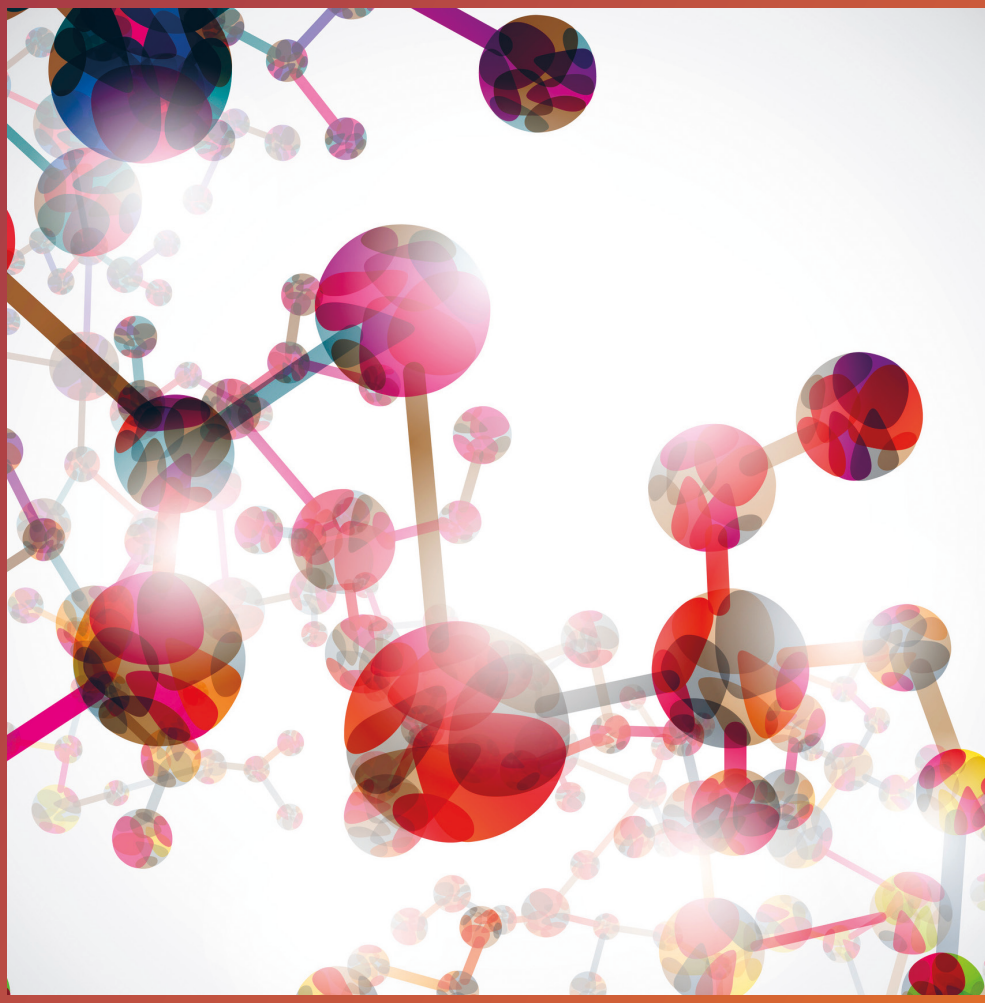
Effects of participation in EU framework programmes for research and technological development

– for researchers, institutions and private companies in Denmark



Research and Innovation: Analysis and Evaluation 3/2015

Ministry of Higher Education and Science
—
Danish Agency for Science, Technology and Innovation

Effects of participation in EU framework programmes for research and technological development

– for researchers, institutions and private companies in Denmark

Research and Innovation: Analysis and Evaluation 3/2015

Published by

Ministry of Higher Education and Science
Bredgade 40
1260 Copenhagen K
Denmark
Telephone: +45 33929700
E-mail: ufm@ufm.dk
www.ufm.dk

Cover

Sergil Ieromia, Fotolia

Layout

Rosendahls A/S

Print

Rosendahls A/S

Free text

Publication can be downloaded at ufm.dk/publikationer or ufm.dk/en/publications

ISBN: 978-87-93151-65-9
ISBN: (electronic publication): 978-87-93151-64-2
ISSN: 2246-6762

Contents

Foreword 5

Executive Summary 6
Purpose of this report 6
[illegible] 6
[illegible] 8

[illegible] 9
1.1. EU's Sixth and Seventh Framework Programmes for Research 10
[illegible] 12

[illegible] 13
2.1. Main findings 13
2.2. Overview of Danish participation in FP6 and FP7 14
[illegible] 18
[illegible] 19
[illegible] 22
2.3.3. Danish research and technology organisations (RTOs) 23
2.4. Danish participation in FP6 and FP7 by region 24
2.5. The [illegible]
and Horizon [illegible] 25
2.6. Danish participation in ERC excellence projects (FP7) 27
[illegible] 28
[illegible] 29
[illegible] 30

3. Importance of FP6/FP7 – perceived effects 34
3.1. Main findings 34
[illegible] 34
3.3. Effects for universities and GTS institutes 35
3.4. Effects for universities 36
3.5. Effects for private companies 41

4. Economic impact on FP6/FP7-participating companies 44
4.1. Main findings 44
[illegible] 45
4.3. Impact assessment 48
4.3.1. The matching sample 48
[illegible] 51
[illegible] 54

5. Private companies' use of FP6, FP7 and the Danish national research and innovation system 5
5.1. Main findings 5
5.2. The companies' use of the Danish research and innovation system 5
5.3. The most popular Danish research and innovation partners 5
5.4. The entrance to the Danish research and innovation system 5
5.5. Conclusion 5

6. Bibliometric performance analysis of publications by Danish researchers linked to FP6 and FP7 6
6.1. Main findings 6
6.2. Results 6
6.2.1. Publication performance FP6 and FP7 6
6.2.2. Benchmark analyses 6
6.2.3. Bibliometric analysis of publication sets linked to programme themes under FP6 and FP7 programmes 6
6.3. Methods 7

7. The individuals participating in FP6 and FP7 7
7.1. Main findings 7
7.2. Characteristics of the individuals participating in FP6 and FP7 7
7.2.1. Gender balance 7
7.2.2. Age 7
7.2.3. Field of science 7
7.2.4. Citizenship 7
7.2.5. Career 7
7.2.6. Sector 8
7.3. Methods 8
7.3.1. Collection of data on individual level 8
7.3.2. Method for comparison – selection of comparable individuals 8

8. Annexes **8**
8.1. Annex 1 – Participation of Denmark and private companies in FP6 and FP7 8
8.2. Annex 2 – Individual participation 9
8.2.1. Age 9
8.2.2. Field of science 9
8.2.3. Career 9
8.2.4. Sector 9

Foreword

An international outlook is essential for research and innovation projects to have a high impact. EU's framework programmes for research and technological development therefore play an important role for the Danish research community and business environment. This means not only EU funding of research and development activities in Denmark but also the opportunity to cooperate with excellent foreign research and innovation environments, and thereby to have access to new knowledge and new markets.

Competition for EU funding is tough, but there are positive measurable effects coming out of the participation in EU projects. The impact of scientific publications linked to EU's earlier framework programmes is outstanding and above the international performance levels. This should give researchers an extra incentive to look into the possibilities for cooperation that are funded by Horizon 2020, EU's 8th framework programme for research and innovation.

Another crucial element in addressing societal challenges and creating growth and jobs is collaboration among various actors in research and innovation projects. Cooperation among universities, GTS institutes and the business community is an important characteristic of the EU framework programmes. This is even more the case with the increased focus on innovation and market opportunities in Horizon 2020.

A constant focus is needed on bridging the gap between research and commercial markets through innovative new solutions. EU's framework programmes also provide an excellent opportunity for Danish companies in this context. Between a quarter and a third of the Danish participants in EU's framework programmes come from the private sector. Those participating are active in the European or global markets; they increase revenue at a fast pace, and they employ intensively highly-skilled workers.

Horizon 2020 provides funding to the innovation leaders. However, with a stronger focus on the commercial exploitation and delivery of solutions to end users, the programme has now become even more relevant for companies within manufacturing and services. To a much higher degree than previously, researchers have to reach out to the private sector. If they want to succeed, they have to design a common approach for how to address major societal challenges within, for example, the bioeconomy or health and demographic development. I therefore expect an increase in the participation of private companies in Horizon 2020.

Continued funding of research and innovation activities needs to be backed up by knowledge about the outcome of these activities. This report gives unique knowledge about the effects of Danish projects funded by previous EU framework programmes. It also shows a number of valuable and interesting effects that participation in European research and development projects has had for Danish researchers and companies. I hope that this report will encourage the Danish research and business communities to increase their participation in Horizon 2020.

Esben Lunde Larsen
Minister of Higher Education and Science

Executive Summary

Purpose of this report

Danish institutions and companies have participated 1,646 times in 1,125 grants in EU's Sixth Framework Programme for Research, Technological Development and Demonstration (FP6) and 2,754 times in 2,011 grants in EU's Seventh Framework Programme for Research and Technological Development (FP7). On an annual basis, Danish researchers and firms have received EUR 79 million per year from FP6 and EUR 151.5 million per year from FP7.

The purpose of this report is both to describe this participation and to study the effects that FP6/FP7 participation has had for Danish institutions, researchers and companies, both with regard to experienced effects and measurable effects. FP7's successor, EU's Framework Programme for Research and Innovation (Horizon 2020), has a budget of almost EUR 80 billion. This has grown substantially in both nominal and real figures compared to FP6 and FP7. Researchers, institutions and companies are invited to take the effects described in this report into consideration when considering participating in Horizon 2020.

This report analyses the effects of participating Danish institutions and companies in three parts: 1) What effects do representatives from universities, GTS institutes and companies experience following their participation in FP6 and FP7?, 2) What economic effect can be measured for private companies participating in FP6/FP7?, 3) What is the scientific impact of FP6- and FP7-linked publications?

This report describes the overall participation of Danish institutions and companies; private companies' use of FP6, FP7 and the Danish research and innovation (R&I) system, and the individuals participating in FP6 and FP7.

Main findings

A very interesting and somewhat surprising finding of the bibliometric analysis is the outstanding performance level of the FP6- and, in particular, the FP7-linked publications. The publications are above (and in some cases far above) international performance levels, when looking at citations. This analysis shows that FP7-linked publications have a higher impact than even publications linked to The Danish Council for Independent Research and The Danish National Research Foundation.

Another main finding from the bibliometric analysis is that it is not only publications linked to the European Research Council (ERC) that have a high impact but also publications linked to strategic programmes under both FP6 and FP7, such as health and environment.

The main FP6/FP7 participants in Denmark are universities and research institutions, followed by private companies and, finally, public authorities. Three Danish universities (University of Copenhagen, Aarhus University and Technical University of Denmark) alone account for almost one third of total EU contribution to Denmark from FP6 and half of total EU contribution from FP7.

The Danish share of total EU contribution from the EU framework programmes has been stable at 2.37 per cent from FP6 and 2.36 per cent from FP7. The yearly nominal contribution rose by more than 90 per cent from FP6 to FP7 – from EUR 79 million annually in FP6 to EUR 151.5 million annually in FP7. EU contribution from Horizon 2020 to Denmark was 2.30 per cent in the first year of Horizon 2020.

Participants from institutions based in the Capital Region received almost two-thirds of total EU contribution to Denmark from both FP6 and FP7. However the Central and North Denmark Regions increased their share of EU contribution to Denmark in FP7.

With regard to the gender balance, we can see that the proportion of men participating in both FP6 and FP7 is higher than the proportion of men within research in general. The higher proportion of men in FP6 and FP7 is most likely related to the fact that natural science and technical science, which both have a higher proportion of men than other sciences, are overrepresented in FP6 and FP7 compared to humanities, for example.

With regard to internationalisation, the percentage of foreigners from Danish institutions and companies participating in FP6 or FP7 is higher than the general level of foreign researchers in Denmark. The PhD students are the group with the largest share of foreigners participating in FP6/FP7, also compared to PhD students in Denmark in general. 11 per cent of participating researchers and 42 per cent of participating PhD students in highly-skilled positions are foreigners.

FP6/FP7 companies are highly unusual companies compared to the average Danish company. On average, they gain about 40 per cent of their revenue through exports, grow revenue at a fast pace and employ intensively highly-skilled workers. Large companies participate frequently in FP6/FP7. The largest share of participants is found in the following industries: manufacturing, professional, scientific and technical activities.

EU programmes are an integral part of the overall landscape for public funding of research and innovation in Danish companies, as half of the companies participating in FP6 and FP7 have also participated in the Danish research and innovation (R&I) system.

Companies participating in FP6 and FP7 do not significantly outperform comparable non-participating companies. Typically, these companies have already succeeded in establishing international ties and breaking through into international markets. Regardless of participation in FP6/FP7 projects, they are well-functioning companies that do not seem to rely crucially on a particular funding body of public-private research partnership projects.

The main finding from the survey analysis is that Danish companies perceive funding of activities that would not otherwise have been implemented as the most important effect, closely followed by cooperation with foreign universities and research organisations and access to new knowledge. Small companies experience greater effects than medium-sized companies and large companies. As many as half of the participating companies say they have launched new products or services as a result of their participation in FP6 and FP7 projects.

Horizon 2020 has a greater focus on funding activities that will create jobs and growth in Europe. However, the first figures from Horizon 2020 show that Danish companies participate less in projects financed by Horizon 2020 than those financed by FP6 and FP7, but it is too early to identify a trend.

Building new European networks is the most important effect of participating in FP6/FP7 for GTS institutes and universities, closely followed by funding of activities that otherwise would not have been implemented, and cooperation with excellent foreign research and innovation environments. Differences in the perception of the most important effects between universities and GTS institutes seem quite small, which could indicate that universities and GTS institutes experience similar effects despite differing main objectives in their normal activities.

Conclusion

Overall it can be concluded that researchers benefit from positive effects in the form of bibliometric impact. The scientific impact of FP6- and, in particular, FP7-linked publications is outstanding. Companies themselves experience substantial effects, though these are not statistically significant when compared to similar non-participating companies. Universities and GTS institutes also experience considerable effects, in particular regarding new European networks and funding of activities that would not otherwise have been funded.

1. Introduction

The purpose of this report is both to describe participation in FP6 and FP7 and to study the effects this participation has had for Danish institutions, individual researchers and companies, with regard to experienced effects and measurable effects. The report focuses on universities, GTS institutes and private companies, as these are the three major groups participating in FP6 and FP7. Other participants, such as hospitals, university colleges, non-governmental organisations, NGOs and public bodies such as municipalities, also play an important role in the participate in.

Danish institutions and companies have participated 1,646 times in 1,125 grants in EU's Sixth Framework Programme for Research, Technological Development and Demonstration (FP6) and 2,754 times in 2,011 grants in EU's Seventh Framework Programme for Research and Technological Development (FP7). On an annual basis, Danish researchers, companies and other participating entities have received EUR 79 million per year from FP6 and EUR 151.5 million per year from FP7 for their participation in EU projects.

Danish participation in FP6 and FP7 was previously studied by Technopolis in 2010[1], where the financial, scientific and commercial benefits of Danish participation were assessed and the strategies employed in relation to framework programme participation were identified. Therefore, this study does not assess the benefits occurring directly from project participation, but the effects of participation on the institution or company. The study found that most of the outputs sought and produced through FP projects were research outputs (such as publications, conferences and trained personnel) and that there is far less activity in relation to the production of innovation outputs (such as new products, patents and licenses). This was to be expected, given the pre-competitive nature of the research carried out within the framework programmes.

The European Commission evaluates the framework programmes on a regular basis. Both ex-post evaluations of FP6[2] and an interim evaluation of FP7, as well as annual monitoring reports on FP7[3], are available. These look at the implementation of the framework programmes, including excellence in research, participation of small and medium-sized companies, outreach and communication to European citizens and leverage effects on overall EU research and innovation efforts. The interim evaluation of FP7 finds, amongst other things, that the European Research Council appears to have been successful in reaching its objectives of excellence and attracting top researchers. The Expert Group finds, however, that the involvement of industry, especially SMEs, in FP7 is "far from optimal"[4].

Chapter 2 of this report describes the Danish participation in terms of how much funding has been awarded to Danish participants, the types of Danish participants

1 http://ec.europa.eu/research/evaluations/pdf/archive/fp7-evidence-base/national_impact_studies/evaluation_of_danish_participation_in_fp6_and_fp7_-_main_report.pdf
2 http://ec.europa.eu/research/reports/2009/pdf/fp6_evaluation_final_report_en.pdf
3 https://ec.europa.eu/research/evaluations/index_en.cfm?pg=home
4 page 68, https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/fp7_interim_evaluation_expert_group_report.pdf#view=fit&pagemode=none

that have participated, and how Denmark has fared in the competition for funds over time and compared to other countries.

Chapter 3 sheds light on what effects Danish universities, GTS institutes and Danish companies perceive to be the most important to them from their participation in projects funded by FP6 and FP7. This is done by means of a survey analysis.

Chapter 4 is an impact assessment of company participation in FP6 and FP7 projects. Using detailed employer-employee-linked data spanning from 2000 to 2012, the participating companies are described relative to other companies. Then a five-year forward-looking impact assessment of company participation in projects initiated between 2002 and 2008 is performed.

Chapter 5 looks at the participation of Danish companies in FP6/FP7 and how this participation is linked to their participation in the Danish R&I funding system.

Chapter 6 analyses the impact of Danish scientific publications that are linked to FP6 or FP7 funding. In order to look at the impact, we have identified citations belonging to scientific publications with at least one Danish author. These results are compared to the results of the bibliometric analyses from the previous evaluations of the Danish National Research Foundation (DNRF) and the Danish Council for Independent Research (DFF). Finally the analyses also explore the impact at the level of programme themes under FP6 and FP7.

Chapter 7 analyses the characteristics of individuals participating in FP6 and FP7. Detailed employer-employee-linked data spanning from 2000 to 2012 are used to describe participating individuals in projects relative to other comparable individuals in the general population working with research and development (R&D).

1.1. EU's Sixth and Seventh Framework Programmes for Research

The EU's Sixth Framework Programme for Research, Technological Development and Demonstration (FP6) ran from 2002 to 2006 and had a total budget of almost EUR 18 billion, while the Seventh Framework Programme for Research and Technological Development (FP7) ran from 2007 to 2013 with a budget of more than EUR 50 billion. The two framework programmes thus differed considerably in both length of programme period and budget size. Also, competition has increased: over the years, the European Union has become larger and the Danish proposers collaborate and compete with legal entities from more and more member states and countries associated with the framework programmes.

FP6 and FP7 had different structures, but they built on each other. The main objectives of FP6 were to contribute to the creation of the European Research Area (ERA) and to strengthen the competitiveness of the European economy. Not all areas of science and technology were covered. FP6 consisted, among other things, of seven priority thematic areas as well as a specific programme to address the structural weaknesses of European research. The thematic areas with the largest budgets were: Information society technologies; Life sciences, genomics and biotechnology for health, and Sustainable development, global change and ecosystems.

FP7 consisted of four specific programmes, with COOPERATION covering seven key thematic areas. FP7 had the aim of responding to Europe's needs in terms of jobs and competitiveness, and maintaining leadership in the global knowledge economy. FP7 introduced the European Research Council, which funds basic research, and included new measures to ensure greater participation from industry and to strengthen the international dimension in the programmes. The individual areas

with the largest budgets were: Information and Communication Technologies; the European Research Council, and Health.

EU research framework programmes are based on open calls for proposals. EU funding of the successful applications comes in the form of an EU contribution to the participants' project-related costs, based on specific reimbursement rates. There are a number of different project types or "funding schemes" in EU framework programmes, such as collaborative research projects, networks of excellence, and co-ordination and support projects. These differ in the number of participants, budget size, EU contribution and main purpose.

In tables 1.1 and 1.2, the overall structure of FP6 and FP7 is outlined:

TABLE 1.1
STRUCTURE OF FP6

Integrating and strengthening the ERA	**Structuring the ERA**
Life sciences, genomics and biotechnology for health	Research and innovation
Information society technologies	Human resources and mobility
Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	Research infrastructures
Aeronautics and space	Science and society
Food quality and safety	
Sustainable development, global change and ecosystems	
Citizens and governance in a knowledge-based society	

TABLE 1.2
STRUCTURE OF FP7

COOPERATION	**IDEAS**	**PEOPLE**	**CAPACITIES**
Health	European Research Council	Marie-Curie Actions	Research Infrastructures
Food, Agriculture and Fisheries, and Biotechnology			Research for the benefit of SMEs
Information and Communication Technologies			Regions of Knowledge
Nanosciences, Nanotechnologies, Materials and new Production Technologies			Research Potential
Energy			Science in Society
Environment (including Climate Change)			Support for the coherent development of research policies
Transport (including Aeronautics)			International Cooperation
Socio-economic Sciences and Humanities			
Space			
Security			

1.2. Horizon 2020 – EU's Eighth Framework Programme

With Horizon 2020 the EU's research and innovation programme has been substantially changed. Compared to FP6 and FP7, more emphasis is placed on innovation and close-to-market solutions. There is a political wish to focus on job creation in a time of financial crisis. Participants have to demonstrate to a much larger extent in their applications that their projects will have an impact on jobs and growth. Horizon 2020 focuses on three main pillars: Excellent Science, Industrial Leadership and Societal Challenges, with the last pillar covering seven thematic areas.

The overall structure can be seen in table 1.3.

TABLE 1.3
STRUCTURE OF HORIZON 2020

Excellent Science	Industrial Leadership	Societal Challenges
European Research Council	Leadership in Enabling & Industrial Technologies	Health, demographic change and wellbeing
Future and Emerging Technologies	- Information and communication technologies	Food security, sustainable agriculture, marine and maritime and inland water research and bioeconomy
Marie Skłodowska-Curie-Actions	- Nanotechnologies - Advanced materials - Biotechnology	Secure, clean and efficient energy
Research Infrastructures	- Advanced manufacturing and processing - Space	Smart, green and integrated transport
	- Access to Risk Finance	Climate action, environment, resource efficiency and raw materials
	- Innovation in SMEs	Europe in a changing world-inclusive, innovative and reflective societies
		Secure societies – Protecting freedom and security of Europe and its citizens

2. Overall Danish participation in FP6 and FP7

This chapter presents a detailed overview of the Danish participation in FP6 and FP7. The purpose of this chapter is to provide a detailed view of the Danish participation in FP6 and FP7 in terms of participants, EU contribution, development over time, and collaborative links with other countries, in order to provide an insight into the Danish participation across the two framework programmes and put it into perspective in relation to the current framework programme, Horizon 2020.

Moreover, the analysis looks at different types of participants and geographic spread in FP6 and FP7), as well as the development of the Danish participation throughout the two framework programmes. The analysis also takes a closer look at Danish participation in two specific programmes of FP7, namely the European Research Council (ERC) and Marie Curie Actions, a mobility programme. Furthermore, the collaborative links between Danish participants and participants from other countries in FP6 and FP7 are presented. Finally, the analysis includes a comparison of the participation of Denmark and other countries in the two framework programmes.

2.1. Main findings

The Danish share of total EU contribution from the EU framework programmes has been stable at 2.37 per cent from FP6 and 2.36 per cent from FP7. However, in absolute terms, there was an increase in EU contribution to Denmark of almost 168 per cent from EUR 396.1 million in FP6 to EUR 1,060.6 million in FP7. Danish institutions participated 1,646 times in 1,125 FP6 projects and 2,754 times in 2,011 projects under FP7.

The three most successful Danish universities (University of Copenhagen, Aarhus University and Technical University of Denmark) alone account for a large part of the total EU contribution to Denmark: almost one third of total EU contribution from FP6 and half of total EU contribution to Denmark from FP7.

The participation of private companies rose from FP6 to FP7. The Danish private companies' share of the total number of Danish participants increased (27 per cent in FP6 and 29 per cent in FP7), but their share of EU contribution is slightly less (21 per cent in FP6 and 24 per cent in FP7) meaning that their average EU funding is slightly less than, for example, for the universities.

439 successful applicants from private companies obtained EUR 81.3 million from FP6, one fifth of the total EU contribution to Denmark, while 801 successful applicants received EUR 255.3 million from FP7, equal to one quarter of the Danish total from FP7.

Participants from institutions based in the Capital Region received almost two-thirds of total EU contribution to Denmark from both FP6 and FP7. The Central

and North Denmark Regions however increased their share of EU contribution to Denmark in FP7.

FP7 introduced the European Research Council (ERC), which supports top-level investigator-driven frontier research across all fields. During FP7, Denmark obtained 83 ERC grants. Most grants were obtained by University of Copenhagen (33 ERC grants), Aarhus University (25) and Technical University of Denmark (11).

Danish institutions participated in 384 Marie Curie Actions (PEOPLE), involving 433 Danish participants in total. This makes the PEOPLE programme the largest single programme in terms of number of participants from Denmark in FP7.

The countries with which Denmark collaborates the most in FP6 and FP7 projects are Germany, the United Kingdom and France. Danish institutions and companies also collaborate extensively with participants from the Nordic countries in both framework programmes. There are relatively fewer projects in FP7 than in FP6 with participants from both Denmark and one of the countries that acceded to the EU as part of the 2004 and 2007 enlargements.

2.2. Overview of Danish participation in FP6 and FP7

The EU framework programmes for research and innovation are based on open calls for proposals. This subanalysis examines the Danish participation in FP6 and FP7, and partly Horizon 2020, which is the result of these calls for proposals. The term ”EU contribution” refers to the funding from the framework programmes awarded to research and development activities.

The Danish share of total EU contribution from FP6 and FP7 is almost the same. However, there are big differences in the size of the budgets of the two framework programmes and, as a result, the Danish contribution from FP7 in absolute terms is much larger than for FP6. The EU contribution from the framework programmes rose by around 169 per cent from FP6 to FP7. As shown in table 2.1, the total EU contribution to Denmark from FP6 was EUR 396.1 million, equal to 2.37 per cent of the total EU contribution from the programme, while in FP7 Denmark took home EUR 1,060.6 million, equal to 2.36 per cent of the total EU contribution distributed from that programme. This corresponds to a 168 per cent increase of EU contribution to Denmark in absolute terms.

TABLE 2.1
EU CONTRIBUTION TO DENMARK FROM FP6, FP7 AND HORIZON 2020[5] [6]

	FP6	FP7	Horizon 2020
			(as of March 2015)
Total number of participations	74,583	133,615	17,118
Danish participations	1,646	2,754	376
Total number of projects	10,107	25,238	3765
Projects with Danish participation	1,125	2,011	286
Total EU contribution (EUR m)	16,697	44,917	6,621
EU contribution to Denmark (EUR m)	396.1	1,060.6	154,4
Average yearly EU contribution to Denmark (EUR m)	79	151.5	154.4
Share of EU contribution to Denmark (per cent)	2.37 %	2.36 %	2.30 %

One year into Horizon 2020, the Danish share of total EU contribution is EUR 152.4 million, equalling 2.30 per cent as of March 2015.

Tables 2.2 and 2.3 show the Danish participation in FP6 and FP7 per thematic area, while tables 8.1 and 8.2 in Annex 1 present a detailed overview of the Danish participation. The Danish share of total EU contribution is, in relative terms, highest in the area of food quality and safety under FP6. Under FP7, the largest share of EU contribution from a specific thematic area is within energy research, with a Danish share of 5.42 per cent of total funding received by 164 participants in 92 projects. In terms of total EU contribution, health research in FP7 is where Denmark reached the largest amount of funding: almost EUR 137 million. Food research is the thematic area of FP7 from which Denmark has its second largest share of total EU contribution (4.56 per cent).

The European Research Council (ERC) was established with FP7 and funds excellent investigator-driven frontier research across all fields. Funding from ERC, at EUR 146.3 million, accounts for almost 14 per cent of total EU contribution to Denmark from FP7.

Furthermore, funding supporting the mobility of researchers (the so-called Marie Curie actions) rose considerably from FP6 to FP7. Danish institutions and private enterprises took home EUR 40.3 million from the FP6 Human Resources and Mobility programme, equal to around 10 per cent of total EU contribution to Denmark from FP6, whereas Denmark obtained EUR 152.2 million in funding from the Marie Curie Actions (PEOPLE) programme, corresponding to 14.4 per cent of total EU contribution to Denmark from FP7.

5 Sources: The European Commission's Common Research Data (eCORDA) warehouse. For FP6: eCORDA Contracts database. Publication date: 6 June 2008. For FP7: eCORDA FP7 grant agreements and participants' database. Extraction date: 15 October 2014. For Horizon 2020: eCORDA Horizon 2020 consolidated proposals and applicants database. Publication date: 4 March 2015.

6 Includes roughly the results of one call year per programme under Horizon 2020.

TABLE 2.2
THE PARTICIPATION OF DENMARK IN FP6 (2002-2006)

Specific Programme	Priority Area	All Countries		Denmark	
		EC financial contribution (EUR m)	Projects with DK participation	DK Partners	EC financial contribution (EUR m)
INTEGRATING AND STRENGTHENING THE ERA	Life sciences, genomics and biotechnology for health	2,339.60	150	203	80.3
	Information society technologies	3,799.50	134	199	48.6
	Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	1,539.00	76	107	25.7
	Aeronautics and space	1,068.60	21	23	4.4
	Food quality and safety	751.6	60	138	52.9
	Sustainable development, global change and ecosystems	2,306.50	177	317	83.7
	Citizens and governance in a knowledge-based society	244.2	35	44	4.9
	Policy support and anticipating scientific and technological needs	601.7	115	157	20.2
	Horizontal research activities involving SMEs	485.2	74	123	10.9
	Specific measures in support of international cooperation	351.6	25	29	5.3
	Support for the coherent development of research & innovation policies	13.8	1	2	0.1
	Support for the coordination of activities	288	32	38	5
	Integrating and strenghtening the ERA total	**13,789.40**	**900**	**1,380**	**342**
STRUCTURING THE ERA	Research and innovation	225.4	21	33	5.3
	Human resources and mobility	1,693.20	158	172	40.3
	Research infrastructures	725.2	19	22	4.9
	Science and society	77.8	21	30	2.5
	Structuring the ERA total	**2,721.60**	**219**	**257**	**53**
EURATOM	**Euratom**	**185.7**	**6**	**9**	**1.1**
Total		**16,696.60**	**1,125**	**1,646**	**396.1**

TABLE 2.3
THE PARTICIPATION OF DENMARK IN FP7 (2007-2013)

	Priority Area	All Countries		Denmark	
		EU Contribution (EUR m)	Projects with DK participation	DK Partners	EU Contribution to DK (EUR m)
COOPERATION	Health	4,791.70	202	265	136.6
	Food, Agriculture and Fisheries, and Biotechnology	1,850.70	176	285	84.4
	Information and Communication Technologies	7,877.00	218	297	105.7
	Nanosciences, Nanotechnologies, Materials and new Production Technologies – NMP	3,238.60	152	223	81.6
	Energy	1,707.40	92	164	92.5
	Environment (including Climate Change)	1,719.30	130	175	50.8
	Transport (including Aeronautics)	2,284.20	66	99	26.7
	Socio-economic sciences and Humanities	579.6	60	65	15.4
	Space	713.3	31	42	12.5
	Security	1,295.50	33	42	14.3
	General Activities	312.7	3	5	1.1
	Joint Technology Initiatives (JTI)	1,966.40	93	157	51.1
	COOPERATION total	**28,336.30**	**1,256**	**1,819**	**672.7**
IDEAS	European Research Council	7,673.50	90	95	146.3
	IDEAS total	**7,673.50**	**90**	**95**	**146.3**
PEOPLE	Marie Curie Actions	4,777.40	384	433	152.2
	PEOPLE total	**4,777.40**	**384**	**433**	**152.2**
CAPACITIES	Research Infrastructures	1,528.40	78	91	34.5
	Research for the benefit of SMEs	1,249.10	130	217	37.8
	Regions of Knowledge	126.7	9	19	3.2
	Research Potential	377.7			0
	Science in Society	288.4	49	59	12.1
	Support for the coherent development of research policies	28.3	1	1	0.2
	International Cooperation	173.4	5	5	0.7
	CAPACITIES total	**3,772.00**	**272**	**392**	**88.4**
EURATOM	Fusion Energy	5.2	2	2	0.1
	Nuclear Fission and Radiation Protection	352.8	7	13	0.9
	EURATOM total	**358.1**	**9**	**15**	**1**
Total		**44,917.20**	**2,011**	**2,754**	**1,060.60**

2.3. Types of participating organisations

Participants in FP6 and FP7 are divided into a number of organisation types: the Higher Education Sector (HES), which includes all Danish universities and University Colleges; Research Organisations (REC), which includes the Danish research and technology organisations (GTS institutes, RTO), and Private for profit Companies (PRC), which includes both large companies and small and medium-sized enterprises (SMEs). Public institutions (PUB) include ministries, regions and municipalities, as well as university hospitals. Other (OTH) includes participants which could not be ascribed to one of the above-mentioned categories.

In 2007, many governmental research institutions[7] were merged with the universities as a result of the University Reform in 2007, and from then on they appeared in the statistics under the Higher Education Sector instead of Research and Technology Organisations. Therefore, participation by organisation type is not entirely comparable from FP6 to FP7, which is why we also take a closer look at the participation of both universities and GTS institutes.

As shown in figures 2.1-2.4, most of the Danish participation is composed of organisations from the Higher Education Sector (HES). It is interesting to note that Danish HES participation rose from 41 per cent in FP6 to 49 per cent in FP7, while their share of EU contribution to Denmark rose equally from 50 per cent to 57 per cent. The participation of the Danish private companies rose slightly from 27 per cent in FP6 to 29 per cent in FP7, while their share of EU contribution is relatively lower, but rose from 21 per cent in FP6 to 24 per cent in FP7. In other words, private companies typically receive less funding on average than participants from universities. This can partly be ascribed to the fact that fewer private companies coordinate FP6 and FP7 projects than universities. The coordinator would often receive the largest share of funding among the participants in an FP6 or FP7 project.

Figures 2.5 and 2.6 show the Danish participation in Horizon 2020 by participant type. It should be noted that the HES category is relatively large and the PRC category relatively small compared to FP7, both in terms of number of participants and EU contribution. Under FP7, universities and other participants from the HES category were involved in FP7 more than 1,300 times, while private companies participated around 800 times. Under Horizon 2020 (March 2015), 206 participants are from HES and 89 from private companies, out of a total of 376 Danish participants. In sum, the share of EU contribution to participants from the public sector, and especially the universities, has risen from FP6 to Horizon 2020 (as of March 2015).

Figures 2.1-2.6 show the Danish participation in FP6, FP7 and Horizon 2020 by participant type, calculated on the number of participations and on the basis of EU contribution awarded[8].

7 Sektorforskningsinstitutioner

8 FP6 participant data is divided into 14 participant types. For the purpose of this section, we have aligned the FP6 categories of participants to the same 5 categories used in FP7, in order to make the FP6 categories of participants comparable to those of FP7.
FP6 data: A large number of participants under the participant type "OTH" (Other) are in reality SMEs: 87 participants out of a total of 310 participants are from industry. 56 of these partners are SMEs. As a result, there are participants from industry under both of the categories "IND" (Industry) and "OTH" (Other). The organisation type assigned to the individual participants has not been altered for the purpose of this report.

FIGURE 2.1
FP6: PARTICIPANTS BY ORGANISATION TYPE

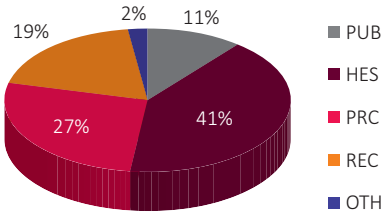


FIGURE 2.2
FP6: EU CONTRIBUTION BY ORGANISATION TYPE

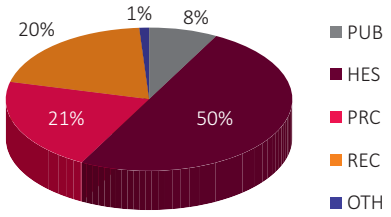


FIGURE 2.3
FP7: PARTICIPANTS BY ORGANISATION TYPE

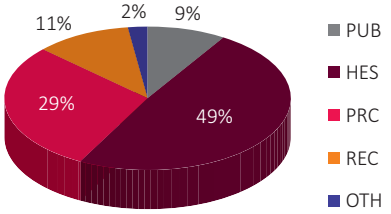


FIGURE 2.4
FP7: EU CONTRIBUTION BY ORGANISATION TYPE

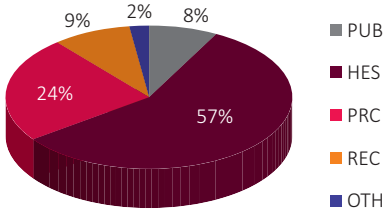


FIGURE 2.5
H2020 (MARCH 2015): PARTICIPANTS BY ORGANISATION TYPE

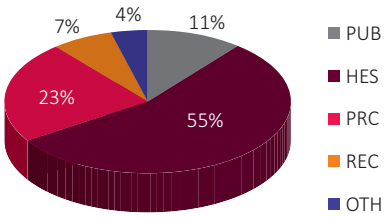
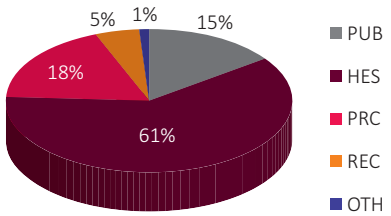


FIGURE 2.6
H2020 (MARCH 2015): EU CONTRIBUTION BY ORGANISATION TYPE



Participant types:
PUB = Public body (excluding research and education), HES = Higher or secondary education, PRC = Private for profit companies, REC = Research organisations and OTH = Other.

2.3.1. Danish universities

As can be seen in tables 2.4 and 2.5, the Danish universities obtained a total of EUR 164.4 million in FP6, while they received EUR 603.4 million in FP7. Thus, the universities have received about 3.7 times more EU funding in FP7 compared to FP6. As can be seen in figures 2.1 and 2.3, the universities' relative share of the Danish participation has increased from around 41 per cent in FP6 to 49 per cent in FP7. The universities' share of participation in FP7 is approximately one and a half times larger than the overall Danish share of participation in FP6. However, as mentioned in section 2.2., this can partly be ascribed to the merger of governmental research institutions with universities in 2007.

The number of coordinators from universities is much higher in FP7 than in FP6, rising from 93 in FP6 to 389 in FP7 (tables 2.4 and 2.5). This is mainly due to the establishment of the European Research Council (ERC) under the so-called IDEAS programme, and the increased number of Danish coordinators of Marie Curie Ac-

tions under the PEOPLE programme. As individual researchers are the main applicants for the projects under these programmes, they are counted as coordinators. This applies to 78 ERC projects and 215 Marie Curie Actions with Danish participation. However, even when removing these two specific programmes, there still is a considerable increase in the number of coordinators from FP6 to FP7.

Most significantly, University of Copenhagen (KU) has 5.8 times as many coordinators in FP7 as in FP6. This corresponds to almost half of all the projects the university participates in. Aarhus University (AU) has 5.3 times as many coordinators in FP7 compared to FP6. The remaining Danish universities have also doubled or more than doubled their number of coordinators from FP6 to FP7.

The Technical University of Denmark (DTU) participated most frequently in projects with Danish participation both in FP6 and FP7. In FP6, DTU accounted for the largest share of participation, but in FP7 it was University of Copenhagen that had the largest share of EU contribution. The IT University experienced the largest increase in participation among all universities from FP6 to FP7. The university's starting level of EUR 0.3 million is however quite low. All universities except one have increased their participation and contribution of European funds from FP6 to FP7. Roskilde University is the only Danish university which has not seen a significant increase in either participation or funding.

The participation of Danish universities in Horizon 2020 is shown in table 2.6. It may be noted that University of Copenhagen has been very successful at the beginning of the new framework programme and accounts for more than half of total EU contribution to Danish universities. Moreover, the share of EU contribution of University of Copenhagen is more than that of Aarhus University and Technical University of Denmark combined. The participation of Danish universities is most prominent under the Excellent Science pillar of Horizon 2020, which now covers both the European Research Council and Marie Skłodowska-Curie actions, where the universities' share of total EU contribution is more than 90 per cent of total EU contribution to Denmark. University of Copenhagen is home to more than 50 per cent of the total Danish share of the Excellent Science pillar, while the Technical University of Denmark is the university that receives the largest share of total EU contribution to Denmark under the Societal Challenges pillar, at around 14 per cent.

TABLE 2.4
THE DANISH UNIVERSITIES IN FP6

University	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK universities
Copenhagen Business School	17	3	3,359,259	2.04 %
Technical University of Denmark	192	28	52,457,819	31.91 %
IT University of Copenhagen	2	0	310,277	0.19 %
University of Copenhagen	145	32	41,227,184	25.07 %
Roskilde University	17	1	2,922,439	1.78 %
University of Southern Denmark	61	7	16,662,517	10.13 %
Aalborg University	60	8	18,685,049	11.36 %
Aarhus University	97	14	28,791,479	17.51 %
Total	**591**	**93**	**164,416,021**	**100 %**

TABLE 2.5
THE DANISH UNIVERSITIES IN FP7

University	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK universities
Copenhagen Business School	31	9	11,276,858	1.90 %
Technical University of Denmark	409	78	186,622,062	30.90 %
IT University of Copenhagen	9	3	4,493,705	0.70 %
University of Copenhagen	397	186	191,354,641	31.70 %
Roskilde University	16	2	3,520,468	0.60 %
University of Southern Denmark	81	15	31,404,808	5.20 %
Aalborg University	136	22	49,081,685	8.10 %
Aarhus University	269	74	125,689,930	20.80 %
Total	**1,348**	**389**	**603,444,156**	**100 %**

TABLE 2.6
THE DANISH UNIVERSITIES IN HORIZON 2020 (MARCH 2015)

University	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK universities
Copenhagen Business School	4	3	2,667,546	3.53 %
Technical University of Denmark	45	14	21,123,478	27.92 %
IT University of Copenhagen	1	0	551,834	0.73 %
University of Copenhagen	92	63	40,280,049	53.24 %
Roskilde University	3	1	579,439	0.77 %
University of Southern Denmark	9	3	3,836,416	5.07 %
Aalborg University	19	3	6,623,458	8.75 %
Aarhus University	31	15	16,371,032	21.64 %
Total	**204**	**102**	**92,033,252**	**100 %**

2.3.2. Danish private companies

The total number of participations of private companies in FP6 was 439. Almost twice as many private companies participated in FP7, with a total of 801. The total EU contribution to Danish private companies from FP6 was EUR 81.3 million, while the EU funding from FP7 to Danish businesses was EUR 255.3 million. In table 2.7, we have divided the private companies into large enterprises and small and medium-sized enterprises (SMEs)[9]. For a detailed view of the participation of Danish private companies in FP6 and FP7, please see Annex 1, tables 8.3 and 8.4.

The overall Danish share of EU contribution for large enterprises has decreased slightly from FP6 to FP7, going from 7.33 per cent to 6.79 per cent. However, in total EU contribution the funding has increased from EUR 29 million in FP6 to EUR 72 million in FP7 in the case of large enterprises. The overall share of EU contribution to Danish SMEs increased by 5 percentage points from 10.84 per cent in FP6 to 15.87 per cent in FP7. The rise is even more prominent when looking at the total EU contribution to SMEs, evolving from EUR 42.9 million in FP6 to EUR 168.3 million in FP7.

The number of successful SME applicants almost doubled from FP6 to FP7, while the large enterprises went from 136 participants in FP6 to 238 participants in FP7. The number of Danish coordinators also experienced an increase, both for large enterprises and SMEs, between the two framework programmes. One reason for the large number of SME coordinators in FP7 can be ascribed to the fact that FP7 included a fine-tuned programme particularly targeted at small and medium-sized enterprises, namely the Research for the Benefit of SMEs programme. Half of those 33 SMEs that coordinated a project within FP7 were funded under the Research for the Benefit of SMEs programme (see Annex 1, tables 8.3 and 8.4). The Research for the Benefit of SMEs programme of FP7 was the successor to the Horizontal research activities involving SMEs programme of FP6, which included the project type CRAFT (Co-operative Research Project) with a number of similarities to the SME projects under FP7. The Horizontal research activities involving SMEs programme of FP6 is home to 10 of 25 Danish participations with an SME as the coordinator.

The Danish participation from private companies is strongest within the thematic areas of energy and nanotechnologies, both in FP6 and FP7. The Danish industry share of the FP6 programme Nanotechnologies and Nanosciences, Knowledge-Based Multifunctional Materials and New Production Processes and Devices totals almost 36 per cent of EU contribution to Denmark of that particular programme (cf. tables 8.3 and 8.4 in Annex 1).

9 The eCORDA FP6 and FP7 data do not indicate whether or not the participant is an SME. For the purpose of section 2.4 (The participation of Danish private companies in FP6 and FP7) we have manually checked all partners under the participant types of FP6 as well as the "PRC" category (Private companies) of FP7 with the Central Business Register, CVR, website (www.cvr.dk) (data checked in January-February 2015). After cleaning the FP6 data, the total number of private companies is 439 with a total EU contribution of EUR 81.3 million. We were unable to characterise 46 of these private companies as either SMEs or large enterprises. In the FP7 dataset the total of private companies is 801 with a total EU contribution of EUR 255.3 million. We were unable to characterise 47 of these private companies as either SMEs or large enterprises. Therefore, these 93 private companies are not included in table 2.7.

TABLE 2.7
PRIVATE COMPANIES IN FP6 AND FP7

FP6				
Large enterprises	**Participants**	**Coordinators**	**EU contribution (EUR)**	**Share of EU contribution to DK of FP6**
	136	9	29,047,725	7.33 %
SMEs	**Participants**	**Coordinators**	**EU contribution (EUR)**	**Share of EU contribution to DK of FP6**
	257	25	42,947,390	10.84 %
FP7				
Large enterprises	**Participants**	**Coordinators**	**EU contribution (EUR)**	**Share of EU contribution to DK of FP6**
	238	14	71,994,336	6.79 %
SMEs	**Participants**	**Coordinators**	**EU contribution (EUR)**	**Share of EU contribution to DK of FP6**
	516	33	168,287,885	15.87 %

2.3.3. Danish research and technology organisations (RTOs)

The participation of Danish RTOs also increased significantly from FP6 to FP7. The total EU contribution from FP7 is almost seven times higher for the RTOs compared to FP6, while the number of successful applicants in the same category is 3.5 times higher from FP6 to FP7.

Most markedly, as table 2.8 shows, Danish Technological Institute went from having 11 projects and an overall participation of EUR 1.7 million in FP6 to 59 projects in FP7 and an EU funding amounting to EUR 27.8 million. Further, Danish Technological Institute is the project coordinator of 13 out of the 17 projects coordinated by Danish RTOs in FP7. The Technological Institute's share of the overall EU contribution to GTS institutes in FP7 is a little more than half of the total. The EU contribution to Danish Technological Institute, Alexandra Institute and DHI together constitutes more than 80 per cent of the total EU contribution to Danish RTOs.

It is noticeable that Alexandra Institute went from 1 project in FP6 to 13 projects in FP7, including one project as coordinator. DHI doubled their number of participations, while their share of EU contribution tripled from FP6 to FP7. Conversely, FORCE Technology participated in 9 FP6 projects and was thereby the Danish RTO with third most participations, while in FP7 FORCE Technology only participated three times, making it the RTO with the least number of participations in FP7. AgroTech is the only Danish RTO that neither participated in FP6 nor in FP7. The share of RTOs of total EU contribution to Denmark was 1.6 per cent from FP6 and 4 per cent from FP7.

TABLE 2.8
THE PARTICIPATION OF DANISH RTOs IN FP6 AND FP7

FP6

Research and Technology Organisation	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK RTOs
Alexandra Institute	1	0	105,587	1.7 %
Bioneer	0	0	0	0
DBI – Danish Institute of Fire and Security Technology	0	0	0	0
DFM – Danish Institute of Fundamental Metrology	1	0	276,318	4.3 %
DELTA – Danish Electronics, Light & Acoustics	1	0	77,587	1.2 %
DHI – Water and Environment	12	1	2,812,906	44.3 %
FORCE Technology	9	0	1,345,283	21.2 %
DTI – Danish Technological Institute	11	1	1,737,422	27.3 %
Total	**35**	**2**	**6,355,102**	**100 %**

FP7

Research and Technology Organisation	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK RTOs
Alexandra Institute	13	1	5,089,602	11.8 %
Bioneer	7	0	2,476,022	5.7 %
DBI – Danish Institute of Fire and Security Technology	4	1	1,727,200	4.0 %
DFM – Danish Institute of Fundamental Metrology	5	1	1,165,349	2.7 %
DELTA – Danish Electronics, Light & Acoustics	5	0	1,736,546	4.0 %
DHI – Water and Environment	26	1	8,221,854	19.0 %
FORCE Technology	3	0	952,887	2.2 %
DTI – Danish Technological Institute	59	13	21,797,989	50.5 %
Total	**122**	**17**	**43,167,450**	**100 %**

2.4. Danish participation in FP6 and FP7 by region[10]

Table 2.9 shows the participation of Denmark in FP6 and FP7 by region. Unsurprisingly, the Capital Region of Denmark, which is home to four of the eight Danish universities and many research-intensive private companies, is the region receiving the largest EU contribution from the framework programmes. It can be noticed that in the Central Denmark Region three times as many partners have taken the respon-

10 This includes all participants from the Danish regions, based on the Nomenclature of Units for Territorial Statistics (NUTS) classification. Thus, the regions mean not only the administrative bodies participating (such as the Zealand Region), but all participants from the specific region. Information on data: Not all participants in the FP6 and FP7 datasets have been assigned a NUTS code. Therefore, we have manually assigned a NUTS code to those participants with missing NUTS information.

sibility of coordinating projects in FP7 compared to FP6. However, it is worth noting that in FP7, 74 of the coordinators from the Central Denmark Region are from Aarhus University, and that 62 of these projects are single-applicant grants (ERC grants and Marie Curie Action projects). Both the Central Denmark Region and the North Denmark Region increased their relative share of EU contribution among the regions of Denmark. On the other hand, the share of EU contribution to the Zealand Region dropped from around 4 per cent in FP6 to only 1.5 per cent of the total Danish EU contribution in FP7.

In FP7, university participation constitutes around half of the total number of participations in the Capital Region of Denmark (48 per cent) and the Central Denmark Region (55 per cent), compared to 34 per cent and 41 per cent in FP6, while it is more than half in the North Denmark Region (60 per cent), compared to 54 per cent in FP6, and less than half in the Region of Southern Denmark (38 per cent versus 41 per cent in FP6). The Zealand Region stands out as the region with least university participation: Roskilde University constitutes one fourth (25 per cent) of the total number of participations of Zealand in FP7 (20 per cent in FP6).

TABLE 2.9
THE PARTICIPATION OF DENMARK IN FP6 AND FP7 BY REGION

FP6

Region	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK
Capital Region of Denmark	1,061	140	264,333,375	66.7 %
Central Region Denmark	238	33	58,185,492	14.7 %
North Denmark Region	112	15	25,563,903	6.5 %
Region Zealand	85	7	16,335,163	4.1 %
Region of Southern Denmark	149	15	31,621,800	8.0 %
Greenland	1	0	86,300	0.0 %
Total	**1,646**	**210**	**396,126,034**	**100 %**

FP7

Region	Participations	Coordinators	EU contribution (EUR)	Share of total EU cont. to DK
Capital Region of Denmark	1,764	354	692,622,678	65.3 %
Central Region Denmark	485	91	197,710,088	18.6 %
North Denmark Region	226	29	76,108,804	7.2 %
Region Zealand	63	8	15,690,901	1.5 %
Region of Southern Denmark	215	21	78,276,273	7.4 %
Greenland	1	0	188,250	0.0 %
Total	**2,754**	**503**	**1,060,596,995**	**100 %**

2.5. The development of Danish participation in FP6, FP7 and Horizon 2020

Tables 2.10, 2.11 and 2.12 show the Danish versus total EU contribution for all countries over the years in FP6 (2002-2006), FP7 (2007-2013) and in Horizon 2020

(until March 2015). As can be seen, the Danish EU contribution from FP6 and FP7 fluctuates over the years.

It can be noted that most of the funds are distributed in the middle of the programme periods. This is due to the fact that only a few calls for proposals have deadlines in the beginning or the end of the programme period. It can be noted that the immediate Danish EU contribution from FP7 after the first year was relatively low, and increased along the programme period, ending with a share of the total EU contribution of 2.36 per cent. As mentioned earlier, the Danish share of total EU contribution was almost the same in both framework programmes, while the actual amount of EU contribution from FP7, given the size and duration of the programme, was far more than the double. The first Horizon 2020 proposals data were made available in November 2014 and contained only a small number of calls, while the update in March 2015 contains on average one concluded evaluation round per thematic area.

TABLE 2.10
THE DEVELOPMENT OF DENMARK'S PARTICIPATION IN FP6 [11]

Year	Unspecified	2003	2004	2005	2006	2007	Total
Participations	50	168	425	435	418	150	1646
EU contribution to Denmark (EUR)	6,014,418.40	44,426,878.10	91,352,663.60	101,875,959.20	104,060,839.40	48,395,275.00	396,126,033.70
Total EU contribution (EUR)	145,283,923	1,794,984,070	4,391,441,661	4,450,152,468	4,880,101,220	1,034,643,172	16,696,606,514
DK share of total contribution	4.14 %	2.48 %	2.08 %	2.29 %	2.13 %	4.68 %	2.37 %

TABLE 2.11
THE DEVELOPMENT OF DENMARK'S PARTICIPATION IN FP7[12]

Year	2007	2008	2009	2010	2011	2012	2013	2014	Total
Participations	72	341	392	411	461	485	486	106	2754
EU contribution to Denmark (EUR)	27,817,678	104,155,432	137,513,735	143,114,090	162,178,313	206,963,605	220,055,013	58,799,129	1,060,596,995
Total EU Contribution (EUR)	1,748,654,830	5,062,843,149	5,389,520,539	6,207,495,142	7,181,377,801	7,873,387,844	8,943,319,350	2.510.586.803	44,917,185,458
DK share of total EU contribution	1.59 %	2.06 %	2.55 %	2.31 %	2.26 %	2.63 %	2.46 %	2.34 %	2.36 %

11 Year = date of grant signature
12 Year = date of grant signature

TABLE 2.12
THE DEVELOPMENT OF DENMARK'S PARTICIPATION IN HORIZON 2020[13]

Year	2014 (November)	2015 (March)
Participations	118	376
EU contribution to Denmark (EUR m)	48.6	152.4
Total EU contribution (EUR m)	2,229	6,621
DK share of total EU contribution	2.18 %	2.30 %

2.6. Danish participation in ERC excellence projects (FP7)

The European Research Council (ERC) was introduced along with FP7 in 2007. The ERC supports investigator-driven frontier research across all fields, on the basis of scientific excellence. ERC grants are among the most prestigious in FP7 and now in Horizon 2020.

The three main grants are the ERC Starting Grant (up to EUR 1.5 million per project, for researchers with 2-7 years of experience past PhD), ERC Consolidator Grant (up to EUR 2 million per project, for researchers with 7-12 years past PhD) and the ERC Advanced Grant (up to EUR 2.5 million, for experienced researchers with a significant track record within the last 10 years). The ERC Consolidator Grant scheme was introduced in 2013. In 2012 and 2013, the ERC Synergy Grant supported groups of principal investigators with a maximum EU contribution of up to EUR 15 million. Proof of Concept was introduced in 2011 and is a grant of up to EUR 150,000, which is open to researchers who have already been awarded one of the other ERC grants.

The most successful host institutions in attracting ERC grants are University of Copenhagen and Aarhus University. Until 2011 both universities had obtained the same number of grants. However, in the last years of FP7, the applications of University of Copenhagen were very successful and finally obtained a total of 33 ERC grants. Technical University of Denmark has achieved 11 ERC grants in FP7 and is thereby third among the Danish institutions. All Danish universities have obtained at least one ERC grant, except Roskilde University. Furthermore, researchers at a number of other research institutions, namely Danish Cancer Society, Statens Serum Institut (SSI) and Geological Survey of Denmark and Greenland (GEUS), have received ERC grants.

13 Year (month) = eCORDA release. The release year is not necessarily the same as the year of grant signature.

TABLE 2.13
ERC GRANTEES TO DENMARK (FP7)

Institution	Starting Grant	Consolidator Grant	Advanced Grant	Synergy Grant	Proof of Concept	Total
University of Copenhagen	16	4	12	1*	1	33 (34*)
Aarhus University	11	1	12	0	1	25
Technical University of Denmark	6	0	4	0	1	11
University of Southern Denmark	1	0	3	0	0	4
Copenhagen Business School	3	0	0	0	0	3
Danish Cancer Society	1	0	1	0	0	2
IT University of Copenhagen	0	1	0	0	0	1
Capital Region of Denmark	1	0	0	0	0	1
SSI (Statens Serum Institut)	1	0	0	0	0	1
Aalborg University	0	0	1	0	0	1
Geological Survey of Denmark and Greenland (GEUS)	0	0	1	0	0	1
Danish Meteorological Institute	0	0	0	1*	0	(1*)
Total	40	6	34	2*	3	83 (85*)

*University of Copenhagen and Danish Meteorological Institute participate as partners in the very large Synergy Grant project ICE2ICE. The total number of coordinators with a Danish host institution is 83.
**The number of ERC grantees is connected to the host institution at the time of main list (acceptance of funding to the proposal). The number of ERC grantees that potentially have transferred to a different institution (in Denmark or abroad) is therefore not reflected in the above figures.

2.7. Danish participation in Marie Curie mobility projects (FP7)

This section focuses on the FP7 mobility programme, the Marie Curie Actions. The Marie Curie Actions are the successor to the FP5 Marie Curie Fellowships and FP6 Human Resources and Mobility programme. Marie Curie Actions seek to make Europe more attractive for researchers and to establish a "brain circulation" within the EU Member States and Associated Countries. It means that, first and foremost researchers must change country. Beside transnational mobility, the Marie Curie Actions also aim to foster inter-sectoral mobility between academic and private sectors. The Marie Curie Actions follow a bottom-up approach, i.e. research fields are chosen freely by applicants. All domains of research are eligible.

In table 2.14, the most successful Danish institutions in host-driven actions under the Marie Curie programme have been listed[14]. Not surprisingly, the three largest Danish universities (Technical University of Denmark, University of Copenhagen and Aarhus University) are involved in most Marie Curie Actions. Most participa-

14 The Marie Curie programme can be divided into individual-driven actions and host-driven actions. For the purpose of this analysis, we focus on the host-driven actions. The host-driven actions are IAPP: Industry-Academia Partnerships & Pathways; ITN: Initial Training Networks; COFUND: Cofunding of national pro-grammes, and IRSES: International Research Staff Exchange Scheme.

tions are within the Initial Training Networks, which support collaboration between academic and non-academic institutions in different countries. The total number of Danish institutions that have participated (once or several times) in a host-driven Marie Curie Action under FP7 is 65. Among these were 45 private companies.

TABLE 2.14
TOP 10: DANISH INSTITUTIONS WITH MOST PARTICIPATIONS IN HOST-DRIVEN MARIE CURIE ACTIONS (COFUND, IAPP, IRSES, ITN)

Institution	COFUND	IAPP	IRSES	ITN	Total
Technical University of Denmark	1	4	5	32	42
University of Copenhagen		2	5	35	42
Aarhus University	1	1	5	27	34
University of Southern Denmark			2	12	14
Aalborg University		3	3	5	11
Carlsberg A/S				4	4
Qiagen Aarhus A/S				3	3
Novozymes A/S		2		1	3
Copenhagen Business School			1	2	3
Rambøll Danmark A/S				3	3

2.8. Denmark compared to other countries

While this analysis mainly focuses on Denmark, it is interesting to look at Danish participation from a comparative perspective. The participation of Denmark has been high, but relatively stable from FP6 to FP7 in relative terms. However, this has not been the case for other countries. Tables 2.15 and 2.16 show the participation of Denmark and other Nordic countries as well as a selection of other countries, measured by number of participations and coordinators, EU contribution and share of total EU contribution.

All Scandinavian countries and Finland experienced a slight drop in share of EU contribution from FP6 to FP7. This is particularly true for Sweden and Finland, where the share of EU contribution dropped from FP6 to FP7. However, other countries experienced an increase in the share of EU contribution. This is most significant for the Netherlands, where the share rose from 6.63 per cent in FP6 to 7.41 per cent in FP7, and Switzerland, where the share of EU contribution rose by more than 60 per cent from FP6 to FP7. If we look at the EU contribution per citizen, Denmark is in the lead among the Nordic countries in both FP6 and FP7. However, Denmark receives less EU contribution per citizen in FP7 than the Netherlands, and significantly less than Switzerland.

TABLE 2.15
DANISH PARTICIPATION IN FP6 COMPARED TO OTHER COUNTRIES[15]

FP6	Country	Partici-pations	Coordina-tors	EU Contri-bution (EUR m)	Share of EU Contribution	EU Con-tribution per citizen (EUR)*
Nordic Countries	Denmark	1,646	210	396	2.37 %	72.7
	Sweden	2,648	330	677	4.06 %	74.3
	Norway	1,300	149	284	1.70 %	60.7
	Finland	1,440	156	342	2.05 %	64.9
Other countries	The Netherlands	4,080	677	1,108	6.63 %	67.7
	Belgium	2,866	454	710	4.25 %	67.1
	Switzerland	1,995	209	465	2.79 %	61.9
	Austria	1,957	285	426	2.55 %	51.4
Total for all countries participating in FP6		74,583	10,106	16,697	100 %	

TABLE 2.16
DANISH PARTICIPATION IN FP7 COMPARED TO OTHER COUNTRIES[16]

FP7	Country	Participa-tions	Coordina-tors	EU Contri-bution (EUR m)	Share of EU Contribution	EU Con-tribution per citizen (EUR)**
Nordic Countries	Denmark	2,754	503	1,061	2.36 %	188.8
	Sweden	4,506	722	1,709	3.80 %	177.1
	Norway	2,185	350	754	1.68 %	147.6
	Finland	2,650	355	876	1.95 %	160.7
Other countries	The Netherlands	8,151	1,634	3,330	7.41 %	197.9
	Belgium	5,458	919	1,815	4.04 %	162.0
	Switzerland	4,457	1,036	2,034	4.53 %	249.9
	Austria	3,516	675	1,184	2.64 %	139.2
Total for all countries participating in FP7		133,615	25,237	44,917	100 %	

2.9. Denmark's international collaborators

The most favoured collaborators of Danish institutions and companies have not changed significantly in relative terms from FP6 to FP7. Germany is the most frequent partner for Danish participants, with the United Kingdom and France as numbers two and three in both FP6 and FP7. The overall number of Danish project collaborators has, along with the number of total participations, increased from FP6 to FP7. The tables primarily show Danish international collaborators from Europe, but it is worth noticing that Denmark collaborates more with the United States in

15 *Eurostat: Population on 1 January 2007: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00001&plugin=1"
16 **Eurostat: Population on 1 January 2014: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00001&plugin=1

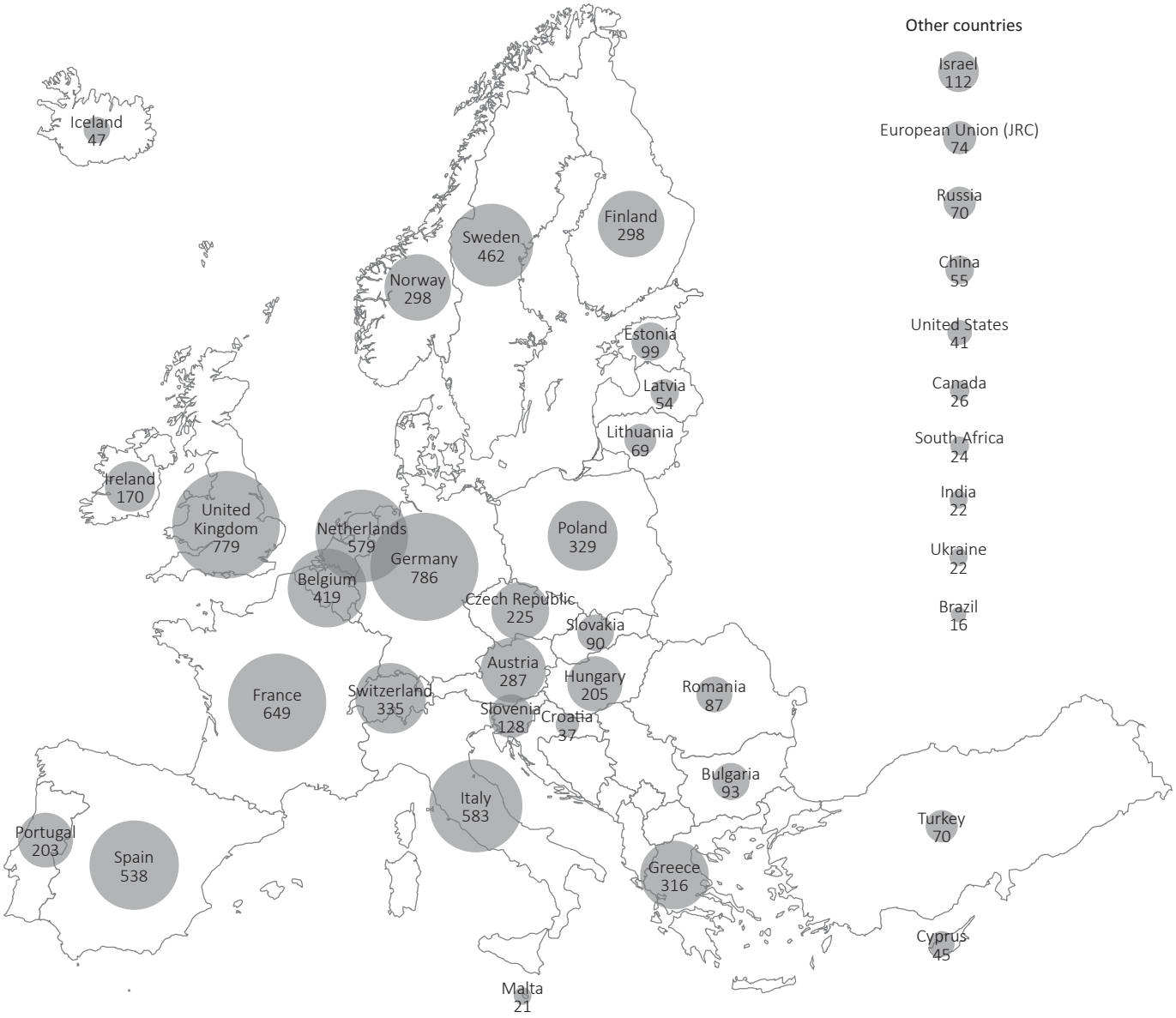
FP7 than in FP6, moving from number 33 to 24 on the list of countries that Danish partners collaborate most frequently with.

The other Nordic countries, namely Sweden, Norway and Finland, seem to retain a strong collaborative position with Danish institutions throughout FP6 and FP7.

The collaborations with Spain (FP6: 6th, FP7: 4th), Austria (FP6: 14th, FP7: 10th), Portugal (FP6: 17th, FP7: 15th) and Ireland (FP6: 18th, FP7: 16th) increased from FP6 to FP7.

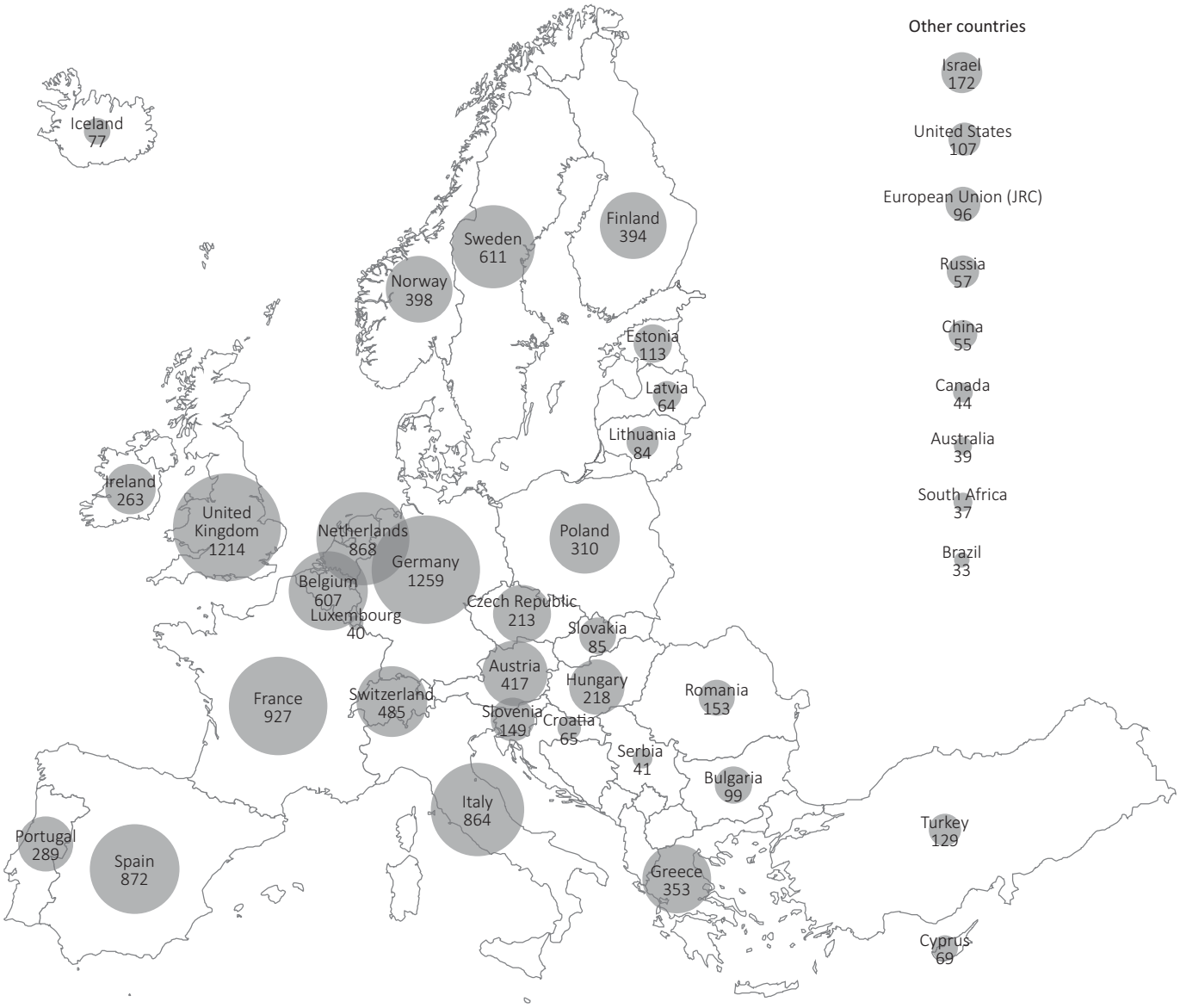
Interestingly, Danish participants' collaboration with EU-10 countries (countries that acceded to the Union as a result of the EU enlargements in 2004 and 2007) decreased in relative terms from FP6 to FP7, with Romania as the only country moving up the ranks in FP7.

FIGURE 2.7
DENMARK'S COLLABORATORS IN FP6[17]



17 The number of collaborative links is the number of times a minimum of one participant has participated in a project with a minimum of one participant from country x.

FIGURE 2.8
DENMARK'S COLLABORATORS IN FP7



3. Importance of FP6/FP7 – perceived effects

This chapter presents an analysis of what effects Danish universities, GTS institutes[18] and Danish companies perceive to be the most important to them from their participation in projects funded by FP6 and FP7. The purpose is to describe effects that may not be identifiable in a statistical impact assessment.

3.1. Main findings

The overall picture is that *building new European network* is perceived to be the most crucial effect of participating in FP6/FP7 for universities and GTS institutes, closely followed by *funding of activities that otherwise would not have been implemented* and *cooperation with excellent foreign research and innovation environments*. The differences in the perception of the most important effects between universities and GTS institutes seem rather limited, which could indicate that universities and GTS institutes experience similar effects, despite the difference in the main objective of their normal activities.

Danish companies perceive *funding of activities that would not otherwise have been implemented* as the most important effect, closely followed by *cooperation with (excellent) foreign universities and research organisations* and *access to new knowledge*. Interestingly, small companies experience greater effects than mid-size and large companies. Furthermore approximately half of the participating companies indicate having launched new products or services as a result of their participation in FP6 and FP7 projects.

3.2. Methodology

The results of this chapter are based on a questionnaire which was developed on the basis of 6 pilot interviews. The questionnaire was sent to 183 representatives from the universities (Provosts for Research, Deans and Heads of Institutes). 74 respondents from universities answered the questionnaire, giving a response rate of 40 per cent. The questionnaire was sent to one representative (general manager) from the 9 GTS institutes and all 9 answered, giving a response rate of 100 per cent. A slightly changed version of the questionnaire was sent to 652 Danish companies that had participated in a FP6 or FP7 project. 116 companies answered, giving a response rate of 18 per cent.

18 The objective of the GTS institutes is to spread the most recent knowledge and state-of-the-art technology to the business community and thus further the competiveness of companies. Companies can buy services from the GTS institutes or participate in collaboration projects that are co-funded.

The questionnaire to the universities and the GTS institutes listed in total 25 effects, and the questionnaire to the companies listed 16 effects. The representatives were asked to estimate the importance of their FP6/FP7 participation on these effects on a scale of 1-5 (5 being very important). We have then ranked the effects in order of importance.

3.3. Effects for universities and GTS institutes

Both universities and GTS institutes perceive *building new European network* as the most important effect from participating in FP6/FP7, cf. table 3.1. Universities also rank *highly funding of activities that otherwise not would have been implemented.*

TABLE 3.1
FIVE MOST IMPORTANT EFFECTS OF PARTICIPATING IN FP6/FP7 FOR UNIVERSITIES AND GTS INSTITUTES

Universities	GTS Institutes
Building new European network	Building new European network
Funding of activities that otherwise would not have been implemented	Cooperation with excellent foreign research- and innovation environments
Cooperation with excellent foreign research- and foreign environments	Access to new knowledge/knowledge retrieval
Expansion of existing European network	Construction of new scientific or technological strengths
International prestige	Cooperation with foreign companies

Both universities and GTS institutes find *cooperation with excellent foreign research and innovation environments* as an important effect of participating. One difference is especially worth noticing: *cooperation with foreign companies* is perceived as an important effect for the GTS institutes, whereas *international prestige* is an important effect experienced by the universities. Given the results described in chapter 6, it could be expected that the respondents from the universities would see an important influence of FP6/FP7 on *publishing in international scientific journals*, but it is ranked as number 13 out of a total of 25 effects. Universities may not have been aware of the outstanding performance levels of publications linked to FP6 or FP7.

It is also noticeable that the GTS institutes do not rank access to the marketing of services / products in new markets higher than number 15. According to their latest performance report[19], the GTS institutes' international commercial activities have grown considerably the last 10-15 years, and around 58 per cent of the GTS institutes' total turnover now stems from international activities.

Looking at the overall scores, the most important effect for universities and GTS institutes is *building new European network*, rated on average 3.9 out of a maximum of 5 points. Also effects like *funding and cooperation with foreign research and innovation environments* are perceived to be important effects when participating in FP6/FP7.

19 Teknologi for danske virksomheder, performanceregnskab for GTS-net 2015: http://2ah7jj3h-lyru2jz2ai1v8mad.wpengine.netdna-cdn.com/wp-content/uploads/2015/06/GTS_PFR2015_web.pdf

FIGURE 3.1
THE AVERAGE EFFECTS FROM FP6/FP7 PERCEIVED BY UNIVERSITIES AND GTS INSTITUTES

3.4. Effects for universities

In the following section we will examine the answers from the universities in more detail, looking at the responses from different universities and different scientific fields. It is worth mentioning that, with a limited number of respondents, some of the conclusions should not be overstated. For instance, there are only two respondents from Roskilde University (RUC) and Copenhagen Business School (CBS).

TABLE 3.2
FIVE MOST IMPORTANT EFFECTS FOR EACH OF THE EIGHT UNIVERSITIES[20]

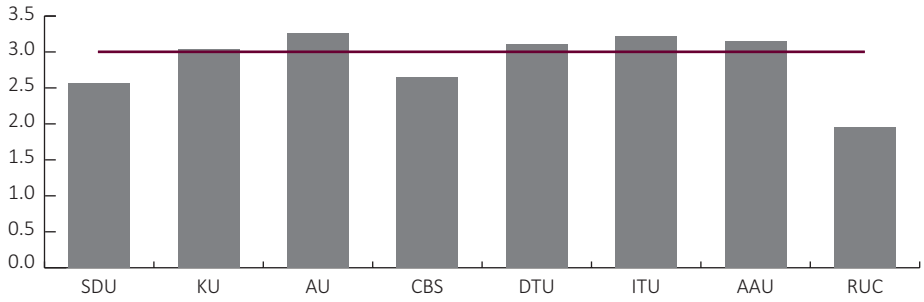
SDU	International prestige	Building new European network	Cooperation with excellent foreign research and innovation environments	National prestige	Expansion of existing European network
KU	Building new European network	Cooperation with excellent foreign research- and innovation environments	Funding of activities that otherwise would not have been implemented	Expansion of existing European network	Publishing in international scientific journals
AU	Funding of activities that otherwise would not have been implemented	Expansion of existing European network	Maintaining existing European network	Building new European network	Cooperation with excellent foreign research- and innovation environments
CBS	Funding of activities that otherwise would not have been implemented	Access to larger empirical databases through partners in the project (eg. Patients, cases, registration data etc.)	Building new European network	Expansion of existing European network	Cooperation with excellent foreign research- and innovation environments
DTU	Building new European network	Funding of activities that otherwise would not have been implemented	Maintaining existing European network	Expansion of existing European network	Cooperation with excellent foreign research- and innovation environments
ITU	Building new European network	Cooperation with excellent foreign research- and innovation environments	International prestige	Publishing in international scientific journals	Access to new knowledge/ knowledge retrieval
AAU	Funding of activities that otherwise would not have been implemented	Expansion of existing European network	Building new European network	Maintaining existing European network	Cooperation with excellent foreign research- and innovation environments
RUC	Funding of activities that otherwise would not have been implemented	Building new European network	Maintaining existing European network	Expansion of existing European network	International prestige

When looking at the effects perceived the eight universities are not that different from each other. The most important effect perceived is either *funding of activities that otherwise would not have been implemented* or *building new European network*, cf. table 3.2.

Although the universities are quite similar, some of the effects differ in smaller detail. The respondents from CBS rank *access to larger empirical databases* as the second most important of the effects, and CBS is the only university that has this specific effect in the top 5. The respondents from the University of Southern Denmark (SDU) are the only ones that rank *national prestige* as a top 5 effect. The respondents from Aarhus University (AU) have experienced the highest effects, together with the respondents from the Technical University of Denmark (DTU). This is not surprising, due to the fact that DTU is a fairly specialized university that matches the themes in both FP6 and FP7.

20 SDU: University of Southern Denmark; KU: University of Copenhagen; AU: Aarhus University; CBS: Copenhagen Business School; DTU: Technical University of Denmark; ITU: IT-University; AAU: Aalborg University; RUC: Roskilde University

FIGURE 3.2
AVERAGE EFFECT OF THE EIGHT UNIVERSITIES

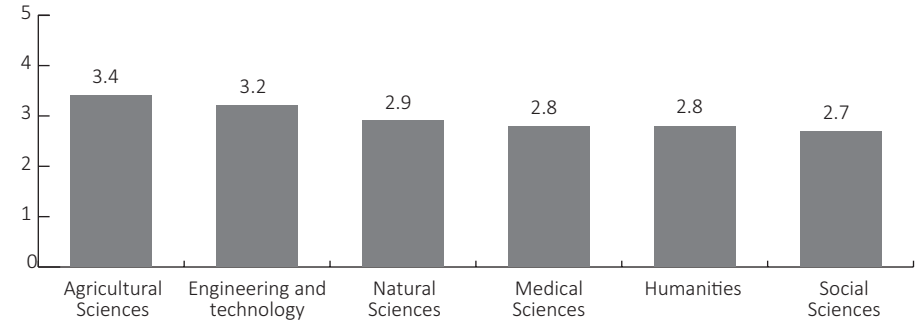


Note: Each university ranks the individual effects from 1-5, 5 indicating significant effect. The line illustrates the average effect of the universities.

The respondents from RUC, which is mainly a university for the humanities and social sciences, evaluate that the effects in general are smaller.

The overall picture is more or less the same when the rated effects are divided into the fields of science. In general the fields of science that experience the highest effect are agricultural sciences as well as engineering and technology, cf. figure 3.3. This is in line with the observations for the universities, where, for example, DTU experienced high effects.

FIGURE 3.3
AVERAGE EFFECT OF PARTICIPATION ACROSS FIELD OF SCIENCE



Correspondingly, social sciences experience the lowest effects of participating in FP6/FP7. When looking at the top-rated effects of participating, *building new European network* is the highest-ranked effect for humanities, agricultural, medical and technical science, cf. table 3.3. Agricultural science in particular experiences higher effects than average.

TABLE 3.3
FIVE MOST IMPORTANT EFFECTS DIVIDED BY FIELDS OF SCIENCE FOR THE UNIVERSITIES

Humanities	Building new European network	Expansion of existing European network	Access to new knowledge/ knowledge retrieval	Maintaining existing European network	Attracting PhD students
Agricultural Sciences	Building new European network	Expansion of existing European network	Cooperation with excellent foreign research- and innovation environments	Expansion of existing scientific or technological strengths	Access to larger empirical databases through partners in the project (eg. Patients, cases, registration data etc.)
Natural Sciences	Funding of activities that otherwise would not have been implemented	Expansion of existing European network	Cooperation with excellent foreign research- and innovation environments	Building new European network	National prestige
Social Sciences	Funding of activities that otherwise would not have been implemented	Cooperation with excellent foreign research- and innovation environments	International prestige	National prestige	Building new European network
Medical Sciences	Building new European network	Funding of activities that otherwise would not have been implemented	Expansion of existing European network	Cooperation with excellent foreign research- and innovation environments	Maintaining existing European network
Engineering and technology	Building new European network	Funding of activities that otherwise would not have been implemented	Maintaining existing European network	Expansion of existing European network	Expansion of existing scientific or technological strengths

For both natural sciences and social sciences, the highest-rated effect is *funding of activities that otherwise would not have been implemented*. Social science and medical science are the only fields of science with *international prestige* rated in top 5 effects.

The answers collected from the universities are now divided into three different positions: Head of Institution, Dean and Provost for Research. Overall the Provosts for Research estimate FP6/FP7 to have a stronger influence on a number of effects than their colleagues.

TABLE 3.4
FIVE MOST IMPORTANT EFFECTS DIVIDED INTO JOB POSITIONS AT THE UNIVERSITIES

Head of Institute	Dean	Provost for Research
Funding of activities that otherwise would not have been implemented	Building new European network	Building new European network
Building new European network	Expansion of existing European network	Cooperation with excellent foreign research and innovation environments
Expansion of existing European network	Cooperation with excellent foreign research and innovation environments	Publishing in international scientific journals
Cooperation with excellent foreign research and innovation environments	Funding of activities that otherwise would not have been implemented	Access to new knowledge/knowledge retrieval
Maintaining existing European network	International prestige	International prestige

For the Provosts, an important effect they experienced is *publishing in international scientific journals*. This may not be surprising when measuring the effects on universities, but was nevertheless not ranked in the top 5 for all respondents from the universities.

The numbers of participations vary for the individual institutions. In general, when participating between 0-20 times in either FP6 or FP7, the institutions seem to experience FP6/FP7 as having a less important influence on a number of effects than when participating more often. But the main effects are still the same, regardless of the number of participations. *Prestige*, both national and international, seems to become more important, though, when participating more often cf. table 3.5.

TABLE 3.5
FIVE MOST IMPORTANT EFFECTS DIVIDED INTO NUMBER OF PARTICIPATIONS, UNIVERSITIES AND GTS INSTITUTES

0-20 FP6 participations	Above 21 FP6 participations	0-20 FP7 participations	Above 21 FP7 participations
Building new European network	Cooperation with excellent foreign research- and innovation environments	Building new European network	Building new European network
Funding of activities that otherwise would not have been implemented	Building new European network	Cooperation with excellent foreign research- and innovation environments	Cooperation with excellent foreign research- and innovation environments
Cooperation with excellent foreign research and innovation environments	Funding of activities that otherwise would not have been implemented	Funding of activities that otherwise would not have been implemented	Expansion of existing European network
Expansion of existing European network	International prestige	Building new scientific or technological strengths	International prestige
Building new scientific or technological strengths	National prestige	Expansion of existing European network	Maintaining existing European network

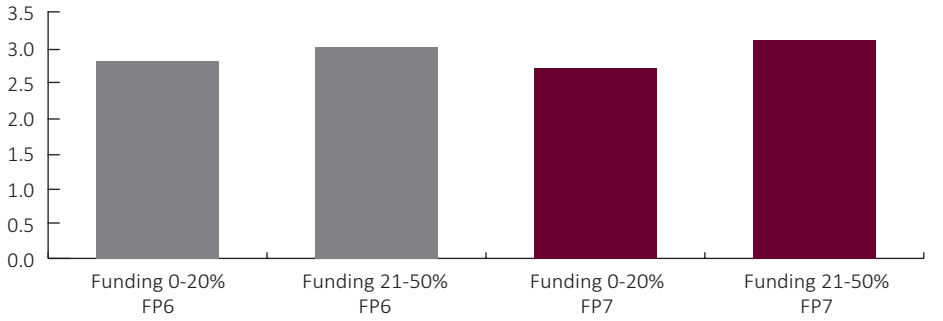
Looking closely at the share of external funding that comes from FP6/FP7, there do not seem to be great differences with regard to the effects perceived, cf. table 3.6. Overall the effects are the same, independent of the share of the total external funding.

TABLE 3.6
FIVE MOST IMPORTANT EFFECTS FOR THE SHARE OF EXTERNAL FUNDING OF THE INSTITUTIONS THAT COMES FROM FP6/FP7 (THE TOTAL POPULATION)

FP6 share 0-20 per cent	FP6 share 21-50 per cent	FP7 share FP7 0-20 per cent	FP7 share 21-50 per cent
Building new European network	Funding of activities that otherwise would not have been implemented	Building new European network	Cooperation with excellent foreign research and innovation environments
Cooperation with excellent foreign research and innovation environments	Maintaining scientific or technological strengths	Funding of activities that otherwise would not have been implemented	Cooperation with foreign companies
Funding of activities that otherwise would not have been implemented	Expanding new scientific or technological strengths	International prestige	Building new European network
Expansion of existing European network	Building new European network	Expansion of existing European network	Access to new knowledge/ knowledge retrieval
International prestige	Cooperation with excellent foreign research and innovation environments	Cooperation with excellent foreign research and innovation environments	Funding of activities that otherwise would not have been implemented

When looking at the degree of importance, the results indicate that the larger the FP6/FP7 share of participations, the more the institutions experience higher effects of the funding, cf. figure 3.4.

FIGURE 3.4
AVERAGE EFFECT SCORE FOR THE SHARE OF EXTERNAL FUNDING OF THE INSTITUTIONS, THE TOTAL POPULATION



3.5. Effects for private companies

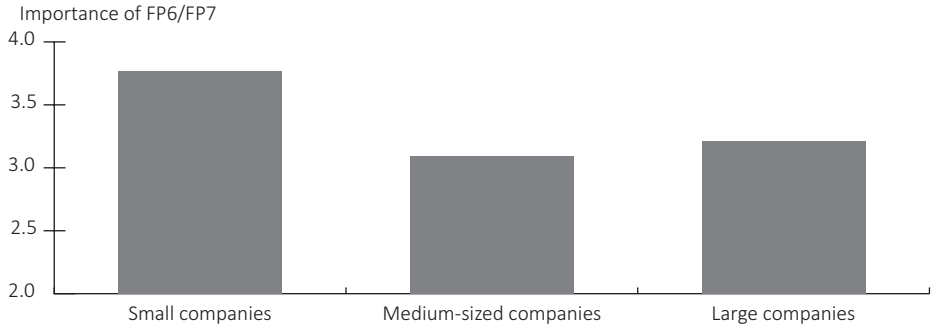
Private companies rank *funding of activities that otherwise would not have been implemented* highest and *cooperation with (excellent) foreign universities and research organisations* second highest. Just like the GTS institutes, companies do not rank *access to the marketing of services/products in new markets* highly. In fact it is the effect with the lowest average score of 2.56 (the highest average is 3.97).

TABLE 3.7
FIVE MOST IMPORTANT EFFECTS OF PARTICIPATING IN FP6/FP7 FOR COMPANIES

Private companies
Funding of activities that otherwise would not have been implemented
Cooperation with (excellent) foreign universities and research organisations
Access to new knowledge
Building and expansion of existing European network
Building new technological strengths

When looking at the importance of FP6/FP7 for the different size of companies, small and medium-sized companies experience higher effects than medium-sized companies and large companies. On average, small companies (0-50 employees) evaluate the effects of FP6/FP7 on all named parameters with a score of 3.77 (on a scale of 1 – 5), whereas the figures are 3.09 for medium-sized companies (50-250) and 3.21 for large companies. An explanation would be that the participation in a FP6 or FP7 project is more important for a small company, where EU project funding can amount to a considerable percentage of the company's overall expenditure on research and innovation, whereas the isolated effect for a large company will be more difficult to identify.

FIGURE 3.4
AVERAGE EFFECT BY FP6/ FP7 ON ALL PARAMETERS FOR SMALL COMPANIES, MEDIUM-SIZED COMPANIES AND LARGE COMPANIES



When asked if their participation in FP6 or FP7 projects has led to the launching of new products or services, 49 per cent answer in the affirmative. Considering that research and innovation projects often have uncertain outcomes, this figure is quite high. Launching of new products or services should hopefully have a positive effect for the company on both turnover and the number of employees. 18 per cent answer that their participation has led to the admission of new patents. It is not surprising that new products or services are not necessarily linked to the issuance of patents, and therefore this figure is equally considered to be quite high.

TABLE 3.8
HAS YOUR PARTICIPATION IN FP6/FP7 PROJECTS LED TO THE LAUNCHING OF NEW PRODUCTS OR SERVICES?

Yes	49 %
No	43 %
Don't know	8 %

TABLE 3.9
HAS YOUR PARTICIPATION IN FP6/FP7 PROJECTS LED TO THE ADMISSION OF NEW PATENTS?

Yes	18 %
No	79 %
Don't know	3 %

Although we were unable to detect any statistically significant increase in the share of PhDs and masters employed (chapter 4), almost half of the companies answering the questionnaire reply that their participation in FP6/FP7 projects has led to the employment of new knowledge workers. See table 3.10 below.

TABLE 3.10
HAS YOUR PARTICIPATION IN FP6/FP7 PROJECTS LED TO THE EMPLOYMENT OF NEW KNOWLEDGE WORKERS?

Yes	46 %
No	51 %
Don't know	3 %

4. Economic impact on FP6/FP7-participating companies

This chapter presents the impact assessment of company participation in FP6 and FP7 projects. The purpose is to gain a better understanding of what economic impact the participating companies gain from taking part in projects under FP6 and FP7.

Using detailed employer-employee-linked data spanning from 2000 to 2012, we first describe participating companies relative to other companies. We then perform a five-year forward-looking impact assessment of company participation in projects initiated between 2002 and 2008, which are evaluated from the end of 2007 to the end of 2012.

The premise for the existence of public support for public-private research partnerships such as the Sixth Framework Programme (FP6) or the Seventh Framework Programme (FP7) is that the financial support will strengthen research activity within industries — and thus companies. This impact assessment is a micro study of the average isolated effects of participation of the individual companies. It does not focus on macro outcomes such as increasing the size and strength of the research infrastructure of industries, which is an overall objective of the framework programmes.

Because FP6/FP7 projects offer access to top scholars in the academic world, strengthen international relations and thus potentially widen the scope for business, we are particularly interested in finding out whether participation leads to higher long-term investments in Danish research and development (R&D) activity, added economic growth and value creation.

To perform such an analysis we must establish the alternative scenario: What would have happened had these companies not participated in FP6/FP7 projects? For this purpose, we construct a control group of companies to perform a counterfactual analysis. A very useful and well-recognised tool for this purpose is a matching analysis. For each participant, we find a similar, non-participating company we might expect to participate. We try to mitigate the selection bias of participants who are not randomly picked for projects.

We assess impact through six performance variables that cover knowledge intensity, value creation and growth. More specifically, we measure the share of employees that hold at least a master's degree, export intensity, labour productivity, full-time equivalent employees and revenue. Unfortunately, not enough of the participating companies are covered by the Danish R&D expenditure statistics. Thus we have to rely on indirect indicators of R&D intensification.

4.1. Main findings

The overall picture that we obtain from the analysis is that FP6/FP7 companies are quite different from the average Danish company on a range of economic performance indicators. They gain, on average, about 40 per cent of their revenue through exports, grow revenue at a fast pace, and employ intensively highly-skilled workers. Larger companies also make up a larger percentage of the participating companies compared to their general share of companies in Denmark. The largest share of participants is found in the following industries: manufacturing, professional, scientific and technical activities.

Our results from the assessment of impact on a range of different performance variables suggest that participating companies do outperform comparable non-participating companies. The difference is, however, not statistically significant, meaning that it is not possible to identify whether the difference is random or due to FP6/FP7 participation. What characterises participating companies is the intensive use of highly-skilled employees, and a high degree of exports. In other words, these companies have, in general, already succeeded in breaking through into international markets, and they are, regardless of their participation in FP6/FP7 projects, well-run companies that do not seem to be critically dependent on particular funding of public-private research partnership projects.

We emphasize that our matching sample for the impact assessment – though on average resembling the total population of participating companies and by size large enough to mechanically test mean differences — should preferably have been larger, with more observed participating companies and more control companies. Having a larger sample would have made us able to assert more rigorously whether, for example, a few individual outlier matches of participating companies and control companies that may appear to be good matches at the matching point are not too influential on the group means. Furthermore, the sample size limits the scope for digging deeper and searching for subgroup trends.

The impact assessment task is demanding: we require that the impact can be measured already five years after project start, and 1) not be influenced significantly by other decisions or circumstances within the company, and 2) that projects with an average dedicated budget of less than a third of the cost of a full-time equivalent (FTE) employee can stimulate change at the overall performance level of the company — a company that has already dedicated resources for employing highly-skilled employees.

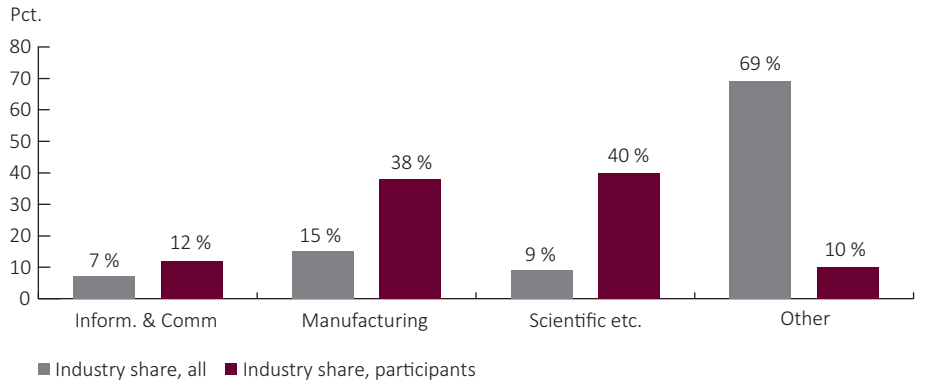
Despite missing statistically significant and positive results from the analysis of six company performance variables, project participation may still play an important role for the companies that we cannot measure. The motivation for participating may also be related to indirect objectives for future growth and earnings potential, e.g. by serving as signalling to other potential partners or investors, or networking, including lower recruitment search costs. Such reasoning and associated outcomes are difficult to identify in an economic impact assessment.

The chapter proceeds as follows: Section 4.2 presents a descriptive view of FP6/FP7 participants, while section 4.3 presents the results of the impact assessment. Section 4.4 sums up.

4.2. Characteristics of participating companies

This section briefly describes the characteristics of the companies participating in FP6/FP7. In our descriptive statistics we observe 400 unique companies participating in FP6/FP7. We have aggregated the industries into three relevant, broad sectors and a residual sector ("Other"). Thus, the described figures presented in this section are aggregated accordingly. (This has no influence on the impact assessment later on.) Figure 4.1 compares the average allocation of Danish companies participating in FP6/FP7 projects between 2002 and 2012 to the allocation of the number of active companies (legal entities) in the Danish economy during the same period. Clearly, these two distributions of companies are different. While Danish manufacturing companies constitute 15 per cent of all active Danish companies, 38 per cent of all participating companies belong to the manufacturing sector. Together with companies in the sector Professional, scientific and technical activities (Scientific etc. in the figure), these companies make up 78 per cent of all participating companies.

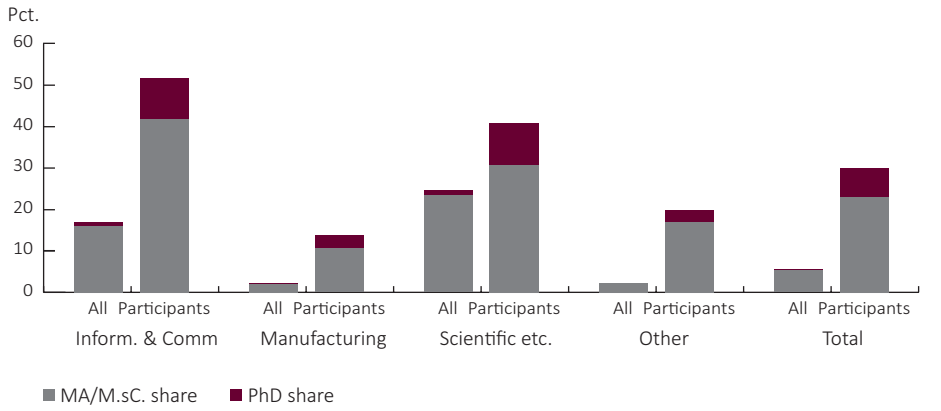
FIGURE 4.1
RELATIVE ALLOCATION OF COMPANIES BY INDUSTRY



Source: DASTI's own calculation using registry data from Statistics Denmark and eCORDA database.

Within the four sectors, the participating companies are also different from other companies. The average share of their employees that hold at least a master's degree is higher. The same is the case for the share of PhDs employed, cf. figure 4.2.

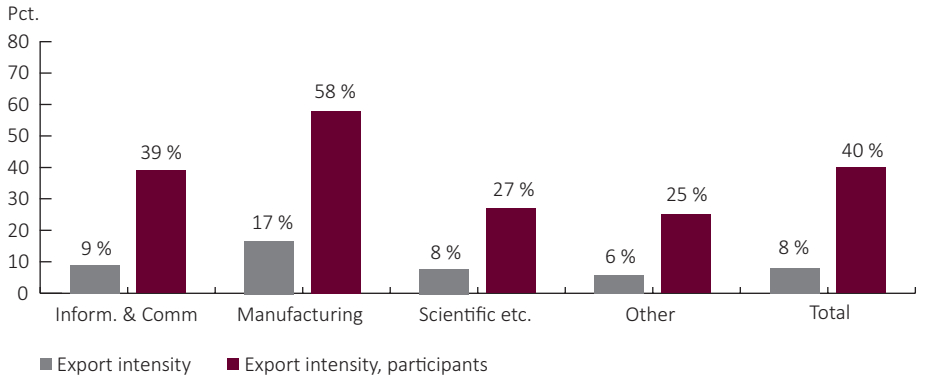
FIGURE 4.2
AVERAGE SHARE OF MAs/M.Sc.s AND PhDs BY INDUSTRY



Note: The stacked bars are indicative, as they are simple averages of PhD shares and MA/M.Sc. shares across companies.
Source: DASTI's own calculation using registry data from Statistics Denmark and the eCORDA database.

Participating companies are in general considerably dependent on export sales. In the manufacturing sector the relative share of exports to total revenue is on average 58 per cent compared to 17 per cent in general. The difference is also notable in other sectors of the economy, cf. figure 4.3.

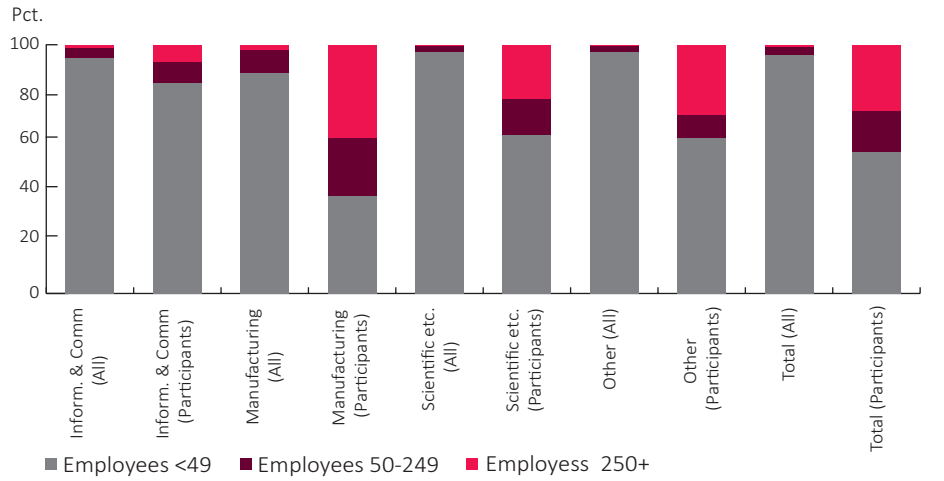
FIGURE 4.3
RELATIVE SHARE OF REVENUE FROM EXPORTS



Source: DASTI's own calculation using registry data from Statistics Denmark and the eCORDA database.

In addition to belonging to certain sectors and relying heavily on the highest skill types of labour, large companies are also more frequently represented in FP6/FP7 than comparable companies in general, cf. figure 4.4.

FIGURE 4.4
COMPANY SIZE AND (WITHIN) INDUSTRY ALLOCATION



Notes: Companies participating more than once are counted individually. Employees are measured as full-time equivalent employees.
Source: DASTI's own calculation using registry data from Statistics Denmark and the eCORDA-database.

About 90 per cent of all Danish manufacturing companies have less than 50 employees, whereas only 40 per cent of the participating manufacturing companies have less than 50 employees. The picture is that small companies constitute a considerable share of the participating companies, but large companies are relatively more represented among participants than their share of the Danish distribution of companies by size. A few large companies tend to increase the overall average number of employees, and the median participating company has about 40-70 employees.

Clearly, when performing an impact assessment by matching participating companies with other similar companies that are likely to be participants, we must address the characteristics — and others — presented above. The participating companies are high-performance companies compared to the average Danish company.

4.3. Impact assessment

We base our impact assessment on a difference-in-differences matching analysis. Our sample time span covers a five-year window, which is aligned individually for each company according to observed participation initiation (i.e. some participate in 2003, some in 2007 etc.).[21] We start by briefly describing how we measure impact before presenting the results.

4.3.1. The matching sample

The data sample for the impact assessment has been carefully constructed by combining propensity score matching with pre-selection of possible control group companies to accommodate selection bias, 1-1 matching within each year on industry,

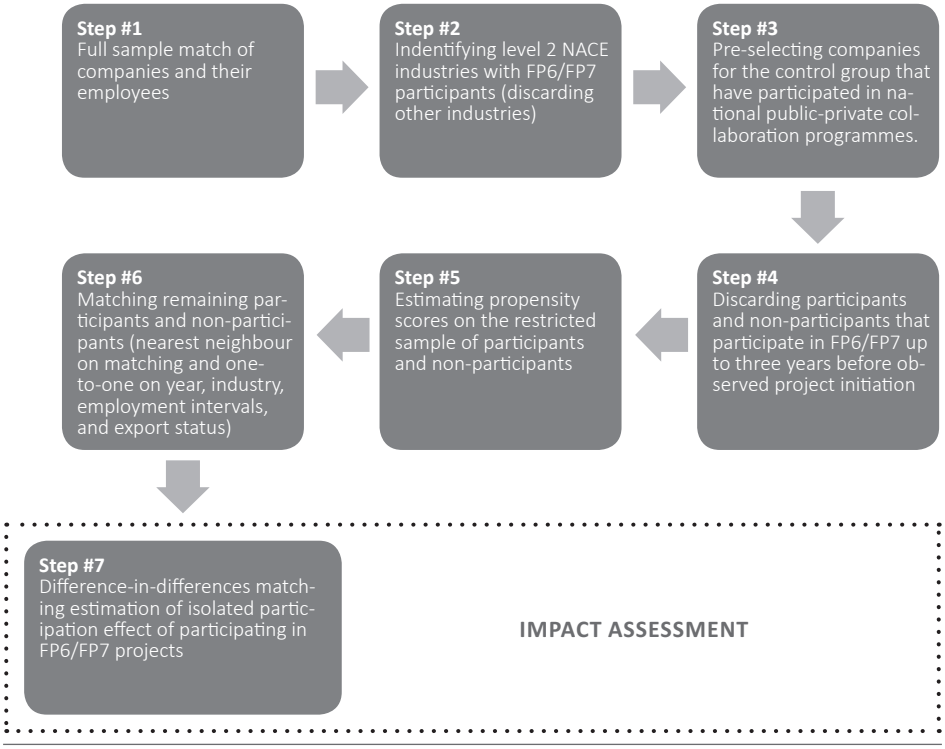
21 Our outcome variables in the analysis are differences between base year and up to five years forward.

and exporter status, and to a large extent on employment (intervals).[22] Finally the sample has been examined and cleared for outliers and unlikely matches, despite the rigorous matching process and balancing testing.

The matching process ensures that we are comparing participating companies with non-participating companies that are likely to have participated in the same industries.

Figure 4.5 briefly shows the main process of the sample construction leading to the impact assessment. We draw control group companies from the Innovation Denmark database. This database covers Danish national innovation and research support programme participation by companies and their potential project partners (universities, research institutions, etc.). Potential control group companies include companies that at some point in time between 2000 and 2012 have participated in national public-private collaboration projects.[23] We do this to mitigate selection issues in such a highly selective programme as FP6/FP7. Participation in other collaboration programmes indicates that these could also be successful in FP6/FP7 projects.[24]

FIGURE 4.5
AN OVERVIEW OF THE STEPS OF THE MATCHING SAMPLE CONSTRUCTION



The resulting sample consists of participating companies that are matched with highly similar companies not participating that we can observe for five years. The

22 In the intervals "250-499" and "+500", there are a few odd matches, but company size is still relatively well-matched.
23 The control group companies have either participated in Research Voucher, The Danish National Advanced Technology Foundation or Innovation Consortia.
24 We also tested matching with all companies (irrespective of prior participation in national support programme) as potential control group companies. This does not result in different conclusions.

sampled participants are drawn from a population of 344 unique participating companies between 2002 and 2008 (to observe companies five years forward from latest 2007 to 2012). Because participating companies sometimes return to participate, we must be aware of not using participating companies as controls at a later point, or evaluating them as participants again when the impact of an earlier project may start to kick in. Therefore, the analysis has a clear 3-year window to obtain the effects of participating in FP6/FP7. Table 4.1 presents the results of the matching procedure. The table below presents averages, but it is worth mentioning that the median company has between 40 and 60 employees, which is similar to the full population of participating companies.

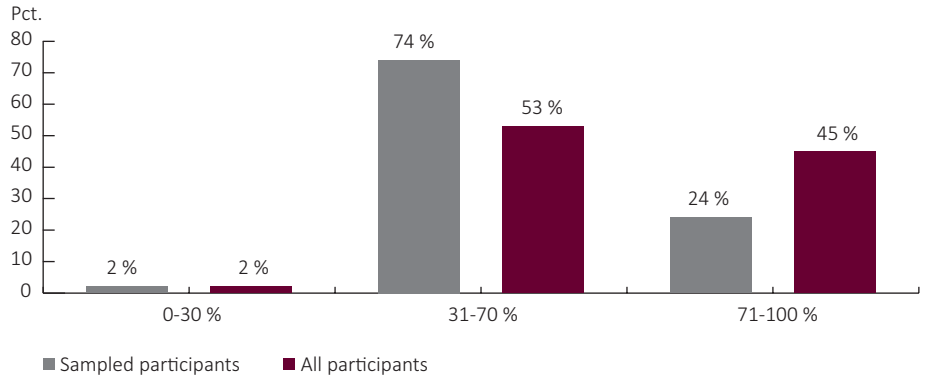
TABLE 4.1
THE MATCHING SAMPLE

	Participants	Control group	t-test for match quality		
Number of companies	110	107	%-bias	t-value	p-value
Revenue (million DKK)	210.92	180.27	9.5	0.74	0.46
Total fixed assets (million DKK)	109.14	126.68	-6.2	-0.37	0.71
EBIT (million DKK)	12.84	10.37	4.6	0.33	0.74
Labour productivity (thousand DKK)	467.54	475.58	-1.9	-0.15	0.88
FTE employment	166.72	142.35	12.1	0.86	0.39
FTE size categories					
- FTE<50	0.49	0.49	0	0.00	1.00
- FTE 50-249	0.27	0.28	-3.9	-0.30	0.77
- FTE 250-499	0.12	0.16	-11.5	-0.76	0.45
- FTE 500+	0.12	0.07	19.6	1.35	0.18
Export intensity	0.45	0.45	-0.7	-0.05	0.96
MA/M.Sc. share	0.22	0.20	14.5	1.05	0.29
PhD share	0.06	0.05	0.6	0.04	0.97
Company age	18.29	17.31	5.9	0.46	0.65

Note: All companies are matched using propensity score matching and one-to-one match on semi-aggregated NACE 2 industries (see separate technical note), export status, FTE interval dummies, and participation year minus one.
Source: DASTI's own calculation using registry data from Statistics Denmark and the Innovation Denmark-database.

The sampled companies participating in FP6/FP7 resemble the full population of participating companies well, also with regard to the overall budget for the FP6/FP7 project they participated in, as well as their own share of the project's budget. The sample includes relatively few companies that participated in projects receiving an EU contribution of +70 per cent of the project's budget rather than in the full population of participating companies, cf. figure 4.6.

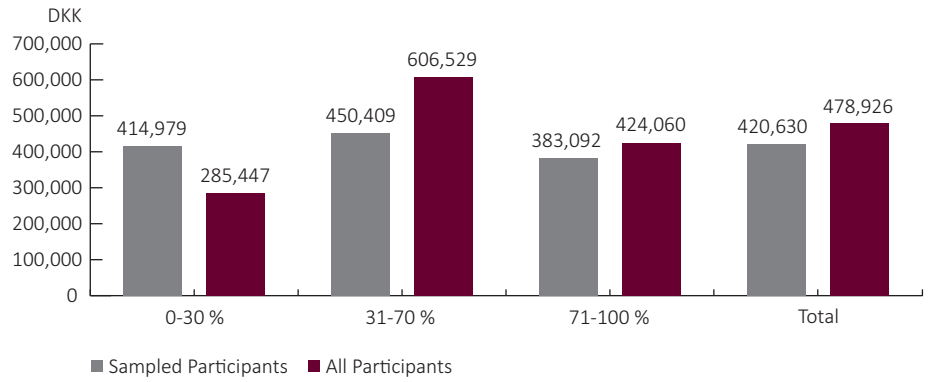
FIGURE 4.6
EU CONTRIBUTION AS SHARE OF PROJECT BUDGET (EU CO-FINANCING)



Source: DASTI's own calculation using registry data from Statistics Denmark, the InnovationDenmark-database and eCORDA database.

The sampled companies participating in FP6/FP7 also have to resemble the full population of participating companies with regard to the importance of the EU contribution in relation to the company's research capacity. Therefore, the project budget was distributed on employees within R&D. An average project in the sample has a budget of roughly DKK 400,000 per employee holding an MA, M.Sc., or PhD, cf. figure 4.7.[25]

FIGURE 4.7
BUDGET IN DKK PER MA/M.Sc./Ph.D



Note: The mean for "All, 31-70 per cent" excludes a few companies (99th percentile) with very high budgets per employee that disturb the overall picture of the distribution of budget per employee.
Source: DASTI's own calculation using registry data from Statistics Denmark, the InnovationDenmark database and eCORDA database.

4.3.2. Results

In this section we illustrate the development of six key performance variables: The share of PhDs employed, share of masters employed, export intensity, labour productivity (value added per full-time equivalent employee), full-time equivalent labour force (FTE), and revenue. These variables sum up indicators for organic

25 The measure is not perfect because non-scientific personnel also hold master's degrees. Only using PhDs, on the other hand, would exclude companies that do not employ PhDs. Therefore value itself is not as interesting as creating a common unit for comparison across companies of varying size and skill levels.

growth (revenue, exports and employment), longer-term investments in research activities (skill intensity), and increased value creation (labour productivity). The illustrations sum up the average development of the participants and their comparable control companies (i.e. companies are followed up to five years ahead but from different points in time). This illustration approach can blur the results, because of business cycle trends. However, we correct for business cycle trends in our formal tests of impact (i.e. the underlying difference-in-differences estimation).

We start out by inspecting the structural indicators of intensifiying R&D, following the startup of an FP6/FP7 project. Developments in the intensity level of skilled labour may indicate that by entering FP6/FP7 projects, companies focus more intensively on research than before. The development in the share of PhDs indicates that participating companies, on average, intensify their use of PhDs, cf. figure 4.8. The share of PhDs for control group companies has a declining trend. The difference in the development of the two groups is, however, not statistically significant. The same case applies to the share of masters employed in the sampled companies.

FIGURE 4.8
SHARE OF PhDs

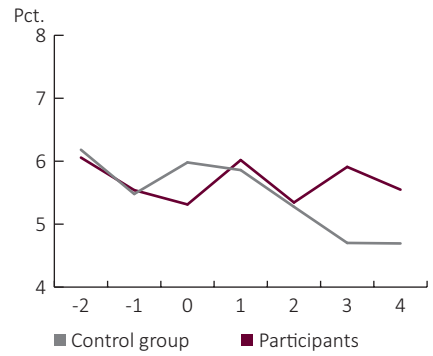
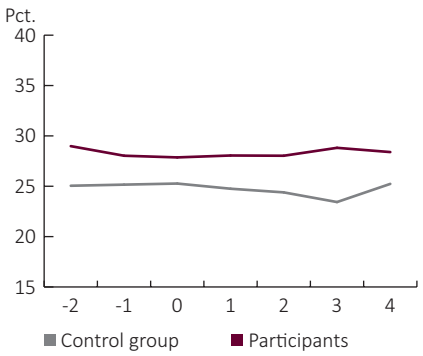


FIGURE 4.9
SHARE OF MA/M.Sc.s AND PhDs



Source: Matching analysis performed on data from Statistics Denmark and eCORDA database.

Because FP6/FP7 facilitates Danish companies to team up with global partners, it seems relevant to investigate whether export intensity levels change differentially from control group companies. Export intensity levels do increase over time, but they are not significantly different for the two groups of companies, cf. figure 4.10. On average, participating companies, though not developing significantly differently from control group companies, increase labour productivity by about 6 per cent per annum over a five-year period, cf. figure 4.11.

FIGURE 4.10
EXPORT INTENSITY

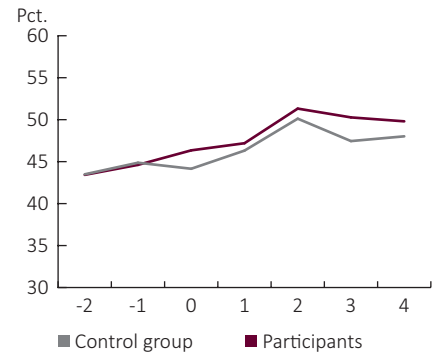
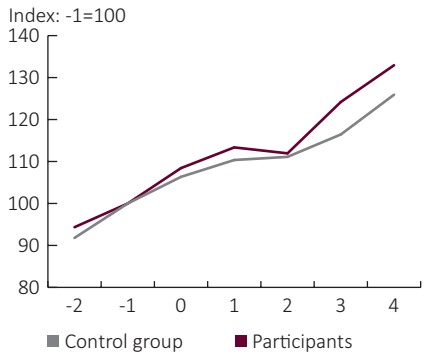


FIGURE 4.11
LABOUR PRODUCTIVITY



Source: Matching analysis performed on data from Statistics Denmark and eCORDA database.

There seems to be stagnation in employment, cf. figure 4.12, both for the participating companies and the control group. This stagnation could be the result of the abrupt change of development in the employment level past mid-2008. However, the average accumulated growth in revenue post participation shows that the average growth rate over a five-year period is 42 per cent, cf. figure 4.13. Behind this average growth of 42 per cent over five years we find varying growth rates for each of the matching years ranging from 25 to 58 per cent. Common for full-time equivalent employment and revenue is that the developments are not significantly different from the control group companies.

FIGURE 4.12
EMPLOYMENT

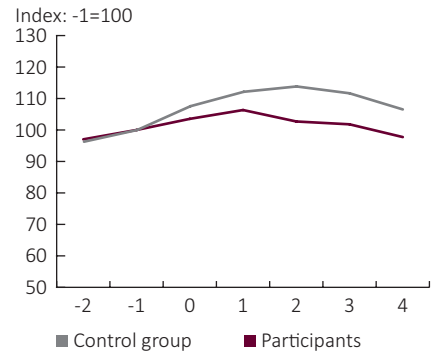
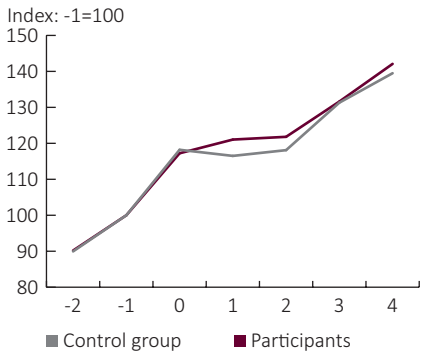


FIGURE 4.13
REVENUE



Note: Accumulated average growth in employment and revenue relative to the base level in year -1 (index 100).
Source: Matching analysis performed on data from Statistics Denmark and eCORDA database.

One interpretation for not observing a differential increase for participating companies is that participation does not stimulate isolated increases in business performance in the short run.

The overall picture that we obtain from this analysis is that FP6/FP7 companies and the very similar control group of companies are highly unusual companies compared to the average Danish company. They export, on average, about half of their revenue, grow revenue at a fast pace, and employ intensively highly-skilled workers.

4.4. Why the missing statistical difference in impact?

Working with micro analysis of companies and comparing growth rates is always difficult, because standard errors of growth terms are often relatively large. Micro level growth is often abrupt and unpredictable.

When comparing the development of revenue, export intensity, and labour productivity, participating companies grow faster but not statistically significantly. We have tried to find control group companies that could have participated, but ultimately it is very difficult to tell whether decisions to initiate a project crucially depend on FP6/FP7 funding or not.

More observations could allow an even more rigorous selection of control companies. Searching for other indicators should also be part of future reassessments of the impact, as should further discussion about which other public R&I funding systems participating and control group companies participate in.

Reassessment some years from now should be done, when the number of observations could be increased. Longer time spans might also help some years from now; however, the further away from the base year we evaluate impact, the more likely other factors are to play a role. These issues should be discussed before new assessments can be made.

Finally, note that both participating and non-participating companies are strong economic performers that create and increase value by exporting.

5. Private companies' use of FP6, FP7 and the Danish national research and innovation system

This chapter presents a mapping of the FP6 or FP7-participating Danish companies' use of the Danish research and innovation (R&I) system. The purpose is to gain a better understanding of what the links are between the funding opportunities in FP6 and FP7 and the Danish R&I system for Danish companies.

As far as the methodology is concerned, data from the European Commission's eCORDA database are linked together with data from the InnovationDenmark database (see box 5.1), which include data from 14 different Danish R&I schemes.

5.1. Main findings

The participating Danish companies in FP6 or FP7 are multiple users of the Danish R&I system. Approximately two-thirds of the companies participating in FP6 or FP7 have participated in one or more Danish R&I scheme.

There is a positive correlation between the number of different schemes the companies participate in and the size of the companies.

The companies participating in FP6 or FP7 make up a relatively large share of the companies that take part in large-scale programmes[26] – programmes which are similar to FP6 or FP7.

There is an increasing participation in other schemes up to the time when the companies take part in FP6 or FP7.

5.2. The companies' use of the Danish research and innovation system

The mapping shows that the Danish companies participating in FP6 or FP7 make use of the different schemes in the Danish R&I system. Approximately two-thirds of the Danish companies participating in FP6 or FP7 have also participated in one or more schemes in the Danish R&I system (see figure 5.1).

37 percent of the companies participating in FP6 or FP7 have not received any funding from the Danish R&I system. One in four Danish companies from FP6 or

26 The Danish National Advanced Technology Foundation, The Danish Council for Strategic Research and Strategic Platforms for Innovation and Research.

FP7 has participated in one scheme in the Danish R&I system. Approximately 40 per cent of the participating companies have participated in more than one national scheme. The participating Danish companies in FP6 or FP7 are in other words multiple users of the Danish research and innovation system.

When looking at the size of the participating companies in FP6 or FP7 that do or do not participate in the Danish research and innovation system, there is a positive correlation between the number of different schemes the companies participate in and the size of the company. Figure 5.2 shows that approximately 90 per cent of the companies that only participate in one scheme are SMEs, while SMEs account for only approximately 40 per cent of the companies that participate in 5 to 8 other schemes. 97 per cent of the companies that do not participate in any Danish R&I scheme, but that are in FP6 or FP7, are SMEs.

FIGURE 5.1
SHARE OF PARTICIPATION OF UNIQUE COMPANIES FROM FP6 OR FP7 IN THE DANISH RESEARCH AND INNOVATION SYSTEM FOR THE PERIOD 2002-2013

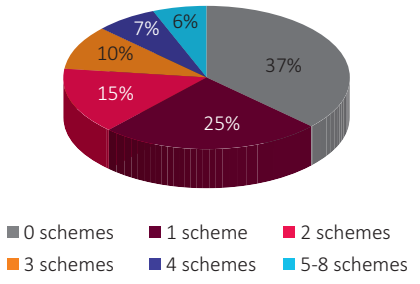
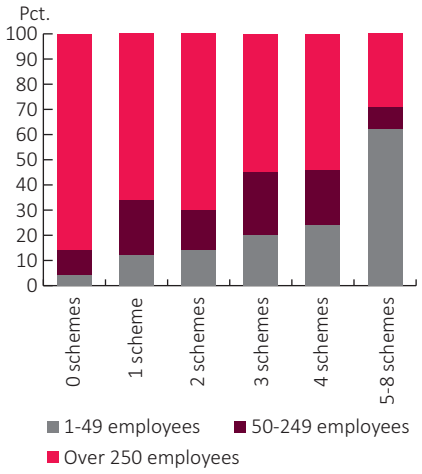


FIGURE 5.2
SIZE OF THE COMPANIES FROM FP6 OR FP7 RELATED TO THEIR PARTICIPATION IN THE DANISH RESEARCH AND INNOVATION SYSTEM FOR THE PERIOD 2002-2013



Note: The figures are based on unique participation both in FP6, FP7 and other schemes, so the companies can have participated more than once in the different schemes, but this only accounts for one.
Source: The Danish Agency for Science, Technology and Innovation, the InnovationDenmark Database 2015.

5.3. The most popular Danish research and innovation schemes

When looking at the different Danish schemes that the participating Danish companies in FP6 and FP7 took part in, the most popular one is Innovation Network Denmark. This is not surprising, as an analysis of the Danish companies' use of the Danish national and regional innovation and research funding landscape (DASTI 2013)[27] showed that Innovation Network Denmark is the entrance to the national research and innovation system. Only 5 per cent of the companies in Innovation Network Denmark, however, have participated in FP6 or FP7. This indicates that there is a potential for an increased participation in EU framework programmes.

27 DASTI (2013), Sammenhæng for vækst og innovation. En databaseret kortlægning af sammenhænge i udbud og efterspørgsel i det danske innovations- og erhvervsfremmesystem.

The participating companies in FP6 or FP7 make up a relatively large share of the companies that take part in large-scale programmes[28] – programmes which resemble thematic areas under FP6 or FP7. They account for approximately 35 to 45 per cent of the total participation of unique companies.

TABLE 5.1
SHARE OF DANISH COMPANIES PARTICIPATING IN FP6 OR FP7 THAT ALSO TOOK PART IN ONE OR MORE SCHEMES IN THE DANISH R&I SYSTEM OUT OF THE TOTAL NUMBER OF COMPANIES THAT PARTICIPATE IN THE SAME SCHEME FOR THE PERIOD 2002-2013

	Number of companies	Share of FP6/FP7 companies in the same scheme
Innovation Networks Denmark	265	5 %
The Danish National Advanced Technology Foundation	113	35 %
Industrial PhD	112	24 %
Innovation Consortia	103	22 %
Innovation Vouchers	72	4 %
Innovation Agents	67	2 %
The Innovation Incubator Scheme	47	5 %
The Danish Council for Strategic Research	45	45 %
EUopSTART	36	35 %
Strategic Platforms for Innovation and Research (SPIR)	32	35 %
Open Funds	26	16 %
Knowledge Pilots	23	2 %
Gazelle Growth	11	22 %
Research Vouchers	4	22 %
Spin-outs from Danish Universities	4	5 %
Total	**960**	**7 %**

Note: The table is based on unique participation both in FP6, FP7 and other schemes, so the companies can have participated more than once in the different schemes, but it only accounts for one.
Source: The Danish Agency for Science, Technology and Innovation (2015), the InnovationDenmark Database.

5.4. The entrance to the Danish research and innovation system

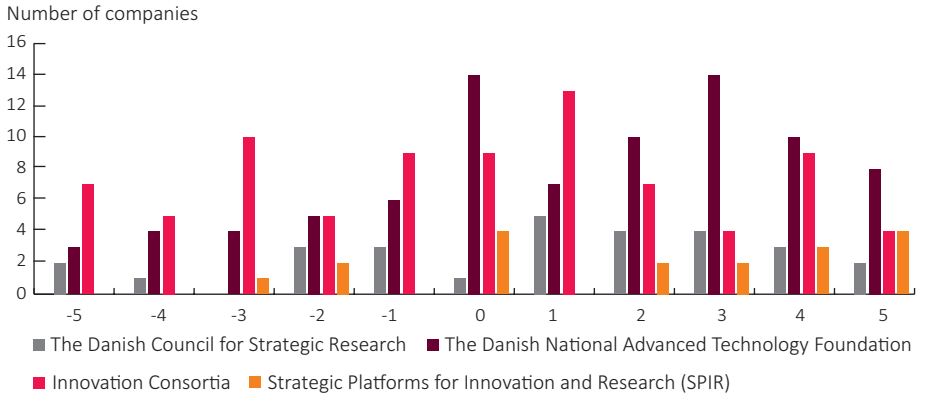
Figure 5.3 shows when the participating companies in FP6 or FP7 take part in other schemes over a period of five years before and five years after their participation in FP6 or FP7. 46 per cent of the companies participated in another scheme under the Danish R&I system before their participation in FP6 and FP7, while 54 per cent did after.

Year 0 shows the number of companies that obtained a grant from FP6/FP7 participated a Danish scheme within the same year. Year 1 shows the number of companies that participated in a national scheme the year after the start of their FP6/ FP7 participation.

There is a trend towards an increasing participation in national schemes prior to FP6/ FP7 participation.

28 The Danish National Advanced Technology Foundation, The Danish Council for Strategic Research and Strategic Platforms for Innovation and Research

FIGURE 5.3
PARTICIPATION OF UNIQUE COMPANIES IN FP6 OR FP7 AND OTHER LARGE-SCALE PROJECTS OVER A FIVE-YEAR PERIOD FOR THE PERIOD 2002-2013



Note: The figure is based on unique participation in FP6, FP7 and other schemes, so the companies can have participated more than once in the different schemes, but this only accounts for one – the first participation.
Source: The Danish Agency for Science, Technology and Innovation (2015), the InnovationDenmark Database.

5.5. Conclusion

The results from this analysis show that the participating Danish companies in FP6 or FP7 are multiple users of the Danish national research and innovation system. They also show that the participating companies in FP6 or FP7 make up a relatively large share of the companies that take part in large-scale Danish programmes. All these findings demonstrate that FP6 and FP7 is an integral part of the funding landscape for Danish companies. Only 5 per cent of the companies in Innovation Network Denmark, have participated in FP6 or FP7. This indicates that there is a potential for an increased participation in EU framework programmes.

BOX 5.1 THE INNOVATIONDENMARK DATABASE

Danish Agency for Science, Technology and Innovation (DASTI) has an increasing focus on collecting data from the different national research and innovation schemes. The data are harmonized in a joint database called the InnovationDenmark database.

The InnovationDenmark database includes data from 16 national and international research and innovation programmes, and includes approximately 12,800 projects and 11,700 Danish and international participants. There are approximately 11,300 unique Danish companies in the database. The database covers the period from 2002 to 2013.

As standard, the following harmonised data are collected for all research and innovation schemes in DASTI:

- Variables for each project: Name of programme, project title, grant status (rejection or approval), application year, start date for the project, end date for the project, total budget and total grant
- Variables for the participating partners in each project: Company registration number (CVR number), type of organisation, region, sector (NACE) and number of employees.

6. Bibliometric performance analysis of publications from Danish researchers linked to FP6 and FP7

This chapter presents an analysis[29] of the impact of Danish scientific publications that were the result of FP6 or FP7 funding. The purpose is to gain an insight into the scientific impact researchers can achieve when participating in FP6 and FP7.

In order to look at impact we have identified citations belonging to scientific publications with at least one Danish author. This is done using data from the international citation database Web of Science (WoS). These results are compared to the results of the bibliometric analyses from the previous evaluations of the Danish National Research Foundation (DNRF) and the Danish Council for Independent Research (DFF). Finally the analyses also explore the impact at the level of programme themes under FP6 and FP7.

6.1. Main findings

The present bibliometric analyses examine the performance of journal articles affiliated to scholars at Danish research institutions and linked to projects funded by the European Framework Programmes FP6 and FP7. The data sets analysed include 2,020 unique publications linked to 171 FP6 projects in the period 2002 to 2013 and 3,583 unique publications linked to 461 FP7 projects in the period 2007 to 2013.

We examine the citation impact of these publications and we compare the impact to other funding benchmark units. Benchmark units include validated publication sets linked to two main Danish funding institutions, i.e. the Danish National Research Foundation (DNRF) and the Danish Council for Independent Research (DFF). To align the FP6 and FP7 publication sets for comparison with the benchmark units, the time period for these comparisons is restricted to 2005-2011 (FP6) and 2007-2011 (FP7). We analyse the publication sets at the aggregate level of FP programmes and the disaggregate level of FP-specific "programme themes". The main findings and some caveats are presented below in this summary.

29 The study was produced by Jesper W. Schneider and Thomas Kjeldager Ryan, Danish Centre for Studies in Research and Research Policy, Department of Political Science and Government, Aarhus University, Denmark. Data was collected and provided by DASTI.

Overall the aggregate publication sets linked to FP6 and FP7 examined in this study perform respectively above and far above the international performance levels, when it comes to citation impact. The impact levels are generally high, and the impact levels for the FP7 set can be considered outstanding. The average article citation score for the FP6 set is approximately 50 per cent above the international level, whereas the score for the FP7 set is close to 75 per cent above the international level. Likewise, the FP6 set has 1.75 times as many publications as expected among the 10 per cent most cited in the database, whereas the FP7 set has twice as many as expected.

Noticeable for both sets is the degree of internationalisation. Although we expected that a considerable number of the publications would be international collaborations, the observed proportion of approximately 70 per cent was higher than expected. The general proportion of Danish publications with international collaboration is around 55-60 per cent in the period examined.

Also characteristic for both sets are the publication profiles, when it comes to output in the "multidisciplinary sciences" journal subject category. For both groups, this is the single largest journal subject category when it comes to output, and it is also the category with the highest citation impact. This is the category where broad journals such as Science, Nature and PNAS (Proceedings of the National Academy of Sciences) are categorised. The FP6 and FP7 sets vary to some degree when their subject profiles are characterised according to the OECD's main research fields (cf. technical report). Not surprisingly, the natural science field is the largest in both sets, but in the case of FP6 the field of engineering and technology performs at the same level as the natural science field, whereas in the case of FP7 the natural science field markedly outperforms all other fields.

A main finding of the present analyses is the outstanding performance level of the FP7-linked publications. As a set it has a higher citation impact compared to all the benchmark units. As in previous analyses of funding units[30], we also see that, in the present case, removing either the FP6 or the FP7 set causes a decrease in overall Danish impact. The results are robust, yet the decrease is most marked for the FP7 set. Like the benchmarks sets, this analysis confirms that the FP6 and FP7 publication sets contain a relatively larger proportion of the most highly-cited articles in the database compared to the overall distribution of Danish articles. As the distribution of citations is highly skewed among articles, removing the funding sets stepwise compared to random sets causes important drops in the overall national impact.

Interestingly, the two sets differ when it comes to the actual impact of the articles with international collaboration. As expected, impact is generally high and considerably higher than the impact of publications with no or merely national collaboration. Nevertheless, the impact level for the FP6 set is below the levels for the two funding units used as benchmarks, whereas the FP7 set outperforms them all.

Statistical modelling suggests that substantial parts of the impact received by FP6 and FP7-linked publications are associated with the high level of international collaboration. But again there are differences between the two sets. The expected marginal impact for FP6-linked publications is on the same level as the DFF set, but below the DNRF set when controlling for international collaboration. Without the statistical control, the expected impact level for FP6-linked publications is on a level

30 http://ufm.dk/en/publications/2013/files-2013/appendiks-5_bibliometrisk_report_03122013.pdf
http://ufm.dk/publikationer/2014/filer-2014/analyses-of-the-scholarly-and-scientific-output-from-grants-funded-by-the-danish-council-for-independent-research-from-2005-to-2008.pdf

with or slightly below the benchmark sets. Consequently, international collaboration, with its derived impact effects, to a large extent seems to statistically explain the performance level of the FP6 set.

International collaboration is, however, not the only explanation for the outstanding performance levels for the FP7 set. Controlling for international collaboration reduces the expected marginal impact, nevertheless even after the statistical control the expected impact of FP7-linked publications is markedly higher than the two benchmark sets. Consequently, the high impact of FP7 publications cannot be explained as primarily an effect of international collaboration. Other factors are at play.

Publications linked to ERC and Marie Curie grants are included in the FP7 set. They constitute 27 per cent of the total FP7 set and 33 per cent of the restricted set used for the benchmark analyses. Removing the ERC and Marie Curie-linked publications causes a considerable drop in impact for the remaining FP7-linked publications. Depending on whether we focus on indicators based on full or fractional counts, the performance level for the remaining FP7 publications is on a level with the DNRF with full counts, or below the DNRF but on par with the DFF set using fractional counts. It is noticeable here that the more robust indicator for the proportion of highly-cited articles suggests that the drop is most marked in the average-based indicators, as they are less robust in relation to the influence of outliers on indicator values. Subsequent modelling confirms these findings, in as much as controlling for ERC and Marie Curie grants seems to explain most of the gap to the DNRF set, although the expected marginal impact is still slightly higher for the FP7 set, even after controlling for these specific grants.

Finally, the disaggregate analyses at the level of thematic areas reveal that no single type of thematic area seems to dominate performance, as high impact levels are spread among various different funding themes and types. It is interesting to observe that other "thematic areas" than ERC and Marie Curie grants both have large volume and high impact in the FP7 set.

When interpreting the results presented in this report it should be kept in mind that measuring the properties of science is a difficult exercise. Bibliometric data can contribute important insights to this exercise, but cannot stand alone. Indicators measuring citation impact capture the short-term reception of journal articles in the scholarly communication system. But it is important to realize that there is no one-to-one relationship between impact and research "quality". Under reasonable circumstances, impact on aggregate levels of analysis may be seen as a partial or indirect measure of "quality". As a consequence of the partial and one-dimensional nature of the indicators, a single indicator is often not reliable.

However, when various complementary indicators suggest similar insights, more convincing evidence about the property observed is offered. Furthermore, the indicators have to be appropriate to the units under investigation. The limitations with regard to this are well-known within the humanities and major parts of the social sciences, but also apply to certain areas of the hard sciences. While the units analysed in this study have good coverage and can be seen as valid, they only include journal articles indexed in the Web of Science. Finally, bibliometric indicators are unreliable below certain levels of aggregation and need careful mathematical normalization to be used across diverse research areas. However, these normalization procedures are by no means perfect. The interpretation of the data in this report should in other words be done with care; however, despite these limitations, bibliometric data do have a lot to offer when examining academic performance.

One specific issue needs to be emphasised in relation to the presented analyses: the potential risk of systematic selection bias in the examined data sets. The two-step data collection process neither provides apparent populations nor generates random samples. Although we seem to have included approximately half of the originally targeted FP6 and FP7 projects, we definitely cannot rule out some selection bias. We cannot expect the missing projects and their affiliated publications to be an exact mirror of those included, although it is also highly unlikely that a large majority of the missing publications should be specifically located in the tails of the distributions, potentially causing major changes to the calculated indicator values.

In the technical report we try to examine to what extent the included data may be biased. Would the citation distributions significantly change if the FP6 and FP7 publication sets were substantially enlarged? The general impression is that the constitutions of the two sets are fairly robust given their actual size, and combined with the experience we have with larger data sets such DFF and DNRF, we are inclined to say that an enlargement will probably not change the distributions and thus impact levels in any substantial way – yet we cannot rule it out. Consequently, the results presented in this report should be interpreted carefully, as systematic bias cannot be excluded. However, we have good indications that the results are indeed robust and to a large extent reliable.

The subsequent section presents the main results in tables and figures, and the final section gives an overview of the methods and indicators used. The methods and results presented here are documented and scrutinised more comprehensively in the supplementary technical report.

6.2. Results

6.2.1. Publication performance FP6 and FP7

Table 6.1 presents the overall performance statistics for the publication sets linked to the FP6 and FP7 programmes. Even though the time period is longer for the FP6 programme, the analysed FP6 publication sets are considerably smaller compared to the FP7 set. The FP6 and FP7 publication sets have coverages in the database of slightly above 80 per cent, which conventionally is interpreted as “excellent” for the purpose of citation analyses.

When looking at impact we use two main indicators: an average article citation score (MNCS - mean normalised citation score) and a score for the share of highly-cited publications (PPtop10 per cent). The average article citation score (MNCS) is based on the actual number of citations publications have received. A value above 1 indicates that the mean impact for the unit of analysis is above world average, whereas a value below 1 indicates the opposite. The indicator for the share of highly-cited publications (PPtop10 per cent) shows the proportion of publications belonging to the top 10 per cent most frequently cited publications in a field. A share of 20 per cent means that 20 per cent of the unit of analysis is among the 10 per cent most frequently cited. The level for Danish scientific publications is normally around 12 per cent.

When it comes to citation impact, the FP6 and FP7 publication sets differ considerably. With full count average article citation score values of 2.03 and share of highly-cited publication values of 22.2 per cent, the FP7 set has an outstanding performance level. The performance level of the FP6 publication sets is also noticeably

above the international standard, but also distinctly below the impact level of FP7 set. Looking at the indicators based on fractional counts and comparing them, the average article citation score for the FP6 set is approximately 50 per cent above the international level, whereas the score for the FP7 set is close to 75 per cent above the international level. Likewise, the FP6 set has 1.75 times as many publications as expected among the 10 per cent most cited in the database, whereas the FP7 set has twice as many as expected.

All analyses have been done with both full and fractional counting – as shown in table 6.1: No. of fractional publications, Average article citation score and Share of highly-cited publications. With full counting, a unit of analysis is given full credit for a publication regardless of the number of authors, institutions or countries mentioned in the address field of the publication. With fractional counting a unit is credited a fraction of each publication - in the present case in proportion to its share of all countries mentioned in the address field in a publication. Consequently, we fractionalise at the country level because a principal interest in the analyses is the units' degree of internationalisation.

The indicator for average journal citation score (MNJS) reflects the journal publication profile of the unit under investigation. It measures the average citation impact of the journals in which a set of publications has appeared, where the citation impact has been normalized for the fields to which the journals belong. Above one means that on average the journals have been cited more frequently than would be expected based on their fields. The stable indicators of 1.47 for FP6 and 1.55 for FP7 can be considered high. In other words, the FP6 and FP7 publications are on average published in journals with a high impact in their respective fields. On an aggregate level, one can expect that publications in higher impact journals will result in higher overall citation impact scores (although this reasoning does not hold for individual articles).

TABLE 6.1
OVERALL PERFORMANCE STATISTICS FOR PUBLICATION SETS LINKED TO FP6 AND FP7 PROGRAMMES

	FP6	FP7
	(2002-2013)	(2007-2013)
No. of publications	2,020.0	3,583.0
No. of fractional publications	1,083.5	1,958.9
Database coverage	82 %	85 %
Share of international collaboration	71 %	69 %
Average article citation score (MNCS)	1.79	2.03
Average article citation score - fractional ($MNCS_{frac}$)	1.52	1.74
Share of highly-cited publications (PPtop10 per cent)	19.6 %	22.2 %
Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)	17.2 %	19.8 %
Average journal citation score (MNJS)	1.47	1.55

Interestingly, the journal publication profiles are similar for the two sets when it comes to output in the "multidisciplinary sciences" journal subject category in Web of Science. For both sets, this is the single largest journal subject category when it comes to output, and it is also the category with highest mean normalized citation impact. This is the category where broad journals such as Science, Nature and PNAS

are categorised (journal and OECD subject profiles for the FP6 and FP7 sets can be found in the technical report).

Besides the outstanding performance level for FP7 publications, the most interesting finding from this overall performance analysis is the very high proportion of articles with international collaboration both in the FP6 and FP7 sets. Obviously, we would expect that a majority of the articles would be a result of international collaboration, given the nature of the EU funding programmes and combined with the general trend of larger shares of annual publication volumes with international collaboration (e.g., for Denmark this share has been between 55 and 60 per cent in the last decade). Nevertheless, 71 per cent for FP6 and 69 per cent for FP7 is more than expected, and knowing that international co-authored articles on average have higher citation rates compared to articles with no or merely national collaboration, this fact no doubt influences the overall impact of the two publication sets.

Table 6.2 shows performance statistics for articles from the two publication sets with no collaboration, national or international collaboration. If we compare the performance of the articles with no extra-institutional collaboration with the performance of articles with national institutional performance, we see that for both the FP6 and FP7 sets the performance for both the journal publication indicator (MNJS) and the article impact (MNCS) is considerably higher for articles with no collaboration.

TABLE 6.2
PERFORMANCE STATISTICS FOR ARTICLES WITH NO (NO COLLAB.), NATIONAL (NAT. COLLAB.) OR INTERNATIONAL COLLABORATION (INT. COLLAB.) IN THE PUBLICATION SETS LINKED TO FP6 AND FP7

	FP6			FP7		
	(2002-2013)			(2007-2013)		
Publication sets	No collab.	Nat. collab.	Inter. collab.	No collab.	Nat. collab.	Inter. collab.
No. publications	348	213	1441	689	420	2474
No. of fractional publications	348	213	503.5	689	420	850.5
Average article citation score (MNCS)	1.49	1.32	1.93	1.64	1.47	2.22
Average article citation score - fractional ($MNCS_{frac}$)	1.49	1.32	1.63	1.64	1.47	1.95
Share of highly-cited publications (PPtop10 per cent)	17.6 %	14.3 %	20.9 %	19.1 %	18.4 %	23.7 %
Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)	17.6 %	14.3 %	18.2 %	19.1 %	18.4 %	21.3 %
Average journal citation score (MNJS)	1.37	1.28	1.53	1.34	1.31	1.66

If we then compare the performance of the two previous collaboration types with international collaboration, we clearly see that the previous two sets were relatively smaller in size, and that the performance of internationally co-authored articles on average is markedly higher compared to articles with no or national collaboration. Nevertheless, the patterns between the three collaboration types deviate from the overall characteristics for Danish publications in as much as articles with no collaboration have a higher impact compared to articles with national collaboration. What is noticeable is that articles with international collaboration are generally published in journals with higher international impact (MNJS) and have themselves on average a much higher impact compared to the other two categories. But it is also remarkable that the performance for the FP7 set is higher in all three categories

compared to the FP6 set and considerably higher when it comes to articles with international collaboration.

6.2.2. Benchmark analyses

We present the main performance statistics for the benchmark comparisons in tables 6.3 (FP6) and 6.4 (FP7) below; for more detailed analyses we refer to the technical report. Two overall benchmark approaches have been used. One where we examine what happens to the overall national impact for Denmark, when the FP6 and FP7 publication sets are removed from the total Danish set of publications (similar consequences when removing the DFF and DNRF sets in combination with the FP6 and FP7 sets are documented in the technical report). The second benchmark approach simply compares the performance between the two benchmark funding sets and the FP6 and FP7 sets for the publication periods 2005-2011 and 2007-2011 respectively.

Overall, removing the FP6 or FP7 sets causes a drop in national Danish impact. The effect of removing the FP6 set is smaller than removing the FP7 set. This is a consequence of the smaller volume of the FP6 publication set but also the lower impact levels compared to the FP7 set. Notice that successively removing the FP sets together with DFF and then DNRF results in a continuous decrease of overall Danish impact, from 1.46 to 1.40 (Average article citation score) in the FP6 case and from 1.48 to 1.40 (Average article citation score) for the FP7 case (cf. technical report).

The general drop is more marked when removing the FP7 set. In previous analyses of DNRF and DFF we discussed how to interpret the seemingly small changes in impact. Significance tests are irrelevant here[31], yet resampling techniques, where random sets of articles of similar size to the funding units are removed from the overall Danish sets, reveal that the changes caused by the funding sets are indeed substantial. Nothing happens to the Danish impact when we resample, but removing publications linked to the specific funding units decreases overall Danish impact. This is so because the funding sets have a substantially higher proportion of highly-cited articles.

Comparing the overall performance for the FP6 publication set to the benchmark units (table 6.3), we see that the impact levels are comparable to the DFF set, but below the DNRF set. Notice that when we compare the units according to fractional counted average article citation score, the impact score for FP6 drops below the DFF. This is most probably an effect of the larger proportion of publications with international collaboration in the FP6 set in combination with the lower level of intrinsic robustness of the average article citation score indicator (we will examine this below). In all instances, the FP6 set is considerably smaller compared to the benchmarks. Notice that approximately 10 per cent of the FP6-linked publications are also linked to either a DFF grant or a CoE funded by the DNRF.

31 Cf. previously mentioned DNRF and DFF reports, and Schneider, J.W. (2013). Caveats for using statistical significance tests in research assessments. Journal of Informetrics, 7(1), 50- 62.

TABLE 6.3
COMPARISON OF PERFORMANCE BETWEEN FP6 PUBLICATION SET (2005-2011) AND BENCHMARK UNITS, THE DNRF AND DFF FUNDING SETS, AND THE OVERALL DANISH SET OF PUBLICATIONS

	No. of publications	Average article citation score (MNCS)	Share of highly-cited publications (PPtop10 per cent)	Average journal citation score (MNJS)	No. of fractionalized publications	Average article citation score - fractional ($MNCS_{frac}$)	Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)
Denmark (DK)	78,173	1.46	15.5 %	1.24	51,538.9	1.28	13.5 %
DK excl FP6	76,930	1.45	15.5 %	1.24	50,860.5	1.28	13.4 %
Total FP6 set of pubs	1,267	1.82	20.0 %	1.46	695.0	1.57	18.1 %
Total DFF set of pubs	6,272	1.81	19.3 %	1.49	4,182.6	1.62	17.9 %
Total DNRF set of pubs	7,164	1.88	21.7 %	1.57	4,458.0	1.72	19.6 %

The differences in impact levels between FP7 and the benchmarking units are noticeable. The difference between the DFF and DNRF is well-known and was documented in previous reports. While the time period is slightly different in the present analysis, the impact scores are similar to the ones in the previous reports. Notice that previously the DFF and DNRF publication sets have been considered to have high performance levels; the DNRF in particular has been characterized as having a very high performance when it comes to the proportion of highly-cited articles. Remarkably, the performance of the FP7 set in the present analysis is above that of the DNRF, and the level can therefore be considered to be outstanding.

TABLE 6.4
COMPARISON OF PERFORMANCE BETWEEN FP7 PUBLICATION SET (2007-2011) AND BENCHMARK UNITS, THE DNRF AND DFF FUNDING SETS, AND THE OVERALL DANISH SET OF PUBLICATIONS

	No. of publications	Average article citation score (MNCS)	Share of highly-cited publications (PPtop10 per cent)	Average journal citation score (MNJS)	No. of fractionalized publications	Average article citation score - fractional ($MNCS_{frac}$)	Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)
Denmark (DK)	59,130	1.48	15.8 %	1.26	38,490.8	1.29	13.6 %
DK excl FP7	57,355	1.46	15.6 %	1.25	37,515.7	1.28	13.4 %
Total FP7 set of pubs	1,908	2.11	23.0 %	1.57	1,068.1	1.81	21.7 %
Total DFF set of pubs	5,841	1.82	19.3 %	1.5	3,895.0	1.63	18.0 %
Total DNRF set of pubs	5,638	1.89	22.2 %	1.58	3,421.0	1.72	19.9 %

The share of highly-cited publications is also markedly higher. The marked differences are also visible with fractional counts, but here the degree of internationalization must also be taken into consideration. This influences the scores – not only the fractioning of scores but also in relation to the fact that international co-authored articles on average have higher citation density rates. The similar journal publication profiles for the FP7 and DNRF sets are also noteworthy. The average journal

citation score (MNJS) confirms that average publication behaviour is directed towards journals with the highest impact in their respective fields; largest among them is the "multidisciplinary sciences". The volume of the FP7 set is larger than FP6, but at the same time also considerably lower compared to the benchmarks. Note that approximately 11 per cent of the FP7-linked publications are also linked to either a DFF grant or a CoE funded by the DNRF.

As already documented, around 70 per cent of publications in the FP6 and FP7 sets are a result of international collaboration. In table 6.5 we compare the degree of internationalisation between the FP6 and FP7 publication sets and the benchmark units.

We also outline the performance for the internationally co-authored articles in these sets. The FP6 set has a markedly higher share of internationally co-authored articles, and the DNRF set has the second highest share, albeit more than nine percentage points less than the FP6 set. Interestingly, even though the DFF and DNRF sets have considerably lower shares of articles with international collaboration, their impact levels for this group of articles are markedly higher than the FP6 set. On the other hand, the FP7 set has a slightly lower proportion of internationally co-authored articles compared to the FP6 set, but still a larger proportion compared to the benchmark units; yet the impact for this set is remarkable.

TABLE 6.5
COMPARISON OF PERFORMANCE OF INTERNATIONAL CO-AUTHORED ARTICLES BETWEEN THE FP6 AND FP7 PUBLICATION SETS AND THE TWO FUNDING BENCHMARK UNITS (DNRF AND DFF)

	(2005-2011)			(2007-2011)		
	FP6	**DFF**	**DNRF**	**FP7**	**DFF**	**DNRF**
Share of international collaboration	70.9 %	56.5 %	61.4 %	67.7 %	56.5 %	63.2 %
Average article citation score (MNCS)	1.98	2.07	2.05	2.32	2.08	2.07
Share of highly-cited publications (PPtop10 per cent)	21.0 %	20.9 %	24.2 %	23.8 %	20.9 %	24.5 %
Average journal citation score (MNJS)	1.49	1.62	1.69	1.67	1.63	1.69
Average article citation score - fractional ($MNCS_{frac}$)	1.71	1.88	1.92	2.01	1.89	1.93
Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)	18.7 %	19.5 %	22.5 %	21.9 %	19.5 %	22.8 %

In order to explore the relationship between citation impact and the degree of internationalisation further, we examined this in relation to the different funding sets in a number of models controlling for well-known factors influencing citation impact (details on model specification and results can be found in the technical report). Predictably, the regressions generally showed that the expected impact for the FP sets is higher than or comparable to the benchmarks, but when we control for international collaboration the expected impact between the FP sets and the benchmark units diminishes. There are, however, differences between FP6 and FP7. The expected citation impact for the FP6 set after controlling for international collaboration is lower than the DNRF set and equal to the DFF set. However, after controlling for international collaboration, and thus the citation benefits this may give, the expected citation impact for the FP7 set is still higher than the two benchmark sets. Consequently, international collaboration with its derived impact effects seems to a large extent to statistically explain the performance level of the FP6 set compared to

the benchmarks, although this is not the only factor that may explain the outstanding performance levels for the FP7 set.

The FP7 set includes ERC and Marie Curie grants. These grants are different from the more strategic or topic-specific FP7 thematic areas (see next section). Together, the publications linked to ERC or Marie Curie grants constitute 27 per cent of all FP7-linked publications, and 33 per cent of the restricted FP7 set used for the benchmark analyses. Table 6.6 shows what happens to the impact scores when we remove these grants from the restricted FP7 set.

TABLE 6.6
CONSEQUENCES OF REMOVING ERC AND MARIE CURIE GRANTS FROM THE RESTRICTED FP7 SET OF PUBLICATIONS USED FOR THE BENCHMARK ANALYSES (2007 - 2011)

	FP7	FP7 without ERC & Marie Curie	DFF	DNRF
Share of international collaboration	67.7 %	68.0 %	56.5 %	63.2 %
Average article citation score (MNCS)	2.11	1.91	1.82	1.89
Share of highly-cited publications (PPtop10 per cent)	23.0 %	21.1 %	19.3 %	22.2 %
Average journal citation score (MNJS)	1.57	1.49	1.5	1.58
Average article citation score - fractional ($MNCS_{frac}$)	1.81	1.61	1.63	1.72
Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)	21.7 %	19.7 %	18.0 %	19.9 %

It is clear that the degree of internationalisation is not affected, but both full and fractional count average article citation score and the share of highly-cited publications scores drop markedly, and so does the average journal citation score. The latter suggests that the publication profile for these specific grants is perhaps the most important factor influencing citation impact on the aggregate level of publication sets in journals with very high international visibility.

Depending on whether we focus on indicators based on full or fractional counts, the performance level for the remaining FP7 publications is on a level with the DNRF with full counts for the average article citation score, but slightly below in the share of highly-cited publications. With fractional counts the average article citation score is considerably below the DNRF level but similar to DFF. Here it is noticeable that the more robust indicator for the proportion of highly-cited articles (Pptop10 per centfrac) suggests that the drop is most marked in the average-based indicators (average article citation score), as they are less robust in relation to the influence of outliers on indicator values. Consequently, the average-based indicators in the FP7 set are more "vulnerable", because the subset of ERC and Marie Curie-linked publications include some very highly-cited outliers. Note that there is no overrepresentation of ERC or Marie Curie-linked publications that also have links to either the DFF or DNRF sets. For ERC there is a 9 per cent overlap with DFF and 11 per cent with DNRF; for Marie Curie, there is again a 9 per cent overlap with DFF but only 8 per cent with DNRF.

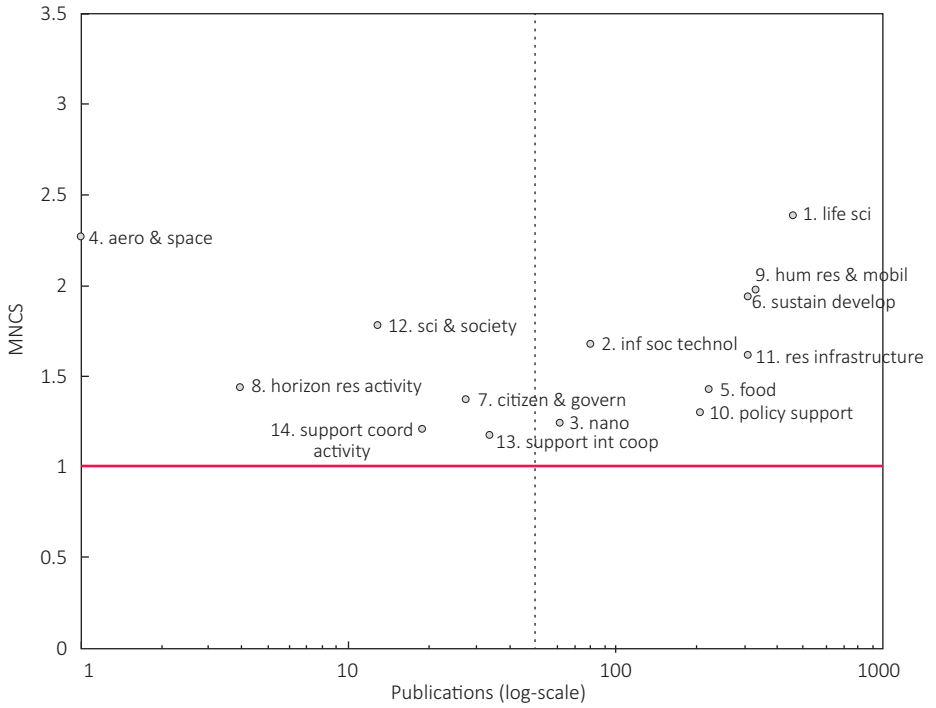
A further regression seems to confirm this general finding: that ERC and Marie Curie-linked publications to a large extent can explain the remaining gap between FP7 and the DNRF when we control for international collaboration. However, for full counts, the expected marginal impact is still slightly higher for the FP7 set, even after controlling for ERC and Marie Curie grants. In other words, even after con-

trolling for international collaboration and specific funding schemes, the FP7 set still performs on a level with the DNRF set.

6.2.3. Bibliometric analysis of publication sets linked to programme themes under FP6 and FP7 programmes

As a final performance analysis we disaggregate the FP6 and FP7 publication sets to the level of thematic areas. Below in figures 6.1 and 6.2 we present the results for full count average article citation score scores plotted as a function of output for the individual thematic areas.

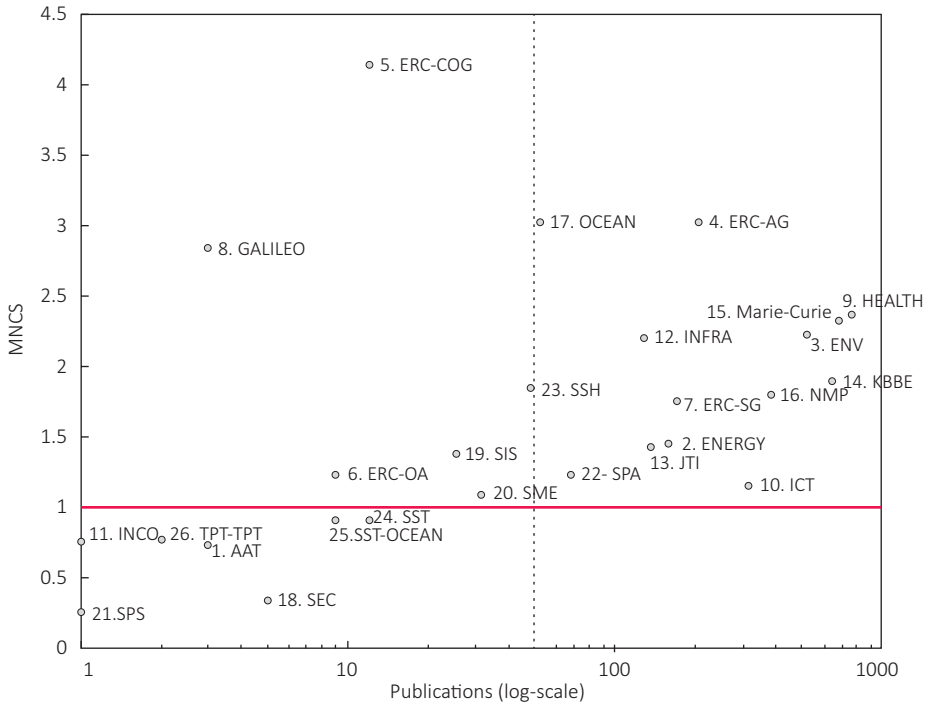
FIGURE 6.1
AVERAGE ARTICLE CITATION SCORES (MNCS) AS A FUNCTION OF PUBLICATION OUTPUT (FULL COUNTS) FOR FP6 THEMATIC AREAS



FP6 thematic areas: 1. Life sciences, genomics and biotechnology for health; 2. Information society technologies; 3. Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices; 4. Aeronautics and space; 5. Food quality and safety; 6. Sustainable development, global change and ecosystems; 7. Citizens and governance in a knowledge-based society; 8. Horizontal research activities involving SMEs; 9. Human resources and mobility; 10. Policy support and anticipating scientific and technological needs; 11. Research infrastructures; 12. Science and society; 13. Specific measures in support of international cooperation; 14. Support for the coordination of activities.

By plotting impact to output it becomes easier to interpret the importance and robustness of the individual indicators. We have plotted a grid line corresponding to 50 full count publications on a log-scaled x-axis (output); this rather arbitrary threshold can be used as a guideline when interpreting the results. Results on or just below the threshold should be treated carefully and results far below should be discarded.

FIGURE 6.2
AVERAGE ARTICLE CITATION SCORES (MNCS) AS A FUNCTION OF PUBLICATION OUTPUT FOR FP7 THEMATIC AREAS



FP7 thematic areas: 1. Aeronautics and air transport; 2. Energy; 3. Environment (including Climate Change); 4. ERC-Advanced Grants; 5. ERC-Consolidated grants; 6. ERC-Other activities; 7. ERC-Starting Grants; 8. ERC-Support to the European global satellite navigation system (Galileo) and EGNOS; 9. Health; 10. Information and Communication Technologies; 11. Activities of International Cooperation; 12. Research Infrastructures; 13. Joint Technology Initiative; 14. Food, Agriculture and Fisheries, and Biotechnology; 15. Marie-Curie Actions; 16. Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP; 17. OCEAN.2010/2011; 18. Security; 19. Science in Society; 20. Research for the benefit of SMEs; 21. EURATOM; 22. Space; 23. Socio-economic sciences and Humanities; 24. Sustainable surface transport (including the 'European Green Cars Initiative'); 25. The Ocean of Tomorrow (OCEAN) 2010/2011; 26. Horizontal activities for implementation of the transport programme.

From figure 6.1 (FP6) we can see that eight thematic areas have publication outputs above 50, and all eight also have impact scores on or above 1.20. One theme, "Life sciences, genomics and biotechnology for health (1.)", has an impressive impact score of 2.30 and at the same time this thematic area is the largest among the 14 examined in this analysis when it comes to publication output.

In figure 6.2 (FP7), 14 thematic areas have outputs from approximately 50 up to 760 full count publications. Thirteen of these areas have indicator values of above 1.20 and 6 with average article citation scores of above 2. The two highest performing themes among those with robust publication outputs are The Ocean of Tomorrow (17.) and ERC-Advanced Grants (4.) with impressive average article citation score scores of 3.02. It is noticeable that there seemingly is a broad variation among the 14 thematic areas, when it comes to project types among the 14 most robust thematic areas. There is a mixture of ERC grants, Marie Curie grants, infrastructure and thematic areas, all with high performance - no single type seemingly stands out. This supports the previous findings, where we removed ERC and Marie Curie grants – the overall performance of the FP7 set is robust and varied among the different thematic areas.

In the technical report supplementary figures are presented for the share of highly-cited publications indicator as a function of output. Two overall tables present the main performance statistics for the FP6 and FP7 thematic areas, as well as demonstrations of the validity when it comes to coverage and publication volume using this disaggregate unit of analysis compared to usage of individual projects.

6.3. Methods

The bibliographic data used in the analyses are validated journal articles (research articles and review articles) indexed in the international citation database Web of Science (WoS). We use the in-house value-added version of WoS at CWTS, Leiden University, Netherlands. A thorough validation process has been set up and managed by the Danish Agency for Science, Technology and Innovation (DASTI) at the Ministry of Higher Education and Science, where individual scholars at Danish research institutions with funded projects under the FP6 or FP7 programmes were contacted and asked to validate pre-selected publication lists, as to whether the specific articles could be linked to the EU funding grant. Since mid-2008 potential funding acknowledgements mentioned in journal articles have been made available for analyses in the WoS. In order to try to enlarge the validated data set of publications, we utilized the WoS funding acknowledgement data and manually analysed the pre-selected publication lists for all non-validated projects, in order to check whether potential FP6 and FP7 grants were acknowledged. If so, these publications and projects were also included in the analyses, thereby extending the data set. Eventually 175 FP6 and 503 FP7 projects and their linked publications were included in the analyses; we refer to the technical report for more details on inclusion and exclusion of projects and publications.

The analyses are based on several different units of analysis. Bibliometric data are characterised by skewed distributions, and robust statistics require considerable sample sizes. A common, although arbitrary, threshold is often a minimum of 50 full count publications, but larger samples are preferable. A further consideration with bibliometric data, especially from citation databases, is the well-known coverage problems. The enhanced citation database we use in the analysis only indexes journal articles, and mainly English language journals. Hence, research areas where international journals are not the primary medium for reporting research results will have lower coverage in the database, and citation analyses in such areas become problematic.

To obtain a proxy for coverage we have examined the reference behaviour in the aggregate units of analysis, in the sense that we calculate the proportion of references given to other journal articles indexed in WoS. This number indicates to what extent the unit is dependent on international journals in the scientific communication process, and eventually the validity of doing citation analysis on such a set of articles. In the technical report we analyse the coverage for the aggregate and disaggregate units of analysis and find that coverage is satisfactory for the aggregate FP6 and FP7 publication sets and the disaggregate sets of thematic areas.

In scientometric analyses it is desirable to compare like with like, such as a research institution with other research institutions, or countries with countries. It is also preferable to compare units of roughly similar size, as it is generally so that with larger units indicator values will tend to move closer towards the reference value as mentioned in the introduction. The units of analysis in this report are Eu-

ropean funding programmes, and we credit publications which are supposedly the direct or indirect result of a project funded by one of these programmes. Obviously, publications as discrete units primarily "belong" to authors and institutions, where funders, and there are often several of them, are given an acknowledgement, but otherwise not credited. Nevertheless, we use the funding institution as the unit of analysis and link publications to it. An ideal benchmark unit would obviously be a very similar funding institution. From previous bibliometric analyses of two main Danish funding institutions, Centres of Excellence (CoE) funded by the Danish National Research Foundation (DNRF), and various smaller grant types (compared to DNRF) funded by the Danish Council for Independent Research (DFF), we have validated publication sets linked to these instruments for roughly the same period as the present analysis of FP6 and FP7. We utilize these publication sets as benchmarks in this analysis because they to some extent can be considered "similar" units of analysis (i.e. publications linked to funding programmes). Such a comparison is however not without problems. The different funding units clearly have different aims and purposes, and are different when it comes to the size of grants. Further, publications may well be linked to several funding institutions and grants, making it very difficult to claim any direct link between funding and performance.

The FP6 programme ran from 2002 to 2006, and the FP7 programme from 2007 to 2013. We have chosen the following time period for the two programmes: FP6, all validated articles published from 2002 to 2013, and FP7, all validated articles published from 2007 to 2013. We use a citation window of three years including the publication year. This means that articles published after 2011 have shorter windows. In the technical report we analyse the robustness of the overall results when removing publications with shorter citation windows, and the findings are generally robust (e.g., excluding the 2013 publications does not change the overall results). Note that the same citation windows are applied to the different benchmark units, yet as the DNRF and DFF sets of publications only have a common coverage between 2005 and 2011, the benchmark analyses are carried out with the following time period: FP6 from 2005 to 2011, and FP7 from 2007 to 2011.

Table 6.7 below presents the standard indicators we use in the analyses. The indicators are defined and constructed by CWTS and tailored to their in-house version of the WoS database. These are the same indicators used in their Leiden Ranking.

TABLE 6.7
OVERVIEW OF STANDARD CWTS BIBLIOMETRIC INDICATORS USED IN THE PRESENT ANALYSES

	Dimension	Definition
No. of publications	Output (participation)	Total number of publications of a unit.
No. of fractional publications	Output (contribution)	Fractionalised publications of a unit; in the present analysis we fractionalise according to country
Coverage	Validity	Internal coverage. Proxy of oeuvre being covered by WoS. Measured by the proportion of cited references in the oeuvre linking to other WoS publications.
Average article citation score (MNCS)	Impact	Mean normalised number of citations of the publications of a unit (self-citations not included).
Average article citation score - fractional ($MNCS_{frac}$)	Impact	Mean normalised number of citations of the publications of a unit (self-citations not included) based on fractional publication counting at the country level.
Average journal citation score (MNJS)	Journal impact	Mean normalized citation score of the set of journals in which a unit has published.
Share of highly-cited publications (PPtop10 per cent)	Impact	Proportion of articles that belong to the top 10 per cent highest-cited publications in the database.
Share of highly-cited publications - fractional ($PPtop10\ per\ cent_{frac}$)	Impact	Proportion of articles that belong to the top 10 per cent highest-cited publications in the database based on fractional publication counting on the country level.

There is an ongoing debate in the scientometric research community of whether to use full counting or fractional counting, or both counting methods. There are valid arguments for both positions. The fractional counting method is usually promoted because it has good mathematical properties. Field-normalized comparisons across units sum up to unity in the database and provide an interpretable scale where 1 corresponds to the average citation impact in the database. Full counting may "favour" minor units with more international publication activity. Due to multiple counts, full counting does not have the same mathematical property as fractional counting, and consequently not quite the same interpretability in relation to a common reference value in the database. Such a rate is higher, and indicator values in general are also higher with full counting (i.e., the "database average" is somewhat higher than 1, probably 0.2-0.3 points). Despite violating mathematical properties, full counting can certainly be relevant for specific analyses. Indeed, full and fractional counts can be seen as measuring different constructs, i.e. participation (full) and contribution (fractional). We provide results using both counting methods because we see these indicators as complementary rather than competing.

It is also important to emphasize that the meaning of an indicator's numerical value is strongly related to the aggregation level of the unit under study. At higher aggregation levels, where publication volumes are generally larger, it becomes more difficult to have relative impact scores substantially above the database average or the expected proportion of articles among the 10 per cent most cited in the database. This "regression-towards-the-mean[32]" phenomenon is mainly an effect of the underlying skewed citation distributions. At the meso-level (e.g., units with 500-1000 full count publications per year), an average article citation score value of between 0.8 and 1.2 is generally interpreted as a performance level comparable to the average in the database (i.e., "world average" citation score), whereas values above

32 Regression-towards-the-mean: A statistical phenomenon. If a variable is extreme on its first measurement, it will tend to be closer to the average on its second measurement.

1.2 mean that the unit's impact as a whole is above the international level, and values of 2 and more are far above the international level of the fields where a unit has published in the examined period. The same yardstick can be roughly used for share of highly-cited publications (full counts), where values above 12 per cent would be considered above the expected, and values above 20 per cent far above the expected for full counts.

7. The individuals participating in FP6 and FP7

This chapter presents the characteristics of individuals from Danish institutions and companies participating in projects funded by FP6 or FP7. The purpose of the chapter is to provide a more detailed insight into who the individuals are, compared to the general research community.

Detailed employer-employee-linked data spanning from 2000 to 2012 are used to describe individuals participating in FP6 and FP7. The participants are compared with the general level of individuals working with research and development (R&D) in 2012. Comparable individuals are selected from the public registers after the same criteria as the participants, such as education and occupation. Participants are categorised as researchers, PhD students or masters.

7.1. Main findings

Participation in FP6 or FP7 has given Danish institutions the possibility of employing part of the pool of international talent. A larger share of the individuals participating in FP6 or FP7 at Danish institutions and companies are foreigners, compared to the general level. The PhD students are the participant group with the largest share of foreigners, also compared to PhD students in general. 11 and 42 per cent respectively of the participating researchers and PhD students in highly-skilled positions are foreigners.

Individuals participating in FP6 or FP7 are most often men. Participating researchers, masters and PhD students all have a higher proportion of men than in general. For example, 62 per cent of the participating PhD students are men, compared to 50 per cent of PhD students in general. The higher proportion of male participation in FP6 and FP7 is probably related to the fact that natural science and technical science are overrepresented in FP6 and FP7.

The chapter proceeds as follows: section 7.2 presents the characteristics of the participating researchers, masters and PhD students in FP6 and FP7. Section 7.3 describes the method. Annex 2 describes the participants not categorised as researchers, masters and PhD students.

7.2. Characteristics of the individuals participating in FP6 and FP7

This section describes the characteristics of the individuals participating in FP6 and FP7 (called participants in the following text) in the year of project start in the period 2003 to 2012.[33] The participants are divided into four groups:

- Researchers: Participants with a PhD degree at the beginning of the project
- PhD students: Participants that are PhD students at the beginning or during the project
- Masters*:* Participants that have a master's degree but are not PhD students
- Others: Participants without a master's or a PhD degree

There are approximately 2,000 participants for whom relevant data is available in the selected registers (see table 7.1). One fifth of the participants are PhD students during the project. The biggest group of participants are researchers, corresponding to 29 per cent, while 26 per cent of the participants are defined as masters and others.

TABLE 7.1
PARTICPATING INDIVIDUALS COVERED BY THIS ANALYSIS, 2003-2012

	Number	Share
Researchers	575	29 %
Masters	525	26 %
Others	520	26 %
PhD students	389	19 %
Total	**2,009**	**100 %**

Note: FP6 covers the period 2002-2006 and FP7 covers the period 2007-2014.
Source: DASTI's own calculation.

The participating researchers, PhD students and masters are each compared with the general level for comparable individuals working with R&D in 2012. Comparable individuals are aggregated into three groups: 1) Researchers, 2) Masters and 3) PhD students – using the same criteria as the participants, such as education and occupation (see section 7.3 for further information). The participant group "others" is described separately in Annex 2.

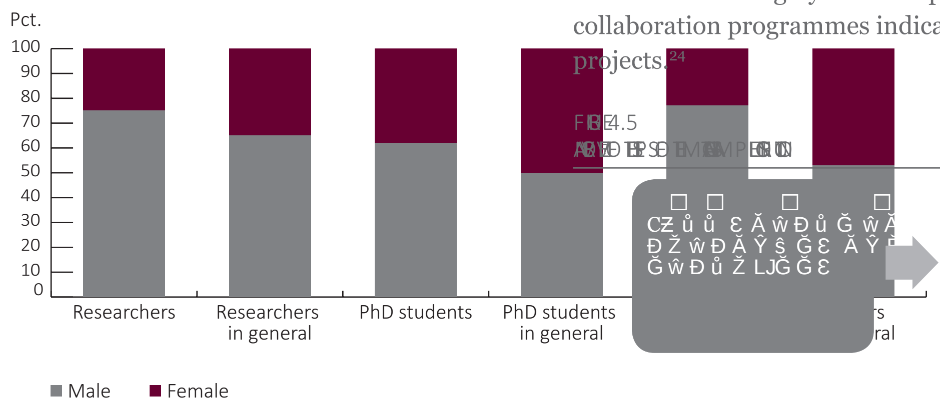
7.2.1. Gender balance

Participating researchers, masters and PhD students all have a higher proportion of men than the general population working with R&D (see figure 7.1). The difference is most striking between masters and masters in general. Approximately 77 per cent of the participating masters are men, compared to 53 per cent for masters in general. The participating PhD students have the most equal gender distribution, where 62 per cent of participating PhD students are men compared to 50 per cent for PhD

33 Year 2012 is the last year for which all relevant public register data are available, meaning that there is no information on participants with project start in 2013 and 2014.

students in general.[34] The higher proportion of men in FP6 and FP7 is related to the fact that natural science and technical science are overrepresented in FP6 and FP7 (see section 7.2.3).

FIGURE 7.1
GENDER DISTRIBUTION COMPARED TO THE GENERAL POPULATION OF INDIVIDUALS WORKING WITH R&D



Source: DASTI's own calculation using registry data from Statistics [illegible]

7.2.2. Age

The age distribution for the participating researchers and [illegible] al is almost identical, whereas the participating masters tend [illegible] mas-ters in general, since 40 per cent of the participating masters are more than 50 years old, while this is the case for 27 per cent of the participating maste[illegible] in general.

The participating masters differ from participating researchers in their age distribution, as only 22 per cent of participating researche[illegible] (see table 7.2).

The PhD students participating in FP6 and FP7 are [illegible] dents in general when starting their PhD. 64 per cent [illegible] dents are under 30 years old when starting their PhD [illegible] per cent for PhD students in general. This is most likely due to a higher proportion of foreign PhD students in FP6 and FP7 projects (see section 7.2.4) than for the PhD students in general. Danish students are generally older than foreign students.

34 In the European Commission's FP6 gender equality report similar results were reached: "The percentage of female coordinators in FP projects (16 – 17 per cent) is distinctly lower than the overall percentage of female researchers recorded in Europe in 2003 (29 per cent). http://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/evaluation_studies_and_reports/evaluation_studies_and_reports_2008/fp6_gender_equality_report.pdf#view=fit&pagemode=none (p. 15) Similarly for FP7: http://ec.europa.eu/research/evaluations/pdf/archive/fp7_monitoring_reports/7th_fp7_monitoring_report.pdf

TABLE 7.2
THE PARTICIPANTS' AGE COMPARED TO THE GENERAL POPULATION OF INDIVIDUALS WORKING WITH R&D

	Researchers	Researchers in general	PhD students	PhD students in general	Masters	Masters in general
Under 25 years	0 %	0 %	4 %	4 %	0 %	1 %
25-29 years	2 %	2 %	60 %	50 %	10 %	19 %
30-34 years	15 %	14 %	26 %	29 %	14 %	20 %
35-39 years	23 %	23 %	6 %	11 %	13 %	14 %
40-44 years	21 %	19 %	2 %	3 %	11 %	10 %
45-49 years	17 %	17 %	2 %	1 %	12 %	9 %
Over 50 years	22 %	26 %	1 %	2 %	40 %	27 %

Source: DASTI's own calculation using registry data from Statistics Denmark.

7.2.3. Field of science

Participants are more likely to be educated within either natural science or technical science compared to the general level. Furthermore, participants are less likely to be educated within either humanities or social science compared to the general level. The share of participating PhD students within health science is substantially lower than for the PhD students in general. For the PhD students participating in a FP6 or FP7 project, only 11 per cent have health as a field of science, while this is the fact for 20 per cent for PhD students in general (see table 7.3).

TABLE 7.3
THE PARTICIPANTS' FIELD OF SCIENCE COMPARED TO THE GENERAL POPULATION OF INDIVIDUALS WORKING WITH R&D

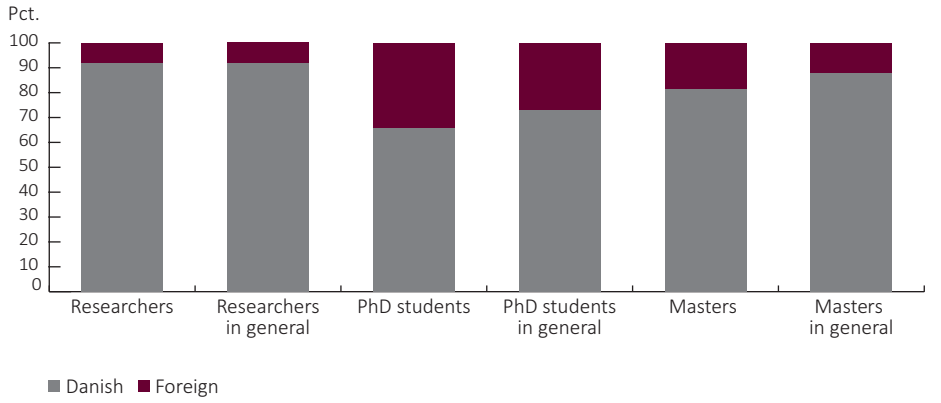
	Humanities	Agricultural science	Natural science	Social science	Health science	Technical science	Unspecified
Researchers	4 %	13 %	34 %	6 %	12 %	31 %	0 %
Researchers in general	19 %	8 %	23 %	16 %	13 %	21 %	0 %
PhD students	6 %	5 %	39 %	6 %	11 %	26 %	7 %
PhD students in general	9 %	4 %	24 %	10 %	20 %	15 %	18 %
Masters	10 %	5 %	34 %	14 %	13 %	22 %	1 %
Masters in general	26 %	4 %	20 %	20 %	10 %	15 %	5 %

Source: DASTI's own calculation using registry data from Statistics Denmark.

7.2.4. Citizenship

Figure 7.2 shows that a larger share of the participants in FP6 or FP7 are foreigners compared to the general level. The participating PhD students have the largest share of foreigners. 34 per cent of the participating PhD students are foreigners compared to 27 per cent for PhD students in general.

FIGURE 7.2
THE PARTICIPANTS' CITIZENSHIP COMPARED WITH THE GENERAL LEVEL



Note: Participants are defined as foreigners if they do not have Danish citizenship and Denmark as country of origin.
Source: DASTI's own calculation using registry data from Statistics Denmark.

7.2.5. Career

Table 7.4 compares the participants' career. The participants' career is described using the International Standard Classification of Occupations (ISCO) (see box 7.1 for further information).

The PhD students participating in FP6 or FP7 are underrepresented in highly-skilled specialist positions compared to PhD students in general. A little more than half of them are highly-skilled specialists, where this is the case for approximately three quarters of PhD students in general. On the other hand, 12 per cent of the participating PhD students have an unknown classification of occupations, compared to only 2 per cent of the PhD students in general. This is due to a higher proportion of foreigners among the participating PhD students, since the registers are not as complete for foreigners as for Danes.

Over 50 per cent of the participating researchers are employed in highly-skilled specialist positions, while over 50 per cent of the participating masters are employed as specialists in general positions. Very few of the participants are working as leaders, equal to 3 and 4 per cent for researchers and masters respectively.

TABLE 7.4
THE PARTICIPANTS' CAREER POSITION COMPARED TO THE GENERAL POPULATION OF INDIVIDUALS WORKING WITH R&D

	Leaders	Specialists in general	Highly-skilled specialists	Others	Unspecified
Researchers	3 %	40 %	54 %	2 %	1 %
Researchers in general	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]
PhD students	0 %	35 %	52 %	1 %	12 %
PhD students in general	0 %	23 %	73 %	2 %	2 %
Masters	4 %	54 %	33 %	5 %	3 %
Masters in general	-[1)]	-[1)]	-[1)]	-[1)]	-[1)]

Note: Leaders are DISCO code 1000-1999, Specialists in general are DISCO code 2000-2999 except 2310, Highly-skilled specialists are DISCO code 2310 and Others are 3000 – 9998.
1) Researchers and masters in general are selected so that individuals with a master's degree and PhD degree are only selected if employed in DISCO 2310 (research at universities) or in NACE codes 72.11.00, 72.19.00 and 72.20.00 (public or private R&D companies). Comparison between participating researchers and masters and their general level is not possible because the selection method for the comparable individuals causes bias.
Source: DASTI's own calculation using registry data from Statistics Denmark.

11 and 42 per cent respectively of the participating researchers and PhD students in highly-skilled positions are foreigners (see table 7.5).

Participation in FP6 or FP7 therefore gives Denmark the possibility of benefitting from the pool of international talent. This hopefully creates a knowledge spill-over to the Danish research teams.

TABLE 7.5
PARTICIPATING HIGHLY-SKILLED SPECIALISTS EMPLOYED AT A UNIVERSITY DIVIDED ON CITIZENSHIP AND COUNTRY OF ORIGIN

		Highly-skilled specialists
Researchers	Danish	89 %
	Foreign	11 %
PhD students	Danish	58 %
	Foreign	42 %
Masters	Danish	70 %
	Foreign	30 %

Note: Participants are defined as foreigners if they do not have Danish citizenship and Denmark as country of origin.
Source: DASTI's own calculation using registry data from Statistics Denmark.

BOX 7.1 THE INTERNATIONAL STANDARD CLASSIFICATION OF OCCUPATIONS (ISCO)

DISCO is the official Danish version of the International Standard Classification of Occupations. DISCO is a six-digit classification with a hierarchical structure with five levels. DISCO divides the Danish labour market into 563 occupational groups, each containing a number of closely-related occupations.

The analysis divides the DISCO codes into five groups:

Leaders: Leadership in a private or public company [1000-1999]

Highly-skilled specialists: Research at universities [2310]

Specialists in general: Work that requires high-level knowledge [2000-2999], excluding Highly-skilled specialists

Others: Work that requires medium-level knowledge or lower [3000-9998]

Unknown: Unknown DISCO [0 and 9999]

7.2.6. Sector

Table 7.6 compares the participants' employment in sectors using the European Industry Standard Classification System (NACE) (see box 7.2 for further information). The participating PhD students are overrepresented in the university sector and in public and private R&D companies, compared to PhD students in general. 82 per cent of the participating PhD students are employed at a university, compared to 75 per cent for PhD students in general.

Comparing the three participant groups shows that masters are more often employed in the private sector compared to researchers and PhD students.

TABLE 7.6
THE PARTICIPANTS' CAREER IN SECTOR COMPARED TO THE GENERAL POPULATION OF INDIVIDUALS WORKING WITH R&D

	Public or private R&D company	Public sector	Private sector	Universities
Researchers	12 %	8 %	14 %	66 %
Researchers in general	-[1)]	-[1)]	-[1)]	-[1)]
PhD students	6 %	9 %	4 %	82 %
PhD students in general	2 %	16 %	7 %	75 %
Masters	11 %	20 %	29 %	41 %
Masters in general	-[1)]	-[1)]	-[1)]	-[1)]

Note: Public or private R&D departments are NACE codes 72.11.00, 72.19.00 and 72.20.00.
1)The masters and researchers in general are selected so that individuals with a master's degree and PhD degree are only selected if employed in DISCO 231000 (research at universities) or in NACE codes 72.11.00, 72.19.00 and 72.20.00 (public or private R&D companies). Comparison between participating researchers and masters and their general level is not possible because the selection method for the comparable individuals causes bias.
Source: DASTI's own calculation using registry data from Statistics Denmark.

BOX 7.2 THE EUROPEAN INDUSTRY STANDARD CLASSIFICATION SYSTEM (NACE)

The NACE (European Industry Standard Classification System) code represents the sector of a company's main activity.

NACE is a six-digit classification where the first four digits correspond to the European classification and the last two are a Danish classification. NACE divides the Danish companies into 730 groups according to their main activities, each containing a number of closely-related activities.

The analysis divides the NACE codes into four sectors:

Universities: 85.42.00

Public sector: [84.10.00 – 89.00.00] excluding Universities but including public administration, hospitals and other health sector

Public or private R&D companies: 72.11.00, 72.19.00 and 72.20.00

Private sector: All the other NACE codes

7.3. Methods

The data for the analysis are from three sources:

- The European Commission's eCORDA database. The information includes the names of the coordinators from the participating Danish institutions and companies.
- Names of the other participants in the projects (i.e. non-coordinators). These data were gathered by contacting the coordinators listed in the eCORDA database.
- Public register data[35] from Statistics Denmark. These are employer-employee-linked data including information on individuals (demographic information, information on education and occupation).

7.3.1. Collection of data on individual level

DASTI has collected data on all individuals that have participated in a FP6 or FP7 project through a Danish research institution or company. These data were gathered by contacting the coordinators from the different participating Danish institutions and companies. DASTI has collected data such as full name, gender of the participants and place of employment at the time of the project. The criteria for participation include also:

- Participants from private companies and not only research and educational institutions
- Foreigners and Danes who are employed by a Danish institution or company.
- Participants who are not paid directly with funds from the project but who have contributed significant academic and professional knowledge.

DASTI has had a response from 40 per cent of the projects. The response rate is higher for FP7 than FP6. Data on 5,324 participants were collected, which is equal to 4,506 unique individuals.

35 Integrated Database of Labour Market Research (IDA), Education, Population and Wage Statistics Database

TABLE 7.7
COLLECTION OF DATA ON INDIVIDUAL LEVEL

	FP6	FP7	Total
Number of projects	302	945	1,247
Response rate	26.8 %	47.9 %	40.2 %
Number of individuals	1,291	4,033	5,324

The collected data on the participants were merged with data from the European Commission's eCORDA database and with public register data from Statistics Denmark. Some participants have quite common names, meaning that the public register data contained several possible personal identification numbers per participant. The right participant out of several possible participants was found by using the person's highest completed education, current education and employment (The International Standard Classification of Occupations) as delimitation. Through the use of public register data it has been possible to identify 2,429 individuals that have participated in a FP6 or FP7 project. Some of these participants have been removed from the analysis due to lack of public register data on the participant in the year of project start, or one to two years after, or due to project start after 2012. Thus, the final group of participants consists of 2,000 individuals for the period 2003-2012.

7.3.2. Method for comparison – selection of comparable individuals

For the comparison the participants are aggregated into three groups:

- Researchers*:* The participants that have a PhD degree at the start of the project
- PhD students*:* The participants that are PhD students during the project
- Masters*:* The participants that have a master's degree but are not PhD students

The participants from the three groups are measured in the year of the project start. If there is no data for the participant in the year of project start, one year or two years after project start is used.

To get an impression of the general level of individuals working with R&D in Denmark, the participants are compared to the general level of the research staff in 2012. 2012 is the last year for which public register data is available for this analysis.

Researchers in general*:* The participating researchers are compared to researchers in general consisting of all individuals with a PhD degree in 2012. To ensure that the participating researchers are compared with researchers still doing research, only individuals with a PhD degree employed in the International Standard Classification of Occupations group "Teaching at universities with research obligation" or in The European Industry Standard Classification Systems group "R&D in a public or private company" are used.

Masters in general: Participating masters are compared to masters in general, consisting of all individuals with a master's degree in 2012 and working within research. Thus, masters in general only contain those who are employed in the International Standard Classification of Occupations group "Teaching at universities with research obligation" or in The European Industry Standard Classification Systems group "R&D in a public or private company".

PhD students in general*:* The participating PhD students are compared to PhD students in general, consisting of all PhD students starting in 2012.

Collecting data on all the participants ex post has been a challenge.

Some of the challenges have been

- to get a satisfying response rate. A low response rate challenges the quality of an evaluation.
- for the coordinators to remember who participated in which projects several years back in time.
- that some participants have such common names that the public register data contained several possible personal identification numbers per participant. It can therefore be difficult to find the right participant.

For the evaluation of Horizon 2020 it could be interesting to do an impact assessment using the propensity score matching method. Then participants would be matched with statistically identical individuals, and a difference-in-differences method would estimate the differences in the development for the participants and the statistically identical individuals. This is difficult to do when we do not know all of the participating individuals.

8. Annexes

8.1. Annex 1 – Participation of Denmark and private companies in FP6 and FP7

Tables 8.1 and 8.2 present a detailed view of the participation of Denmark in FP6 and FP7.

TABLE 8.1
THE PARTICIPATION OF DENMARK IN FP6 (2003-2006) – DETAILED VERSION

		ALL COUNTRIES			DENMARK				
Specific Programme	**Priority Area**	**Projects**	**Participants (incl. Coordinators)**	**EC Contribution (EUR m)**	**Projects**	**Participants (incl. Coordinators)**	**Coordinators**	**EC Contribution (EUR m)**	**Share of EC Contribution**
INTEGRATING AND STRENGTHENING THE ERA	Life sciences, genomics and biotechnology for health	600	6,828	2,339.6	150	203	22	80.3	3.43 %
	Information society technologies	1,093	14,340	3,799.5	134	199	10	48.6	1.28 %
	Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	446	5,883	1,539.0	76	107	7	25.7	1.67 %
	Aeronautics and space	241	3,496	1,068.6	21	23	2	4.4	0.42 %
	Food quality and safety	185	3,209	751.6	60	138	10	52.9	7.04 %
	Sustainable development, global change and ecosystems	671	10,560	2,306.5	177	317	25	83.7	3.63 %
	Citizens and governance in a knowledge-based society	146	1,949	244.2	35	44	1	4.9	2.01 %
	Policy support and anticipating scientific and technological needs	522	4,606	601.7	115	157	12	20.2	3.35 %
	Horizontal research activities involving SMEs	492	5,458	485.2	74	123	13	10.9	2.24 %
	Specific measures in support of international cooperation	343	2,514	351.6	25	29	10	5.3	1.50 %
	Support for the coherent development of research & innovation policies	19	169	13.8	1	2	0	0.1	0.51 %
	Support for the coordination of activities	102	1,204	288.0	32	38	3	5,0	1,74 %
	Integrating and strenghtening the ERA total	**4,860**	**60,216**	**13,789.4**	**900**	**1,380**	**115**	**342.0**	**2.48 %**
STRUCTURING THE ERA	Research and innovation	237	1,841	225.4	21	33	4	5.3	2.33 %
	Human resources and mobility	4,617	8,475	1,693.2	158	172	85	40.3	2.38 %
	Research infrastructures	154	1,841	725.2	19	22	0	4.9	0.67 %
	Science and society	161	1,025	77.8	21	30	6	2.5	3.25 %
	Structuring the ERA total	**5,169**	**13,182**	**2,721.6**	**219**	**257**	**95**	**53.0**	**1.95 %**
EURATOM	Euratom	78	1,185	185.7	6	9	0	1.1	0.59 %
Total		**10,107**	**74,583**	**16,696.6**	**1,125**	**1,646**	**210**	**396.1**	**2.37 %**

TABLE 8.2
THE PARTICIPATION OF DENMARK IN FP7 (2007-2013) – DETAILED VERSION

Priority Area		ALL COUNTRIES			DENMARK				
		Projects	Participants (incl. coordinators)	EU Contribution (EUR m)	Projects	Participants (incl. coordinators)	Coordinators	EU Contribution (EUR m)	Share of EU Contribution
COOPERATION	Health	1,008	11,297	4,791.7	202	265	22	136.6	2.85 %
	Food, Agriculture and Fisheries, and Biotechnology	516	7,903	1,850.7	176	285	26	84.4	4.56 %
	Information and Communication Technologies	2,328	22,502	7,877.0	218	297	24	105.7	1.34 %
	Nanosciences, Nanotechnologies, Materials and new Production Technologies - NMP	805	10,235	3,238.6	152	223	18	81.6	2.52 %
	Energy	368	4,272	1,707.4	92	164	14	92.5	5.42 %
	Environment (including Climate Change)	494	7,148	1,719.3	130	175	12	50.8	2.96 %
	Transport (including Aeronautics)	719	9,029	2,284.2	66	99	3	26.7	1.17 %
	Socio-economic Sciences and Humanities	253	2,770	579.6	60	65	5	15.4	2.66 %
	Space	267	2,636	713.3	31	42	2	12.5	1.75 %
	Security	314	3,836	1,295.5	33	42	3	14.3	1.10 %
	General Activities	26	183	312.7	3	5	1	1.1	0.36 %
	Joint Technology Initiatives (JTI)	736	5,812	1,966,4	93	157	11	51.1	2.60 %
	COOPERATION total	**7,834**	**87,623**	**28,336.3**	**1,256**	**1,819**	**141**	**672.7**	**2.37 %**
IDEAS	European Research Council	4,525	5,405	7,673.5	90	95	83	146.3	1.91 %
	IDEAS total	**4,525**	**5,405**	**7,673.5**	**90**	**95**	**83**	**146.3**	**1.91 %**
PEOPLE	Marie-Curie Actions	10,716	19,515	4,777.4	384	433	232	152.2	3.19 %
	PEOPLE total	**10,716**	**19,515**	**4,777.4**	**384**	**433**	**232**	**152.2**	**3.19 %**
CAPACITIES	Research Infra-structures	341	5,267	1,528.4	78	91	4	34.5	2.25 %
	Research for the benefit of SMEs	1,028	9,124	1,249.1	130	217	33	37.8	3.02 %
	Regions of Know-ledge	84	1,005	126.7	9	19	3	3.2	2.55 %
	Research Potential	206	307	377.7			0	0.0	0.00 %
	Science in Society	183	1,820	288.4	49	59	6	12.1	4.21 %
	Support for the coherent develop-ment of research policies	26	131	28.3	1	1	1	0.2	0.53 %
	International Co-operation	157	1,393	173.4	5	5	0	0.7	0.42 %
	CAPACITIES total	**2,025**	**19,047**	**3,772.0**	**272**	**392**	**47**	**88.4**	**2.34 %**
EURATOM	Fusion Energy	4	67	5.2	2	2	0	0.1	1.79 %
	Nuclear Fission and Radiation Protection	134	1,958	352.8	7	13	0	0.9	0.25 %
	Euratom total	**138**	**2,025**	**358.1**	**9**	**15**	**0**	**1.0**	**0.27 %**
Total		**25,238**	**133,615**	**44,917.2**	**2,011**	**2,754**	**503**	**1,060.6**	**2.36 %**

Tables 8.3 and 8.4 present a view of the participation of Danish private companies in FP6 and FP7, divided into large enterprises and small and medium-sized enterprises (SMEs).

TABLE 8.3
THE PARTICIPATION OF DANISH PRIVATE COMPANIES IN FP6 DIVIDED INTO LARGE ENTERPRISES AND SMES

FP6	Large enterprises				SMEs			
Programme	Participants	Coordinators	EU Contribution (EUR)	Share of EU contribution to DK to the particular programme	Participants	Coordinators	EU Contribution (EUR)	Share of EU Contribution to DK to the particular programme
Integrating and strenghtening the ERA total	**127**	**6**	**28,428,427.90**	**8.31 %**	**241**	**20**	**40,144,656.72**	**10.49 %**
Life sciences, genomics and biotechnology for health	16	1	6,337,552.38	7.90 %	30	1	6,984,444.86	8.70 %
Information society technologies	19	0	2,798,656.05	5.75 %	29	0	5,239,362.99	10.77 %
Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	15	1	2,958,798.00	11.49 %	32	3	6,218,272.49	24.16 %
Aeronautics and space	2	0	303,560.00	6.84 %	8	0	1,169,349.00	26.35 %
Food quality and safety	8	0	1,318,640.00	2.49 %	9	0	948,621.00	1.79 %
Sustainable development, global change and ecosystems	52	4	13,549,319.47	16.18 %	46	6	12,125,892.43	14.48 %
Citizens and governance in a knowledge-based society	0	0	-		1	0	26,400.00	0.54 %
Policy support and anticipating scientific and technological needs	6	0	507,381.00	2.51 %	11	0	1,616,808.00	8.01 %
Horizontal research activities involving SMEs	9	0	654,521.00	6.01 %	73	10	5,652,772.95	51.90 %
Specific measures in support of international cooperation	0	0	0	0	2	0	162,733.00	3.09 %
Research and innovation	0	0	0	0	10	1	1,905,007.00	36.21 %
Human resources and mobility	8	3	445,046.61	1.10 %	1	0	289,587.32	0.72 %
Research Infrastructures	1	0	174,250.00	3.58 %	0	0	0	0.00 %
Science and society	0	0	0	0.00 %	4	1	526,940.00	20.85 %
Structuring the ERA total	**9**	**3**	**619,296.61**	**1.17 %**	**15**	**2**	**2,721,534.32**	**5.14 %**
Euratom total	**0**	**0**	**0**	**0.00 %**	**1**	**0**	**81,199.00**	**7.38 %**
Total	**136**	**9**	**29,047,724.51**	**7.33 %**	**257**	**25**	**42,947,390.04**	**10.84 %**

TABLE 8.4
THE PARTICIPATION OF DANISH PRIVATE COMPANIES IN FP7 DIVIDED INTO LARGE ENTERPRISES AND SMES

FP7	Large Enterprises				SMEs			
Programme	Participants	Coordinators	EU Contribution (EUR)	Share of EU Contribution to DK to the particular programme	Participants	Coordinators	EU Contribution (EUR)	Share of EU Contribution to DK to the particular programme
COOPERATION total	**190**	**10**	**61,028,239**	**9.07 %**	**353**	**13**	**127,431,573**	**18.94 %**
Health	11	0	4,400,360	3.22 %	56	3	38,856,722	28.45 %
Food, Agriculture and Fisheries, and Biotechnology	16	0	3,999,326	4.74 %	44	0	7,126,287	8.44 %
Information and Communication Technologies	21	1	5,487,710	5.19 %	71	1	21,672,109	20.51 %
Nanosciences, Nanotechnologies, Materials and new Production Technologies	29	1	6,507,794	7.98 %	58	2	19,723,092	24.17 %
Energy	35	4	25,906,202	28.02 %	27	2	14,255,505	15.42 %
Environment (Including Climate Change)	1	0	59,998	0.12 %	19	0	3,586,760	7.05 %
Transport	14	0	2,123,919	7.97 %	28	0	5,336,889	20.02 %
Socio-economic Sciences and Humanities	0	0	0	0.00 %	1	0	260,150	1.69 %
Space	0	0	0	0.00 %	4	0	891,448	7.12 %
Security	4	0	1,538,509	10.79 %	13	0	4,734,398	33.21 %
Joint Technology Initiatives (JTI)	59	4	11,004,422	21.52 %	32	5	10,988,213	21.48 %
PEOPLE total	**31**	**2**	**8,856,401**	**5.82 %**	**30**	**2**	**7,661,007**	**5.03 %**
Research Infrastructures	0	0	0	0.00 %	1	0	527,415	1.53 %
Research for the benefit of SMEs	15	2	1,906,508	5.05 %	125	18	32,121,377	85.06 %
Regions of Knowledge	1	0	82,117	2.54 %	1	0	69,225	2.14 %
International Cooperation	1	0	121,070	16.78 %	0	0	0	0.00 %
Science in Society	0	0	0	0.00 %	2	0	332,139	2.74 %
CAPACITIES total	**17**	**2**	**2,109,695**	**2.39 %**	**129**	**18**	**33,050,156**	**37.37 %**
Fission	0	0	0	0.00 %	4	0	145,149	16.77 %
Euratom total	**0**	**0**	**0**	**0.00 %**	**4**	**0**	**145,149**	**15.13 %**
Total	**238**	**14**	**71,994,336**	**6.79 %**	**516**	**33**	**168,287,885**	**15.87 %**

8.2. Annex 2 – Individual participation

This annex describes the characteristics of the participants not categorised as researchers, PhD students or masters.

8.2.1. Age

Other participants are generally younger than participants categorised as researchers, masters and PhD students. 14 per cent of the other participants are under 25 years old compared to 4 per cent for the participating PhD students and 0 per cent for the participating researchers and masters.

TABLE 8.5
OTHER PARTICIPANTS DIVIDED BY AGE

	Under 25 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	Over 50 years
Other	14 %	22 %	19 %	12 %	10 %	6 %	17 %

Source: DASTI's own calculation using registry data from Statistics Denmark.

Since there are no records on when the participants enter the projects, they are measured in the year of project start, even though participants are not necessarily included in the projects from the start. This implies that some participants are measured before they even participate in the projects, and thus they have not yet completed their master's degree or started their PhD. This is one possible explanation for why these participants are not categorised as researchers, PhD students or masters. The high proportion of other participants under 25 years supports this explanation.

8.2.2. Field of science

Like researchers, PhD students and masters, a large share of the other participants have an education within technical science. A quarter of the other participants have an unspecified education.

TABLE 8.6
OTHER PARTICIPANTS DIVIDED BY THEIR FIELD OF SCIENCE

	Humanities	Agricultural science	Natural science	Social science	Health science	Technical science	Unspecified
Others	10 %	4 %	5 %	14 %	7 %	36 %	24 %

Source: DASTI's own calculation using registry data from Statistics Denmark.

8.2.3. Career

Table 8.7 shows other participants' career position broken down by citizenship. 54 per cent of the participating others that are foreigners are in highly-skilled specialist positions, and 27 per cent are employed as specialists in general. Also 44 per cent of the Danish participants are employed as specialists in general or highly-skilled specialists. This indicates that these other participants probably are researchers, PhD

students or masters, but this is not recorded due to incomplete public registers. The public register of education is particularly inadequate for foreigners.[36]

42 per cent of the Danish participating others are in positions that only require skills on an intermediate level or lower (others). As with age, this indicates that these participants are measured at a time when they have not yet started their project participation and thus are not employed in relevant jobs. However, some of the participants employed in positions that only require skills on an intermediate level can also be laboratory technicians or the like.

TABLE 8.7
OTHER PARTICIPANTS DIVIDED BY CAREER POSITION AND CITIZENSHIP

	Leader	Specialists in general	Highly-skilled specialists	Others	Unknown
Danish	4 %	31 %	13 %	42 %	10 %
Foreign	0 %	27 %	54 %	5 %	13 %
Total	2 %	29 %	29 %	28 %	11 %

Note: Leaders are DISCO code 1000-1999, Specialists in general are DISCO code 2000-2999 except 2310, Highly-skilled specialists are DISCO code 2310 and Others are 3000 – 9999.
Source: DASTI's own calculation using registry data from Statistics Denmark.

8.2.4. Sector

Table 8.8 shows the participants' employment in sectors broken down by citizenship. Approximately three-quarters of the participating others that are foreigners are employed at a university. As for the participants' career position, this indicates that they probably have a PhD or master's degree, but this is not recorded due to incomplete registers.

Only a quarter of the Danish participants are employed at a university, which again indicates that these participants are measured at a time when they have not yet started their project participation and thus are not employed in relevant jobs.

TABLE 8.8
OTHER PARTICIPANTS DIVIDED BY SECTORS AND CITIZENSHIP

	Public or private R&D companies	Public sector	Private sector	Universities
Danish	9 %	25 %	43 %	23 %
Foreigner	7 %	6 %	11 %	76 %
Total	8 %	17 %	31 %	44 %

Source: DASTI's own calculation using registry data from Statistics Denmark.

36 Because of incomplete registers, there is a lack of information about some of the participants' highest completed education or ongoing education. The variable "highest completed education" only registers the level of the latest education if this is completed in Denmark. Thus Danes or foreigners who have taken their PhD degree abroad will not be registered as a researcher, as is the case with individuals taking their master's degree abroad.