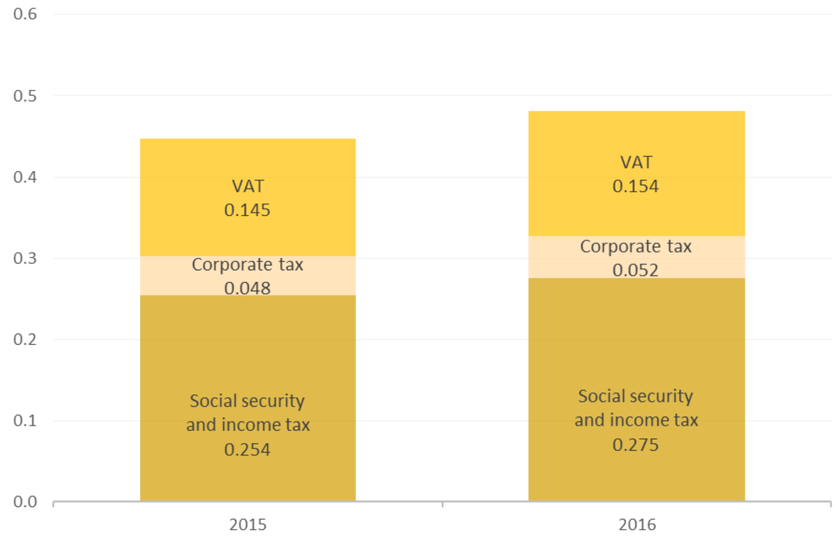
3.2.2 Fiscal return of the spin-offs

- **Fiscal and parafiscal impact: almost 0.5 billion euro flow-back to national governments per year due to spin-off activities.**

Also the economic effects of the spin-off activities of the RTOs leads to fiscal and parafiscal flow-back towards the respective governments of the European countries where the spin-offs are created and where their economic impact is situated. The total fiscal return of RTO spin-offs amounts to 0.5 billion euro in 2016.

More than half of these revenues stem from labour taxes: around 275 million euro. Another 154 million euro is generated through value added creation at the spin-offs and upstream in their value chain. The corporate tax corresponds to around 52 million euro of fiscal return.

FISCAL AND PARAFISCAL RETURN OF SPIN-OFFS
(BILLION EURO)



Source: IDEA Consult based on RTO data

3.2.3 Adding up the economic effects of the RTOs' spin-offs

- **In total for the 7 RTOs' spin-offs in 2016:**

	EMPLOYMENT (HC)	TURNOVER (B€)	VALUE ADDED (B€)
Direct	8,135	1.080	0.526
Indirect	9,106	1.105	0.505
Induced	1,559	0.184	0.085
Spin-off activities	18,800	2.369	1.115
Fiscal return core (B€)	0.275	0.052	0.154

= 0.5 BILLION EURO FISCAL RETURN SPIN-OFF ACTIVITIES

3.2.4 *Survival rate of the RTOs' spin-offs*

- **RTOs' spin-offs are active during on average 7.74 years. 83% of the RTOs' spin-offs survive the first five years of activity.**

Five RTOs reported on 441 spin-offs. The oldest spin-off in the list was created in 1972, the youngest in 2017. 65% was created in the last ten years.

Of the 441 spin-offs, 305 are still active today and 136 have ended their activities (107) or have been merged with another company (29).

On average, the spin-offs of the RTOs are active for 7.74 years before they stop or merge their activities. The survival rate in the first year is 97% - taken over all spin-offs in the entire period.

SURVIVAL RATE OF RTOS' SPIN-OFFS

(SHARE OF SPIN-OFFS THAT ARE STILL ACTIVE AFTER THE NTH YEAR IN THE TOTAL NUMBER OF SPIN-OFFS REPORTED BY THE RTOs)

Survival rate after 1 year	**97%**
Survival rate after 2 years	**94%**
Survival rate after 3 years	**91%**
Survival rate after 4 years	**87%**
Survival rate after 5 years	**83%**

The Eurostat indicator on survival rates of companies is at EU28 level only available for the one-year threshold and in the year 2015[49]. For other years and longer survival periods, only country-level data are available. Even though analysis for the RTOs' spin-offs considers more than one year, starting in 1972, this Eurostat indicator does benchmark the findings. The value of the EU28 aggregate indicator for the one-year survival rate in 2015) is 87%, which is considerably lower than the value found for the spin-offs of the RTOs.

After five years, 83% of the spin-offs are still active. On average across European countries, less than half of the start-ups survived more than five years (data 2015)[50].

49 Eurostat, Business demography by size class (from 2004 onwards, NACE Rev. 2) [bd_9bd_sz_cl_r2], Survival rate 1: number of enterprises in the reference period (t) newly born in t-1 having survived to t divided by the number of enterprise births in t-1 – percentage, 2015. The EU28-level indicator is only available for 2015.

50 Eurostat, Business demography by size class (from 2004 onwards, NACE Rev. 2) [bd_9bd_sz_cl_r2], Survival rate 5: number of enterprises in the reference period (t) newly born in t-5 having survived to t divided by the number of enterprise births in t-5 - percentage, 2015, no EU28 aggregate indicator available but the unweighted average for EU28+NO countries in 2015 is 49%. Data are missing for Denmark, Greece, Croatia, Cyprus, and Malta.

PART 4: Benchmark

Throughout the report, we have guided the reader to interpret the results in the right context and to look for comparable benchmarks. Points of attention are:

- **The scope of the economic footprint**. This study includes the direct, indirect and induced economic effect of RTO core activities, and the economic effects of knowledge transfer through outflow of staff, contracts and spin-offs. It however excludes other types of impacts such as:
  - Catalytic impact: The presence of the RTOs in Europe is an important element in the location and collaboration decisions of many enterprises. Also the role of the RTOs in the international research landscape and the overall ecosystem can be part of a catalytic impact assessment. The attractiveness and specialisation of a region in a specific field, combined with the technological and scientific cooperation of RTOs with both universities and industry, further supports regional (smart) specialisation.
  - Human capital impact: Through employment, training and interaction with higher education, the RTOs are expected to have a positive impact on the development of human research capacity in Europe.
  - Social impact: The societal impact refers to the role an RTO plays in supporting and informing the society at large through education, communication, interaction with the broader public, but also by addressing the societal challenges through research.
  - Tourist impact: RTOs organise events, trainings, conferences that attract local but also international visitors to their region, who in turn make consumptions in hotels, restaurants, transport, etc. in the region.
- **The parameters and assumptions specific to the methodology**. Two elements in our methodology affect the results compared to other existing studies. They are both applied in the spirit of 'careful' estimations (to avoid overestimations or duplications) and thus add to the accuracy and robustness of the results.
  - In the economic footprint assessment, we compare the situation 'as is' with the situation that the RTOs would not be active. We thereby assume that employees (direct and indirect) would be unemployed if the RTOs did not exist. The additional effect of an RTO is thus the difference between employment and unemployment of the direct and indirect employees. In this situation, we assume that the unemployed would receive an unemployment benefit, so that their income would not decrease to 0. Many other impact studies[51] in the field do assume that the unemployed have zero income if the RTO does not employ them, which leads to an overestimation of the additional effects of the RTOs.
  - For the translation of contract research to the value added for the receivers, we apply the Knell (2008) technology multiplier, which is considerably lower than the parameter used in e.g. the BiGGAR Economics study for this purpose. The impact of this parameter on the results is shown throughout the report and demonstrates how these results must be interpreted with care. For reasons of robustness (the Knell (2008) indicator is calculated based on input-output methodology) and carefulness, we prefer to apply the Knell (2008) indicator in our final results. In addition to the previous version of the economic footprint (2013-2014) we have now validated the value of the technology multiplier through a workshop and discussion with RTOs and an external expert in order to assess whether the value is expected to have evolved over time since 2008. In general all experts agreed to the continued use of the value 1.98 for the updated economic footprint, considering it as a 'careful' estimate (cf. Annex 4).

Nevertheless, for a number of results the methodology does not differ (that much) from other studies and we are able to benchmark them. This is the case for the indirect effects, where the indirect effect of the 9 RTOs can be compared to that generated by universities across Europe. BiGGAR Economics calculated the indirect impact of 23 LERU Universities located in 12 countries (Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland and the UK) throughout Europe[52]. They found an indirect employment multiplier (in methodology comparable to the indirect impact calculated for the 9 EARTO members) of 1.74 compared to the 2.12 of the RTOs. Similarly, they find an indirect value added multiplier of 1.67 as compared to 1.96 for the RTOs (cf. Table 2).

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[51] For example, the study of the Economic Contribution of the LERU Universities by BiGGAR Economics (2015, update 2017) does not mention a correction for unemployment benefits.

[52] BiGGAR Economics (2017). The Economic Contribution of the LERU Universities in 2016. The 2015 study included 21 universities in 10 countries, cf. BiGGAR Economics (2015). Economic Contribution of the LERU Universities.

Table 2: Employment and value added multiplier of the 9 RTOs compared to universities

2016	9 EARTO RTOs (2014)	21 LERU universities (2014)	9 EARTO RTOs (2016)	23 LERU universities (2016)
Employment FTE – direct (A)	48,086	158,335	48,199	184,800
Employment FTE – indirect (B)	**45,831**	117,696[53]	53,948	137,600[54]
Employment multiplier type I calculated by (A+B)/A	**1.95**	**1.74**	**2.12**	**1.74**
Value added incl. grants billion euro – direct (C)	4.05	12.10	3.50	14.50
Value added incl. grants billion euro – indirect (D)	2.82	6.20[55]	3.36	9.70[56]
Value added multiplier type I calculated by (C+D)/C	**1.70**	**1.51**	**1.96**	**1.67**

Source: IDEA Consult and BiGGAR Economics (2015, 2017)

Also, to give a sense of magnitude of RTOs' economic leverage effects that were not considered in this study, we can refer to a study on the economic impact of imec (Belgium). This demonstrated that:

- imec attracts visitors from over the world to Leuven and Eindhoven (for joint research activities, conferences, training). These foreign visitors often stay in the region and spend money on local hotels, restaurants, facilities,… A rough estimation of the economic effect of foreign visitors to imec in the Leuven and Eindhoven regions amounts to around 8.4 million euro of additional expenditures (direct, indirect and induced). The direct output (the consumption and expenditures of the visitors) alone corresponds to the turnover of a hotel or restaurant with approximately 50 full-time workers (compared to the 1.262 direct jobs and 290 million euro turnover of imec at that time).
- The knowledge transfer that resulted from imec's contract research, mobility of imec staff to other sectors and training has an economic value for the European economy that is estimated at 259 million euro in 2010 (of which the majority, approximately 84%, via contract research). An update in 2016 roughly estimates this value around 264 million euro, of which 87% from contract research.

It is thus clear that other effects play a role and are to be taken into account when considering the entire range of effects of the RTOs on the European economy.

[53] Sum of employment related to spending on supplies (90,408) and employment related to capital spending (27,288).

[54] Sum of employment related to spending on supplies (108,000) and employment related to capital spending (29,600).

[55] Sum of gross value added related to spending to supplies (4.400 billion euros) and gross value added related to capital spending (1.800 billion euro).

[56] Sum of gross value added related to spending to supplies (7.200 billion euros) and gross value added related to capital spending (2.500 billion euro).

PART 5: Summary and conclusions

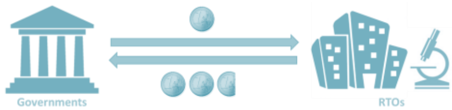
The analysis in this report focuses on the economic footprint of 9 European RTOs. We acknowledge that the main dimensions in the discussion of the 'value' of RTOs are in science, innovation and society. Nevertheless, although RTOs have a specific profile as an organisation and their mission is not necessarily economic in nature, the results of this study show that RTOs also have an important impact on our European economy. Quantifying these economic effects supports the demonstration of the RTOs' value for the economy and society in Europe.

As a result of our analysis, we find that:

- **A total of 284,000 jobs (HC) are created in the European economy that can be linked to the activities of the 9 RTOs included in this footprint, corresponding to a total turnover of 35.8 billion euro and a total value added of 16.8 billion euro. The total fiscal return adds up to 6.7 billion euro (core activities, contract research, spin-off activities), of which 2.6 billion euro stems from the RTOs' core activities.**
  - **Core Activities:** Over 125,000 HC jobs (111,000 FTE) in Europe stem from the core activities of the 9 RTOs, corresponding to a total additional turnover of 15.8 billion euro and a value added of around 7.4 billion euro each year (direct value added is defined as direct revenue, including the operational grant, minus the cost of goods sold). It also leads to 2.6 billion euro of fiscal and parafiscal return to governments.
  - **Collaborative Contract Research:** Almost 2.5 billion euro worth of contracts each year (of which 2.0 billion euro from Europe) result in an annual technological value creation of 3.9 billion euro (directly). This in turn translates into an additional 140,000 jobs, an annual turnover of 17.6 billion euro, and an added value of 8.3 billion euro in the European economy. It also leads to 3.6 billion euro of fiscal and parafiscal return to governments.
  - **Spin-off Activities:** 387 spin-offs created by 7 RTOs result in 18,800 jobs, 2.4 billion euro turnover and 1.1 billion euro value added in the European economy in 2016. This led to 0.5 billion euro of fiscal and parafiscal return to governments in 2016. RTOs' spin-offs are active during on average 7.74 years. 83% of the RTOs' spin-offs survive the first five years of activity.

- **For each job in the RTOs, another 4 jobs are created elsewhere in the European economy (on top of the 1 direct job in the RTO)** either at the suppliers of the RTOs and further upstream, or in the broader economy thanks to the economic activity of the employees of both the RTOs and their suppliers, and thanks to the effects of knowledge transfer through contract research and spin-offs.

- The operational grants received by RTOs, are earned back by national governments through fiscal return mechanisms. **For each euro invested in the form of operational grants, almost 3 euro flow back to the national governments[57].** In other words, 270% of the amount spent on operational grants for RTOs returns to governments through fiscal revenues.



This is a lower boundary to the total effect that would take into account all other types of impact (technological, social, tourism, human capital development, etc.).

Table 3 below summarises the key results from our economic footprint study of 9 RTOs in Europe.

[57] Applying the multiplier of 3.4 instead of 1.98, like in the BiGGAR Economics study on LERU universities, would result in a total fiscal leverage of 3.8 in 2016.

Table 3: Overview of the economic effects of 9 EARTO members

	2015	2016
CORE ECONOMIC ACTIVITIES OF RTOs		
Direct impact		
Employment creation (HC / FTE)	53,443 / 47,727	54,191 / 48,199
Turnover creation (billion euro, incl. grant)	7.018	7.193
Value added creation (billion euro, incl. grant)	3.637	3.503
Indirect impact (through RTOs suppliers)		
Employment creation (HC / FTE)	58,449 / 52,198	60,656 / 53,948
Turnover creation (billion euro)	7.125	7.363
Value added creation (billion euro)	3.234	3.361
Induced impact		
Employment creation (HC / FTE)	10,085 / 9,007	10,385 / 9,237
Turnover creation (billion euro)	1.191	1.223
Value added creation (billion euro)	0.544	0.563
Fiscal and parafiscal returns		
Through employment (billion euro)	1.789	1.834
Through turnover (billion euro)	0.250	0.261
Through valued added (billion euro)	0.521	0.541
TOTAL impact of core economic activities		
Employment creation (HC / FTE)	121,978 / 108,932	125,231 / 111,384
Turnover creation (billion euro)	15.334	15.779
Value added creation (billion euro)	7.415	7.427
Fiscal and parafiscal return (billion euro)	2.561	2.637
Employment multiplier core activities (total of direct, indirect and induced jobs / jobs directly at an RTO)	*2.28*	*2.31*[1]
Fiscal leverage core activities (fiscal return core activities / operational grant)	*0.86*	*0.93*[2]
TECHNOLOGICAL SPILLOVER EFFECTS		
Knowledge transformation & transfer through contract research		
Total employment creation (HC / FTE)	127,083 / 113,491	139,767 / 124,312
Total turnover creation (billion euro)	15.976	17.610
Total value added creation (billion euro)	7.725	8.289
Fiscal and parafiscal return (billion euro)	3.279	3.575
Spin-off activities		
Total employment creation (HC / FTE)	17,334 / 15,481	18,800 / 16,721
Total turnover creation (billion euro)	2.179	2.369
Total value added creation (billion euro)	1.054	1.115
Fiscal and parafiscal return (billion euro)	0.447	0.481
TOTAL AGREGATED EFFECT		
Total employment creation (HC / FTE)	266,395 / 237,904	283,798 / 252,417
Total turnover creation (billion euro)	**33.489**	**35.758**
Total value added creation (billion euro)	**16.193**	**16.831**
Fiscal and parafiscal return (billion euro)	**6.287**	**6.692**
Overall employment multiplier *(FTE core activities, contracts and spin-offs/FTE employed directly at an RTO)*	***4.98***	***5.24***[3]
Total fiscal leverage *(fiscal return core activities, contracts and spin-offs/operational grant)*	***2.41***	***2.69***[4]

Source: IDEA Consult based on RTO data

[1] In 2016, for each 1 job in these RTOs, another 1.31 jobs were created elsewhere in Europe due to the core economic activities of RTOs (on top of the 1 direct job in the RTO).

[2] In 2016, for each €1 invested in the form of operational grants, €0.93 flow back to the national governments due to the core economic activities of RTOs. This multiplier is calculated based on the fiscal returns and operational grants excluding defence research activities (2.08 billion euro and 2.24 billion euro in 2016 respectively).

[3] In 2016, for each 1 job in these RTOs, another 4.24 jobs were created elsewhere in Europe due to both the core economic activities of RTOs and their technological spillover effects (on top of the 1 direct job in the RTO).

[4] In 2016, for each €1 invested in the form of operational grants, €2.69 flow back to the national governments due to both the core economic activities of RTOs and their technological spillover effects. This multiplier is calculated based on the fiscal returns and operational grants excluding defence research activities (6.04 billion euro and 2.24 billion euro in 2016 respectively).

We also looked into the possibility to extrapolate these findings to the entire RTO sector in Europe. However, very little statistics are available for the European RTO sector. In 2010, Technopolis calculated the size of the sector in a report for EARTO[58]. The study integrated and analysed existing information from different sources. It estimated a total turnover of European RTOs between 18.5 and 23 billion euro. If we use this range to roughly estimate the total impact of European RTOs[59], we find a total employment creation of between 322,000 and 400,000 jobs in Europe that are generated through the core activities of European RTOs. Including also the effects from contracts and spin-offs, we find an impressive total of between 730,000 and 907,000 jobs in Europe that are related to (a selection of) activities of the European RTOs.

[58] Technopolis (2010). Impacts of European RTOS, A Study of Social and Economic Impacts of Research and Technology Organisations. A Report to EARTO.

[59] Thus assuming that the 9 RTOs in the sample are on average representative for the total population of RTOs.

PART 6: Annexes

Annex 1 - Sample of 9 RTOs

9 of EARTO's member RTOs have participated in this study. They are listed in the table below and the next paragraphs provide a short description of each RTO's main activities.

Table 4: RTOs in the scope of the study

AIT	Austria	Austrian Institute of Technology
CEA	France	French Alternative Energies and Atomic Energy Commission
DTI	Denmark	Danish Technological Institute
Fraunhofer	Germany	Gesellschaft zur Förderung der angewandten Forschung
imec	Belgium	Interuniversitair Micro-Elektronica Centrum
SINTEF	Norway	Stiftelsen SINTEF
TECNALIA	Spain	Fundación Tecnalia Research and Innovation
TNO	The Netherlands	Netherlands Organization for Applied Scientific Research
VTT	Finland	Technical Research Centre of Finland

AIT (Austria)

Focusing on the key infrastructure topics of the future since 1959, the Austrian Institute of Technology (AIT) has been leading the Austrian innovation system and has played a key role in Europe. As a national and international network node at the interface of science and industry AIT enables innovation through its scientific-technological expertise, market experience, tight customer relationships and high quality technology infrastructure.

AIT provides research and technological development to realize basic innovations for the next generation of infrastructure related technologies in the fields of Energy, Mobility Systems, Low-Emission Transport, Health & Bioresources, Digital Safety & Security, Vision, Automation & Control and Technology Experience. These technological research areas are supplemented by the competence in the area of Innovation Systems & Policy.

CEA (France)

The CEA is the French Alternative Energies and Atomic Energy Commission (Commissariat à l'énergie atomique et aux énergies alternatives). It is a public body established in October 1945 by General de Gaulle.

There are two strands of activities in the CEA: civil activities and defence activities. More specifically, CEA is active in four key areas: low-carbon energies (nuclear and renewable energies), defence and security, information technologies and health technologies. In each of these fields, the CEA maintains a cross-disciplinary culture of engineers and researchers, building on the synergies between fundamental and technological research.

The CEA is based in ten research centres in France, each specialising in specific fields. These CEA laboratories are located in 7 regions which give a strong regional identity and partnerships forged with other research centres, local authorities and universities.

CEA negotiates and implements scientific and technical cooperation agreements with international organizations in both the nuclear and non-nuclear research fields. It is also involved in implementing intergovernmental agreements between France and other countries in the nuclear energy field. Promoting and implementing bilateral agreements allows the French government to have the necessary elements to define its foreign policy in the nuclear area as well as promote the international development of the French firms in partnership with the CEA. However, much of the international cooperation among scientists is spontaneous and many agreements are directly negotiated between laboratories and often include commercial relations.

DTI (Denmark)

The Danish Technological Institute, founded in 1906, is a self-owned and not-for-profit institution. They develop, apply and disseminate research- and technologically-based knowledge for the Danish and International business sectors.

The Institute participates in development projects, which are of use to society in close collaboration with leading research and educational institutions both in Denmark and abroad. On top of this, the Institute carries out consultancy and standardisation services, which contribute to a dynamic and harmonious development of society.

Their most important task is to ensure that new knowledge and technology quickly can be converted into value for customers in the form of new or improved products, materials, processes, methods and organisational structures. DTI works together with new and existing companies, either individually or in groups, on ways to enhance technological and management restructuring and efficiency, across a broad range of industries as well as in leading edge sectors.

Therefore, they focus on innovation and competitiveness, management and training, sustainable exploitation of resources and cost-effectiveness in company and society.

Fraunhofer Gesellschaft (Germany)

Fraunhofer Gesellschaft zur Förderung der angewandten Forschung, is Europe's largest application-oriented research organization, founded in 1949. It promotes and conducts applied research in an international context to benefit private and public enterprise and is an asset to society as a whole. Their research efforts are geared entirely to people's needs: health, security, communication, energy and the environment. As a result, the work undertaken by their researchers and developers has a significant impact on people's lives.

By developing technological innovations and novel systems solutions for their customers, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their region, throughout Germany and in Europe. Their research activities are aimed at promoting the economic development of our industrial society, with particular regard for social welfare and environmental compatibility.

Imec (Belgium)

In 1984 the Flemish Government set up a program in the field of microelectronics with the goal to strengthen the microelectronics industry in Flanders. The decision was inspired by the strategic importance of microelectronics for the industry, and by the major investments required to keep up with developments in this field. This program included setting up a laboratory for advanced research in microelectronics (imec), a semiconductor foundry (former Alcatel Microelectronics, now STMicroelectronics and AMI Semiconductor), and a training program for VLSI design engineers. The latter is now fully integrated in the imec activities.

Today, imec performs world-leading research in nanoelectronics. They leverage their scientific knowledge with the innovative power of their global partnerships in ICT, healthcare and energy. Imec delivers industry-relevant technology solutions. In a unique high-tech environment, their international top-talent is committed to providing the building blocks for a better life in a sustainable environment.

In September 2016, imec merged with another Flemish research centre, iMinds. Imec's broadened research and collaboration offering makes it a unique and world-class research center in the field of nanoelectronics, excelling in software and ICT expertise. The broadened innovation center – which operates under the imec name – will use this knowledge to develop disruptive technologies and solutions in application areas such as health, smart cities and mobility, logistics and manufacturing, and energy.

Its staff of close to 2,000 people includes over 600 industrial residents and guest researchers. imec's research is applied in better healthcare, smart electronics, sustainable energy, and safer transport.

SINTEF (Norway)

SINTEF is a large independent non-profit research organisation in Scandinavia and was founded in 1950. Over the last 60 years, they have created value and innovation through knowledge generation and development of technological solutions that are brought into practical use.

Today, SINTEF is a broadly based, multidisciplinary research organisation with international top-level expertise in technology, medicine and the social sciences. SINTEF consists of several legal entities where Stiftelsen SINTEF has the majority of the shares in the legal entities. There is a common top level management for the legal entities. SINTEF employs around 2,100 people of 70 different nationalities.

TECNALIA (Spain)

TECNALIA RESEARCH & INNOVATION (www.tecnalia.com) is the leading private, non-profit and independent applied research and technology organisation in Spain and a center of international excellence. Legally it is a Foundation, employing around 1,400 people (225 PhDs) and with income of 105.2 million euro in 2017.

The whole team at TECNALIA has one goal: to transform technology into GDP, meaning wealth to improve people's quality of life through generation of business opportunities for industry. In fact, Tecnalia has a strong link with industry as more than 120 companies are involved in our governance and more than 50% of TECNALIA's income comes from contracts with industry. TECNALIA is committed to generate major impacts in economic terms, by means of innovation and technological development addressed by 6 interconnected Business Divisions (Sustainable Construction, Energy & Environment, ICT, Industry & Transport, Health and Advanced Technological services) that perform multi-sectoral & multi-technology research and development in 6 global challenges: Advanced Manufacturing, Low Carbon Energy, Climate Change and Lack of Resources, a Digital and Hyperconnected world, a New Urban Habitat and Health & Ageing of the Population. All in perfect alignment with the regional smart specialisation.

Tecnalia is also very active in technology transfer by means of TECNALIA Ventures which is a wholly owned subsidiary for the commercialisation of innovative technology-based results, turning innovative technology assets into new profitable and sustainable businesses and generating economic value for society. TECNALIA Ventures focuses on accelerating the development of disruptive technologies to transform them into investable business opportunities and managing the portfolio of TECNALIA spin-offs. TECNALIA has been granted over 396 patents and promoted more than 30 spin-off companies.

TNO (The Netherlands)

TNO, the Netherlands Organisation for Applied Scientific Research, was founded by law in 1932 to enable business and government to apply knowledge. As an organisation regulated by public law, they are independent: not part of any government, university or company.

TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. This mission drives over 2,600 professionals in their daily work. As an independent research organisation TNO works in collaboration with partners and focuses on nine domains:

- Buildings, Infrastructures & Maritime: 'Robust constructions, sustainable use'
- Circular Economy & Environment: 'Directing and accelerating sustainability'
- Defence, Safety & Security: 'We're putting our knowledge and technology to work for safety and security'
- Energy: 'Faster towards a sustainable energy supply'
- Healthy living: 'Focusing on participation, not on the disease'
- Industry: 'Innovating for employment, welfare and well-being'
- Information & Communication Technology: 'Interpreting and accelerating digital transformation'
- Strategic Analysis & Policy: 'Turning complex issues into concrete innovations'
- Traffic & Transport: 'Helping to create liveable, sustainable cities'

VTT (Finland)

VTT, Technical Research Centre of Finland, was founded in 1942. As a fully state-owned, not-for-profit company with a specific service mandate, VTT is part of Finland's innovation system, and operates under the mandate of the Ministry of Economic Affairs and Employment.

With the mission to support economic competitiveness, societal development and innovation, VTT carries out research and innovation activities creating growth opportunities for industry and society.

VTT is impact-driven and trans-disciplinary in its approach. VTT's broad networks give access to the best knowledge worldwide. Respectively, VTT employs unique Finnish strengths and expertise for the benefit of the whole society when addressing complex global challenges and collaborating around the key focus areas: climate action, resource sufficiency, good life, safety and security, and industrial renewal.

Annex 2 – Data coverage and quality

Table 5: Data coverage and quality (2015-2016)

	AIT	CEA	DTI	Fraunhofer	imec	Stiftelsen SINTEF	TECNALIA	TNO	VTT
SCOPE	*Consolidated*	*Civil activities and defence activities*	*Consolidated*	*Consolidated*	*imec Belgium* *As of 2016, after the merger: former iMinds included*	*Consolidated*	*Entire organisation*	*Parent company (Organisation of TNO)*	*Parent company*
Employment	x	x	x	x	x	x	x	x	x
Turnover	x	x	x	x	x	x	x	x	x
Value added	x	x	x	NA	x	x	x	x	NA
Operational grant	x	x	No operational grants	x	x	x	x	x	x
Purchases	x	x	x	x	x	x (sector distribution only for national data)	x	x (no cross-distribution sector and country)	x
Investments in infrastructure	Total	Total and case	Total and case	Total	Total and case	Total	NA	Total	x
Government funded research	x	x	x	x	x	x	x	x	x
Collaborative research	x	x (no sector distribution)	x	x	x	x (aggregate sector distribution)	x	x	x
Spin-offs	No spin-offs	Only FTE 2015	No spin-offs	Only estimated average FTE 2015	x	x (only head count)	x	x (only head count)	x
Life expectancy of spin-offs	No spin-offs	x	No spin-offs	NA	x	x	x	NA	x
Outflow of staff	Total only	Total and researchers	Total, geography and destination sector	Total and researchers	Total and geography	Total, geography and destination sectors	Total, geography and destination sectors	Total only	Total, researchers and destination sector

Annex 3 – Evolutions compared to 2013-2014

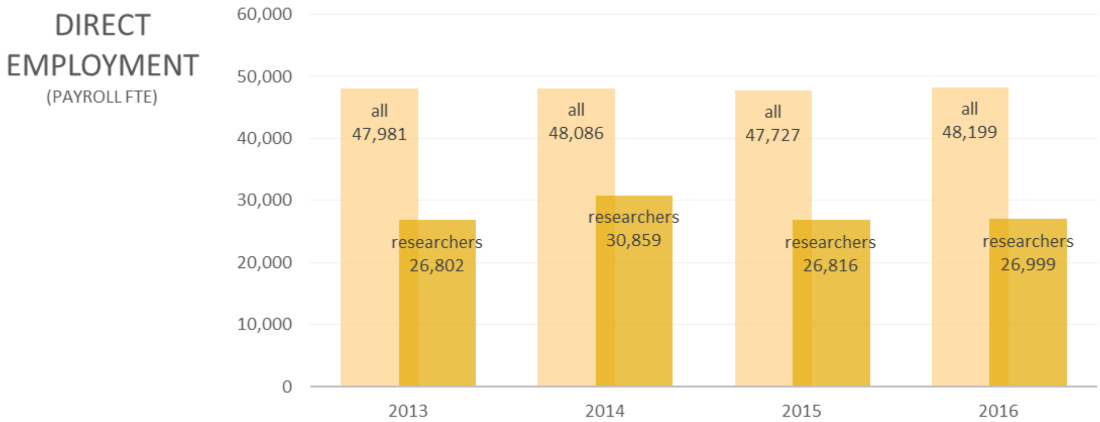
In comparison to the first economic footprint of 9 RTOs in Europe in 2013-2014, the 2015-2016 edition has evolved in some aspects that affect the data and consistency of the results (cf. section 3.2 of Part 1 and Annex 2):

- One RTO dropped out and one new RTO was added. The newly included RTO has a similar order of magnitude but still a slightly lower direct effect than the one that is no longer included.
- The merger of one RTO (included in the first economic footprint) with another RTO (not included in the first economic footprint) in 2015 leads to an increase with the scale of this second RTO;
- The corporisation of one RTO in 2015, meaning that while this RTO used to be state-owned and did not receive a separate grant, it is now a limited liability company which is attributed a separate grant.
- A number of RTOs reported a decline of their revenues or employment due to increased budgetary pressure in their home countries.
- Accuracy of the data increased due to more systematic monitoring by the RTOs, refined definitions and estimations, etc.

These evolutions entail that the results from both editions are not fully comparable. However, some results are or can be interpreted as such. In this Annex to the 2015-2016 economic footprint report, we provide an overview of the relevant evolutions compared to 2013-2014.

Economic footprint of the organisations

The direct effects have not increased compared to 2013-2014: employment has remained stable, with variations across the RTOs, and the reported turnover has decreased considerably from around 8 billion euro in 2014 to around 7.2 billion euro in 2016 – in part due real effects but also in part to alterations in the definitions or calculation methods used by the RTOs.



Source: IDEA Consult based on RTO data

The sum of reported grants has increased from 3.5 billion euro in 2014 to 3.8 billion euro in 2016 due to a number of external reasons:

- The merger of one RTO with another RTO, which is new and additional to the study, as is its grant;
- The corporisation of one RTO in 2015, meaning that while this RTO used to be state-owned and did not receive a separate grant, it is now a limited liability company which is attributed a separate grant;

Otherwise, there is variation across the RTOs with a substantial increase for two RTOs and one RTO facing a considerable decrease of grants compared to 2013-2014.

EMPLOYMENT MULTIPLIER

(DIRECT + INDIRECT + INDUCED EMPLOYMENT / DIRECT EMPLOYMENT)

2013	**2.14**
2014	**2.13**
2015	**2.28**
2016	**2.31**

Even though the direct effects seem to have decreased somewhat, the total impact (indirect and induced) has increased due to real effects: the purchases have increased over time, thus resulting in higher indirect effects, and in turn higher induced effects. Given the status quo in the direct employment and the increase in the total effects, also the employment multiplier (i.e. the ratio of direct, indirect and induced employment over direct employment) from the economic activities of the RTOs increases from 2.13 in 2014 to 2.31 in 2016.

In the calculation of the fiscal multiplier, evolutions in the Eurostat-based parameters have overall little effect on the outcomes. However, the increased fiscal returns of direct, indirect and induced effects are offset by the increased sum of grants. The fiscal multiplier has stayed more or less the same as in 2013-2014, at around 1.

Economic impact of a selection of scientific/technological activities

The results on outflow of staff, contract research and spin-offs are not comparable to the 2013-2014 economic footprint study. For each of these activities, the data delivered by the RTOs was extended and more accurate in the 2015-2016 study. The 2013-2014 results are thus to be considered lower boundaries to the real effects. The 2015-2016 study gives an overall better coverage of the effects, although there is still some room for further improvement in the future.

Outflow of staff:

- This aspect is new compared to the 2013-2014 study. In the latter, we did mention the effect and roughly estimated its order of magnitude based on very limited data from the RTOs. In the 2015-2016 study, the data was part of the monitoring exercise by all RTOs and they were all able to provide information on the total outflow of staff, and around half also on either number of researchers, destination sector or geographical destination. This makes the data much more accurate that in the 2013-2014 study.

Contract research:

- The reported budget from contract research is considerably higher in the 2015-2016 edition because of an extended definition (2.5 billion euro in 2016 compared to 1.9 billion euro in 2014). The budget does not only include the bilateral research contracts, but all collaborative research contracts. This makes a difference in a couple of RTOs. It does not indicate an evolution as such but does concerns real (additional) effects, so the results reflect a better coverage of the effects of the collaborative research contracts.

Spin-offs:

- The data regarding spin-offs was monitored more extensively, with more spin-offs included and more accurate estimates of the number of FTEs per spin-off being available in most of the RTOs. The increased availability of data results in higher values in the analysis (the number of FTEs in spin-offs of the RTOs add up to 7,200 in 2016, compared to 5,600 in 2014) that do not only reflect real evolutions (as a number of spin-offs have grown considerably in terms of FTE compared to 2014), but also reflect a more complete coverage of the same effects (with the FTE number being available for more spin-offs compared to 2014).

Total economic footprint

When looking at the total economic impact of both the economic activities of the RTOs and a selection of their scientific/technological activities, the total employment multiplier increased from around 4 in 2014 to 5 in 2016. This increase is mainly driven by the real increase in indirect and induced effects of the economic activities of the RTOs, as well as by the increased coverage of effects of the scientific/technological activities. The total fiscal multiplier decreased from 3.76 in 2014 to 2.69 in 2016 due to an increase in the sum of reported grants, driven mainly by external factors like the merger and status change of RTOs in the sample (cf. supra).

Annex 4 – Workshop Technology Transfer and Multiplier

Monday 18 September 2017

IDEA's office

1. Participants

Name	Organisation	Present/Telco
Nathalie Popiolek	CEA	Present
Stig Yding Sørensen	DTI	Present
Christopher Frieling	Fraunhofer	Present
Rainer Frietsch	Fraunhofer	Present
Bart Van Bael	imec	Present
Angelica Lopez Sobrado	TECNALIA	Present
Ernst Herlof Kristiansen	SINTEF	Present
Leena Sarvaranta	VTT	Present
Sophie Viscido	EARTO	Present
Miriam Van Hoed	IDEA Consult	Present
Kleitia Zeqo	IDEA Consult	Present
Pierre Padilla	IDEA Consult	Present

2. Agenda

The technology multiplier is generally calculated as the value added created at the company for each euro invested in technology uptake from RTOs. It is used in the IDEA impact analysis to calculate the value added created at the company for each euro invested in contract or collaborative research with an RTO.

IDEA refers to a study by Knell (2008) that calculates the value of 1.98 for the technology multiplier in Europe based on the OECD input/output tables. The main criticisms related to this value are that the value is based on old data (2001) and that the multiplier is defined at country level, so not sufficiently sector-specific.

Other studies refer to return on investment approaches, expert opinions, or previous micro-level research of company data.

In the workshop with RTOs, the aim was to discuss and find consensus on:

- Evolutions in knowledge/technology transfer and uptake in companies of technologies developed in the RTOs, that are expected to influence the value of the multiplier over the last 15 years;
- Sector-specific aspects regarding RTOs that are expected to influence the value of the multiplier compared to that at country level;
- A realistic value/range for the technology multiplier of RTOs in Europe.

3. Conclusions

Overall conclusions

- Evolutions in technology transfer are globalisation, specialisation and more forms of collaboration and recurrence of this collaboration. Also digitalisation is a trend to look into.
- Absorptive capacity remains a crucial aspect for the uptake in the firms, funding and support services are enablers of the collaboration.
- There are many indications that the value set by Knell (2008) for the technology multiplier is a lower boundary to the real multiplier effect, however there are no figures or data underpinning these arguments and that further allow to estimate the extent to which the real value would deviate from it.

- There is too little transparency on values found in other studies. Even though the 3.6 value of the LERU study on research universities seems in line with the expectations for RTOs, it is not underpinned by sufficient data to argument the use of it for RTOs.
- As an outcome of the discussion, all RTOs agree on the continued use of a lower boundary, set by the Knell multiplier, in the economic footprint study. Another argument for this, is to keep consistency with the EF1 study.
- In addition, the range set by the use of an upper boundary (3.6 value of the LERU study) will be reported as well. The report will argument and explain the use of the Knell multiplier value, as well as its limitations, and argue why the technology transfer impact in reality might be higher.

Part 1 of the discussion: Evolutions in knowledge/technology transfer and uptake in companies

Q: How does technology transfer work in RTOS?

- There is a diversity of channels, business models, supporting facilities to address technology transfer towards companies. The people aspect has become more and more important.
- In the past 15 years, the concept of technology transfer has evolved towards the broader concept of collaboration and technology uptake, including not only contract research but also collaborative research, training, funded projects, start-ups etc. Collaboration is more important than before, with the companies becoming partners in research, rather than clients. The broader concept includes more processes, tangible and intangible, and each of these will have a different (type of) impact and multiplier.
- Aspects to take into account in the discussion are: the time lag of effects, the different levels of TRLs (and the influence thereof on absorptive capacity, speed to market, etc.), size of the company (medium-sized technology intensive companies appear to benefit most), 1:1 versus 1:many set-up, access to finance, services/channels, etc.
- Absorptive capacity is appreciated as a crucial factor in the uptake and in the results thereof.
- Trust is appreciated as a crucial factor for collaboration (even in a globalising context (cf. infra)).

Q: Evolution in technology transfer at the companies?

- Companies changed the way they are doing their R&D. What has happened is the globalisation of knowledge, and companies are doing global knowledge sourcing.
    - Specialisation: They link up with universities and companies all over the world and source the best facilities.
    - Complexity: The type of technologies are also more complex and the technology cycles are shorter, requiring more collaboration, more openness and exchange.
    - Proximity to clients is another aspect that influences the globalisation of collaborations.
- Fear of knowledge loss is present but trust and reliability are important.
- RTOs experience that there is not really an increase in the number of companies they work with, but they do increasingly see the companies coming back. The collaboration is recurrent due to the higher need for external knowledge and the increase of complexity.

Q: Evolution in technology transfer at the RTOs?

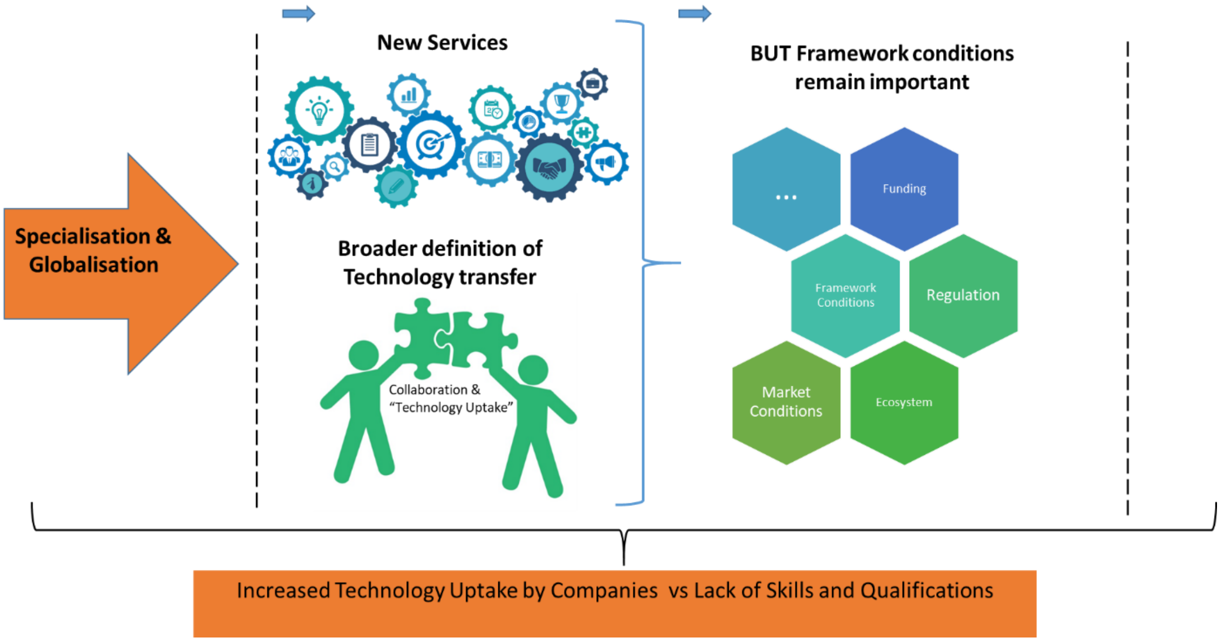
- Different business models, closer to the needs of the market.
- New access doors in reaction to globalisation and specialisation: RTOs' way to approach collaboration has also changed. Networks have grown stronger because of increased competition: there is more choice in the global context, and there is a need to offer more tailored/specialised services.

Q: What are the main enablers and barriers of technology transfer?

- A lack of absorptive capacity is an important barrier, but also the need of qualification.

- In the early phase, many companies do not see the direct benefit and are therefore not prepared to invest the cost. This is in particular true for small companies (1-50 employees), who generally have a shorter term horizon than large companies in terms of investments. They need some support to do things, related to the perception of risks and opportunities.
- Another barrier is the lack of ambition for growth. This barrier is however smaller among the technology-intensive or innovation-oriented companies that are typically the clients of RTOs. Also the lack of market knowledge, of where the market is going and the risks/challenges this evolution may bring for the company, is a barrier in that respect.
- A public programme supporting SMEs in collaborative research helps a lot to enhance collaboration, uptake and start the creation of trust.
- Another enabler are programmes that target SMEs specifically in trying to understand what they need and talk their language. This helps to implement technology transfer in different stages, depending on their capacity and life cycle. Also business models for growth can be part of this support.
- The local ecosystem is an important framework enabling the RTOs to work as they do and support them in their missions.

Concluding scheme:



Source: IDEA Consult

Part 2 of the discussion: Value/Range for the technology multiplier

Discussion on technology multipliers in literature

The Knell (2008) value for the technology multiplier is based on OECD input/output data of 2001. It reflects technology transfers at the macro-level of the country and is thus rather outdated and not sector-specific. It is defined as the multiplication of each euro of intramural R&D expenditures in the Euro zone, to the creation of 1.98 euro of embodied technology.

Other studies indicate that the value of 1.98 is an underestimation of the multiplier for RTOs. A study by Biggar Economics (2015) for research universities in Europe applies a value of 3.6, based on previous studies on companies involved in research contracts with universities. This is in line with the value of 3.4 found by PriceWaterhouseCoopers in their study on the impact of RDA spending. Other references indicate that the value is expected to be at least higher than one (benefits exceed costs) and that the average value disguises large dispersion between few success stories with large multiplication effects, and many other stories with zero effects.

Literature sets a range of 2 to 3.6 for the technology multiplier.

Discussion on factors that have evolved and influence the multiplier value

- A number of factors point at an increase of the technology multiplier compared to 15 years ago:
  - Increased specialisation points at higher value added of the technology transfer for companies than before;
  - The use of adapted business models and tailored support services;
  - The recurrent character of collaborations.
- A number of factors point at a higher value of the technology multiplier compared to literature from university impact studies:
  - More frequent contact with industry than universities;
  - More application oriented knowledge and technology transfer.
- A number of factors influence the value of the technology multiplier compared to the definition of the Knell (2008) multiplier, the direction of the effect can go either way:
  - This multiplier refers to intramural R&D, while it can be expected that a company seeks greater value added in extramural R&D under the condition that absorptive capacity at the company is sufficient;
  - However, the return on investment for venture capitalists would be on average much lower.
- What would be the effect of digitalisation, one of the main trends of the past 15 years? It can be expected that access to knowledge and training has improved and that a broader group of companies around the world is reached through new channels.
- How to take into account the time lag of effects (value for one year, or over time)?

Result of the discussion

- There are many indications that the value set by Knell (2008) for the technology multiplier is a lower boundary to the real multiplier effect, however there are no figures or data underpinning these arguments and that further allow to estimate the extent to which the real value would deviate from it.
- There is too little transparency on values found in other studies. Even though the 3.6 value of the LERU study on research universities seems in line with the expectations for RTOs, it is not underpinned by sufficient data to argument the use of it for RTOs.
- As an outcome of the discussion, all RTOs agree on the continued use of a lower boundary, set by the Knell multiplier, in the economic footprint study. Another argument for this, is to keep consistency with the EF1 study.
- In addition, the range set by the use of an upper boundary (3.6 value of the LERU study) will be reported as well. The report will argument and explain the use of the Knell multiplier value, as well as its limitations, and argue why the technology transfer impact in reality might be higher.
- The RTOs will think about a benchmark within the EF2 study, where they can explain their own deviation from the mean. This interpretation might then allow to come up with more qualifies answers with respect to the technology multiplier.