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An analysis of the role and impact of industry participation in the Framework Programmes

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Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination
Unit A.5 — Evaluation

E-mail: RTD-A5-SUPPORT@ec.europa.eu

European Commission
B-1049 Brussels

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An analysis of the role and impact of industry participation in the Framework Programmes

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EXECUTIVE SUMMARY

Industry represents a vital source of economic growth and job creation in Europe as well as a main driving force for innovation. Since 1984, the EU has run its research and technological development policy on the basis of multiannual framework programmes. In particular, the main strategic objectives of the Seventh Framework Programme included the strengthening of the scientific and technological base of European industry and encouraging its international competitiveness. Despite the acknowledged importance of both large companies and SMEs in stimulating innovation, industry participation, whether as a share of funding or number of participants, has been declining continuously for more than a decade. Although a number of studies have analysed the patterns and impacts of SME participation in the Framework Programmes so far, the role of industry as a whole, including large companies, has been under-examined.

Against this background, this study aims to (1) analyse participation patterns understanding the underlying motivations/barriers, differentiating between large companies and SMEs and also looking at emerging patterns by comparing headline statistics for FP6 and FP7; (2) explore quantitatively and qualitatively the impact of the FP7 with special regard to innovation and job creation. To this end, the study performed a systematic literature review, an in-depth statistical analysis of CORDA data, fifty case studies and one hundred stakeholder interviews, and a state-of-the art quasi-experimental counterfactual impact evaluation on job creation.

1. Participation, motivations and barriers

Level of participation

The findings show that the previous decline in industry participation was reversed, as it increased notably from FP6 and FP7 from 17 to 25% of total EC contribution. Participation of SMEs showed a similar increase from 6 to 13%. The 8 percentage point increase in industry participation can be explained both by the introduction of new instruments and themes and by the growth in the old ones. The majority of the increase is due to growth within existing instruments and themes, especially Marie Curie, whose contribution to industry grew eightfold by 440M EUR (5% of total growth), and themes such as ICT, NMP, Food and Health, which represent 45% of total growth. The rest of the increase is due to the introduction of new instruments and themes, some of which are especially relevant for industry. The main contributions come from the instruments JTI and Research for the benefit of SMEs, which together account for 21% of the growth between FP6 and FP7, and the new themes transport and security, accounting for 13% and 7%, respectively.

Motivations to participate

In line with previous evaluation, the results of this study show that the main motivations to participate are knowledge-, rather than market-driven. Among the five top motivations stated by companies as important, four relate to knowledge and network development: to develop new methods and techniques (91%), new relationships (87%), and gain access to complementary expertise (80%) and develop internal knowledge (74%).

One of the possible explanation for the increase from FP6 to FP7 is the improved perception to respond well to the need of the companies, acknowledged by almost 80% of respondents for FP7, against 66% for FP6.

SMEs tend to emphasise more market-oriented goals such as the importance of creating new markets and improving their commercial capacities more than large companies, which tend to be driven by the gaining of access to complementary expertise and the development of internal knowledge.[1]

Effect of call clarity on participation

There is almost unanimous consensus among respondents that the calls are clear (78%) and the evaluation process fair (82%). There's less consensus on the transparency of evaluation (61%), which is frequently criticized by interviewees because it fails to adequately explain the reasons and as a result does not help to improve the proposal. Workshop participants confirm this and suggest that other programmes in US and UK provide much more substantial and helpful feedback.

[1] While the sample remains too limited to draw conclusion, the most visible difference between SMEs and large companies are for market related motivations which appear far stronger for SMEs (80-89%) than for large companies (36-50%).

Barriers to participation

While previous FP evaluation reports point to administrative burden as the main barrier to industry participation, the findings of this study exhibit different results. Just as knowledge is the main objective of participation, the main barrier to participation is identified in the lack of relevance (considered as important by 37% of respondents) and the absence of an innovation strategy (37%). Relatively less important appear to be factors related to administrative burden (35%), long time to grant (27%), complex reporting requirements (22%) and low funding rates (22%). Regarding the specific issue of application costs, contrary to the findings from the literature, more than 70% of respondents agree that application costs are reasonable. One issue not captured in the original answers but frequently mentioned by interviewees and experts at the workshop is the lack of flexibility to adapt the goals of the project once it has been funded.

The increase in funding rates from FP6 to FP7, particularly important for SMEs, certainly encouraged participation but can't be considered as a determining factor: participation rates increased in very different measure among instruments and themes which share the same relative changes in funding rates. For instance, participation rates for SMEs in ICT grew much more than industry as a whole, while in NMP they display similar growth between SMEs and industrys.

On the demand side, a major barrier remains the lack of necessary skills and networks, so that previous participation is an important factor to explain participation. In this sense, the lack of assistance and support is one of the one of the top barriers, considered as important by 24% of respondents. Demand side factors, such as lack of awareness, lack of previous experience, lack of networks and support, are found to be important barriers for SMEs, gazelles and companies in new Member States (EU13).

Explanation of the different levels of participation

The factors presented so far are common to the whole FP and therefore cannot explain why industry participation varies largely between different themes as illustrated in the box below.

FP7 Theme	FP7 %
Transport (including Aeronautics)	49%
Energy	47%
Security	45%
Nanosciences, Nanotechnologies, Materials and new Production Technologies	37%
Information and Communication Technologies	33%
Space	28%
Health	21%
Food, Agriculture, and Biotechnology	19%
Environment (including Climate Change)	16%
Socio-economic sciences and Humanities	4%

Theme-specific factor that can influence the decision to participate are success rates (low success rates should discourage participation), relative project size and competition (since industry should favour large projects with limited competition), time to grant (the longer they are, the less attractive to industry) and last but not least the actual design of the workprogramme (the more market-oriented is the workprogramme, the more likely is that industry participates). Based on the analysis of the CORDA data, the content of the workprogramme, and the interviews with participants, the most important factor appears to be the alignment of the workprogramme with the strategic objectives of the company: the degree on industry involvement requested in the workprogramme has a higher correlation with industry participation (0.36) than other theme-specific factors such as average success rate (0.21), average project size (0.26) and time to grant

(0.0). In other words, industry participation happens when it is actively pursued as a deliberate choice in the definition of the workprogramme, for instance by emphasizing participation of industry in the description of the topic using expressions such as: "The leading role of relevant industrial partners is essential to achieve the full impact of the project".

This confirms the findings of the interviews related to the main motivations being knowledge rather than opportunity driven, and is further corroborated by the qualitative interviews where respondents emphasize that "more important than the success rate was the chance to accelerate the company's business development. The most important aspect considered was the extent of alignment of the calls with the firm's objectives". Since strategic alignment is the main driver, interviewees confirm that large companies invest substantial time in influencing the design of the workprogramme by participating in existing consultations in order to ensure this alignment, while SMEs and gazelles have more limited resources and skills to do so.

Motivation differences between large companies and SME

In terms of drivers and barriers, there are major differences between large companies, SMEs and gazelles. Large companies are motivated by medium/long term goals of knowledge and networking, are not too impacted by administrative burden, lack of flexibility, costs of application and success rates. Their participation is motivated by the strategic alignment with the work programme. SMEs are more motivated by short/medium-term commercial goals, networking and funding. Lack of awareness and lack of networks, administrative burden, success rates, costs of application and funding rates play a significant role in their decision to participate. Their participation is strongly correlated with the market orientation of the workprogramme. Gazelles are motivated by medium/long term knowledge and market goals. Lack of awareness and information is a major barrier, so as administrative burden, but especially lack of flexibility, long time-to- grant and large consortium constitute important barriers. The design of the work programme is perceived as too prescriptive and jargon- rich to enable them to participate.

Administrative burden, costs of application and low success rates remain important, but not decisive for industry, although they are relatively more important for SMEs. The lack of flexibility during the project and the heavily structured top-down processes are barriers for all participants, particularly, for gazelles. Time to grant is not correlated with participation rates, although it is mentioned as a barrier by gazelles. Regarding funding, large companies obviously seem to participate more in themes with larger projects. The change in funding rates does not seem to have played a major role, although the evidence is far from conclusive.

2. Impact on innovation

Impact on innovative companies

The analysis of the self-reported NACE codes shows that FP7 had a strong orientation towards innovative companies, defined as companies pertaining to high tech or medium high tech NACE sector, according to Eurostat classification. The percentage of High Tech and Medium-high-tech companies participating in FP7 (16%) slightly higher than overall percentage of High Tech and Medium-high-tech companies present in the EU economy (12%). These companies attracted more than half of the total FP7 contribution (62%). Concerning the participation of innovation companies by FP7 theme, the theme of Security (76%),, transport (72%) and ICT (69%) showed the highest concentration of innovative firms.

Despite the overall growth in industry participation, and the overrepresentation of innovative companies, participation of gazelles[2] remains as low as in FP6. 5% of the companies included in Deloitte's "FAST 500" list in the last four years participated in FP7 (67 out of 1346); 52% of them participated in one project only. ICT and the NMP theme attracted about half of them, followed by Marie Curie, which again shows a good attractive capacity towards industry. Gazelles received overall 43M EUR, or 0,4% of the total FP7 funding. The main barriers to participation for gazelles lie in the long time between application and project start, in the lack of flexibility to adapt the goals of the projects and in the excessively prescriptive design of the workprogramme. While these data do not show substantial progress, several scholars and workshop participants point out that

[2] EUROSTAT defines gazelles as those high-growth enterprises (firms with average annualised growth greater than 20% per annum, over a three year period) that are up to five years old, they should also have at least 5 or 10 employees at the beginning of the three-year observation period. The growth can be calculated either by the number of employees or by turnover. Since we do not have microdata and the last data provided by Eurostat is old (2012), we compiled an aggregated list out of the last 4 editions of Deloitte Technology Fast 500TM EMEA report which ranks companies in the region that have experienced exceptionally fast growth. It calculates the percentage revenue growth during the last 4 years, based on fiscal year revenues. Percentage revenue growth is computed as [(FY'15 rev. – FY'12 rev.) / FY'12 rev.] x 100 (FY=Fiscal Year). All companies included in the Deloitte rankings meet the condition of annualised growth greater than 20% per annum, because the lowest growth that appears is 279% growth in 4 years.

attracting gazelles should not be prioritized, since they typically already have access to possible sources of funding and hence their participation would reduce the additional effect of EU funding.

Less than one third (20) of these high-growth companies are startups, since they were founded less than 5 years before participating. Good examples include Valopaa Oy, a LED technology company founded in 2007, which participated in a FP7 project in 2011, obtained 2M EUR capital investment in 2013 by a CIP-sponsored fund, and grew to be in Deloitte report in both 2013 (101st) and 2014 (39th).

Impact on innovation

The vast majority of studies subject to this review concluded that public funding stimulate additional R&D investment by companies (input additionality) and found positive effects of participation in R&D programmes on innovation output, measured in terms of generating new products and to apply for patents (output additionality). Interviewees confirm these findings, although they particularly emphasize the benefits in terms of competence building and network creation, rather than direct commercialization of new products. 29% of respondents are able to mention instances when FP funding helped the firm to commercially valorising the results of R&D activities.[3] In particular there is strong consensus (79% of respondents) that FP allows the company to carry out bigger research projects than would be the case in its absence. This is further confirmed that while the vast majority of respondents (78%) also access national funding, only 36% agrees that national funding helps establishing international networks.

The project AQUAFIT4USE aimed the development and implementation of new, reliable and cost-effective technologies, tools and methods for sustainable water supply, Secondly, the use and discharge in the main water-consuming industries in order to significantly reduce water use, mitigate environmental impact and produce and apply water qualities in accordance with industrial own specifications from all possible sources. The key outputs include 2 pilots and 2 commercial products currently sold in the market by EnviroChemia, a large Polish firm. FP funds have been largely used for the testing and piloting of the research product in "real-life", also involving end-users. This testing phase was only possible thanks to FP funds that, according to a representative of the firm, had a positive impact on the commercialisation of research results. AQUAFIT4USE enabled to commercialise two products that could not have been launched onto the market without the FP7 funds.

TRL impact

The majority of the interviewed companies define the innovation process supported by the FPs among the middle range of technology readiness (77% of answer are for levels between TRL 8 - Demonstration system and TRL 3 – technology formulation, against 8% for TRL9-10 and 14% for TRL 1-2). Overall there is a greater emphasis on research focus (59% for TRL1 to TRL5) than of market focus (41% for TRL 6 to TRL 10). In particular, large-scale prototypes, first of a kind commercial systems and fully commercial applications are less mentioned.

FP7 funds helped Novocaptis (SME) to develop and explore new technologies and to improve its technological readiness. Before receiving the funds the company operated in TRL 3, and after the funding it advanced its technological readiness to a TRL 8. The funds allowed the firm to perform larger R&D projects, which were carried out by dedicated project teams.

Contribution of Joint Technology Initiatives to deploying new technologies

Existing evaluation reports on JTI convene that it is too early stage to show concrete results, even at qualitative level. IMI already produced new screening methodologies pre-clinically and clinically, biomarker identification, platforms for data storage, integration and interrogation, the first human beta pancreatic cell line (already being commercialised by one of the SMEs in the consortium), and tools to improve patient reported outcomes (PROs). As for the other JTIs, as expressed in the evaluation of the FCH JTI, "market break-through has not been achieved yet, except in a few niche markets". However, according to interviewees and participants to the workshop, JTIs have been instrumental in attracting industry participation since they provide a "safe environment" where participating companies can directly shape the research agenda based on their needs.

[3] However, workshop participants signal that such a percentage appears unrealistically high. Traditionally 10% of R&D project can be expected to deliver results.

The Finnish company Empower IM OY participated to a JTI call for project related to "embedded technology for sustainable urban life". The project funded "Internet of Energy (IoE)" aimed to develop hardware, software and middleware for seamless, secure connectivity and interoperability achieved by connecting the Internet with the energy grids. The application of the IoE is the infrastructure for the electric mobility. The project covered the testing stages of innovation including a large scale prototype tested in intended environment and a prototype system tested in intended environment close to expected performance. It resulted in the development of 3 demonstrators and 2 products fully operational for the electric mobility infrastructure, designed in Embedded Systems (ESs). Such a research output is considered as a disruptive and breakthrough innovation since it resorts to disruptive components needed to design services enabling the use of flexible energy. The FP funds have obviously helped the company to achieve such positive research results, because they provided funding regardless of the risk of business management usually borne by project participants. Besides, they accelerated the delivery of the research output thanks to a partnership structure favourable to synergies. Without FP funds, the project ambition would have been reduced in terms of project size and results: the technology would have been less sophisticated.

Reduction of time to market

Participating to the European Framework Programmes can be an accelerator for companies with a go-to-market strategy. Indeed, most of FP projects have an operational objective and aim at introducing a new product to market. Among the companies interviewed and concerned by this issue, the average time from discovery to market is between 3 and 5 years – innovation period are quite long. In general, the FPs is perceived as helpful to accelerate the time from discovery to market, on different stages of the innovation life cycle.

For the AZD Praha company – a Czech producer and supplier of signalling, telecommunication, information and automation technologies –, participating to a FP funded project (called NGTC) clearly concurred to reducing the time to launch the product: it took 6 years for the project to come up with a product, while in railway signalling the usual innovation period is much longer. Furthermore, as the interviewee stated, the specifications for the innovation are the fruit of a common and shared brainstorming and thinking, which makes them more easily accepted by the stakeholders and the community, and then accelerate the whole process to go to market.

Effects on the creation of innovative ecosystem

The literature indicates that public R&D programmes trigger a behavioural change in firms' R&D partnerships, alleviating barriers to cooperation. Our findings confirm this: being part of larger and more stable network of collaboration is the main potential long-term benefits that the companies will retain for its R&D activity from participating to FPs, declared as important by 78% of companies. The most important impact on internal RTD capabilities is in terms of enhanced linkages with research centres and universities (74% of respondents).

The company Enaco SRO is now part, thanks to its participation to the FP7, of a larger and more stable network of collaboration, namely the "UPSOIL consortium". The SME has also kept contact with the former partners of the project all over Europe, and still cooperates with some of them. In this respect, the company took part in new proposals with partners met in the framework of the FP-funded project

Obstacles to innovation

The majority of respondents (60%) state that FP7 has helped the firm to address the obstacles usually encountered when launching a new product, technology or service on the market. However, obstacles to innovation remain present and frequently mentioned: there is insufficient flexibility to accommodate for changes in the project, which are considered an exception rather than the rule. Changing project goals require in depth knowledge and understanding by project officers; unfortunately the increasing number of projects per officer and their rotation make it difficult to ensure a sufficient coverage of each project, leading to a formal rather substantial approach to

changes.[4] Another frequently mentioned challenge is the lack of follow-up funding necessary to bring solution further the TRL scale, in particular when it comes to large-scale pilots and mass production, which require substantial additional investment beyond the scope of the project.

One large Italian firm, for instance, underlines that due to the long timeframe of the project, the technology developed indeed lost competitiveness with respect to other technologies while the project was still ongoing. For this reason, the research group complains about a lack of flexibility of the project terms, which should be adjustable to the project development. A large Czech firm instead thinks that more flexibility should be allowed in terms of project budget, since "sometimes it is difficult to forecast and budget all nuances prior to start research". Finally, a British SME complains of a lack of flexibility in terms of project timing. During the implementation, the project director asked the Commission to extend the project deadline, but the requested was denied. At the end, the project was cancelled due to a lack of results, but the SME has then independently solved the R&D problem that brought the project to failure. However, the company felt that this work could have been done during the project, if the EC would have had allowed the deadline extension.

Higher success in unlocking the innovation potential of businesses in the US

In terms of patents, the EU and the US are in a similar situation, there were 3,75 PCT patents applications per billion GDP in the EU and 3,74 in the US. However, license and patent revenues from abroad (as percentage of GDP) are much higher in the US (0,64) than in the EU (0,43). This implies that the US patents are more valuable. Dosi et al (2006) show that US is ahead in patents in Information Technologies, Pharmaceutical and Biotech while Europe's strengths are in strength related to mechanical technologies and new materials. They stress that Europe lags in terms of lower innovative output and that this is due to "weaknesses in technological fields that are considered as the 'engine' of the contemporary 'knowledge economy'". According to OECD (Squicciarini, Dernis, & Criscuolo, 2013) the higher indices in 2009 are from patents in the fields of pharmaceuticals, control-technologies and biotechnology. Eurostat data reveals on the patents granted by the USPTO (United States Patent and Trademark Office) in 2009 and the applications to the EPO (European Patent Office) in 2011, reveals that the US tends to dominate over the EU in the areas of Physics (Section G), Computing, calculating, counting; and Human necessities (Section A). In the USPTO it has also a clear higher weight in the field of Medical or veterinary science and hygiene. On the other hand, has a larger presence in Performing operations and transporting (Section B), Mechanical engineering; lighting; heating; weapons; blasting (Section F) and Vehicles in general.

3. Impact on job creation

There is strong consensus in the literature that innovation is the main driver of productivity growth, of the creation of new products and market and hence of job creation in the medium term. Our counterfactual analysis aims to assess whether R&D funding also supports direct job creation, both in the short and in the long run. More in particular our analysis is able to assess two effects:

- Additionality of participation, analyzed by measuring the employment during the project, which is an assessment of the direct impact from participation;
- The indirect effect on the company's performance, analyzed by measuring the employment one year after the end of the project, and which is an assessment of the indirect improvements brought to the company by participation, such as higher competitiveness or better networking / innovation.

In practice the above effects cannot be disentangled, as we do not possess enough details on the contracts. Thereby the unit of analysis is the firm and not the single job.

It has to be noticed that the real impact of the intervention is not given by the number of people hired to work in a project, because it is possible that a company would have hired new employees regardless the participation to the FP. In the same way it is possible that a company would carry out the FP project just using the employees already available. Thereby the real impact is given by the comparison of the employment situation in the participant company, with the alternative of non-participation.

[4] Moreover, according to experts participating to the workshop, there are unrealistic expectations. While in reality innovation project have low success rates (around 10%), the vast majority of FP projects are formally delivering successful results and they are stopped only in extreme situations.

In this respect, on average, the impact estimates revealed that within the EU6 (France, Germany, Italy, Netherlands, Spain, United Kingdom, i.e. EU countries with the highest GDP) countries, receiving support from either FP6 or FP7 programmes generates between 2.21 and 2.52 additional jobs. In the same way in EU26 (all the Member States except Ireland and Cyprus), participating to FP6 or FP7 programmes generates between 1.98 and 1.70 additional jobs per subsidized firm. In other words, each company receiving FP funding creates on average 2 additional jobs because of FP participation and these jobs last at least one year after the project end.

These jobs are, as could be expected, high quality jobs. According to interviewees, companies contributed also to the development of research and doctoral training by recruiting PhDs for regular R&D activities (in 46% of the cases), and by hiring PhDs specifically for working in the FP6 and FP7 projects (35%). By doing that, the companies were able to obtain the high level of specialization needed to perform the firm's activities, the high level of expertise to perform the FP projects, as well as a stronger collaboration with universities.

In fact, FP6 and FP7 programmes appear to be capable of generating the same kind of employment additionality than more traditional public investment support policies directly tied to sales and employment improvement objectives. Examples of such policies are reported in Bondonio and Martini (2012) who carried out a one of the few counterfactual impact evaluation of national and regional enterprise support. At the national level their focus was on "Law 488/92", a large-scale programme supporting industrial firms investments in physical capital through non-repayable grants, finding an average of 1,82 additional jobs per firm generated by the intervention. On the other hand at the regional level the focus was on a single Italian region, Piedmont (a NUTS 2 region of 4.5 million people in Northern Italy), for which it was possible to build a unique database on the entire spectrum of 25 different investment support measures available to SMEs ("SME-Piemonte"). The intervention is estimated to generate an average of 0,32 additional jobs per subsidized firm.

In terms of cost of job created, our estimates show ranges for EU26 from 97,991 to 114,118 Euros. While it is difficult to compare because of the absence of thorough counterfactual evaluation, one well-known benchmark is the US recovery act launched in the wake of the financial crisis, for which the cost per job created has been estimated by the White House at around 278,000 dollars, therefore more than the double of FP7.

In our extrapolation we use the impact estimates of the counterfactual exercise to show that if Europe would double the share of companies financed (i.e. doubling the share of CORDA companies over total companies) in order to reach the 2020 target for BERD (i.e. 2% of GDP the European Union), the average cost for the EU28 would be 0.08% of GDP and the average impact on employment would be 0.06%. The estimated elasticity would be 0.68, implying that a 1% investment in R&D through subsidies would increase the employment by 0.69%.

4. Conclusions and recommendations

The study concludes that EU FP funding managed to substantially increase industry participation, although not for gazelles. It is broadly effective in building innovative competences in companies and in creating jobs. Yet substantial action is needed to overcome the European challenges in the innovation ecosystem and to foster greater impact.

The final recommendations confirm the importance of the changes brought by Horizon 2020, which are generally welcome by stakeholders, such as the support towards activities closer to the market, the limitation of costs of participation through the introduction of two-stages funding, and the continuous strive towards administrative simplification.

At the same time, the study provide special emphasis on some additional recommendations:

- Improve the involvement of industry in the design of the work programme, both in terms of defining the research priorities and types of instruments to be used, with particular regard to the involvement of innovative SMEs.
- Different instruments should be used that take into account the different needs of large companies and SMEs.
- Improve the feedback mechanisms on evaluation to guarantee maximum transparency and learning
- Provide greater project flexibility to ensure changes in the course of the project in terms of objectives and consortium.

1. INTRODUCTION

1.1 Background, scope and structure

This is the Final Report of the study "An analysis of the role and impact of industry participation in the framework programmes". Its objectives are to: (1) analyse participation patterns understanding the underlying motivations/barriers, differentiating between large companies and SMEs and also looking at emerging patterns by comparing headline statistics for FP6 and FP7; (2) explore quantitatively and qualitatively the impact of the FP7 with special regard to innovation and job creation.

To deliver these objectives, the study carried out:

- A systematic literature review of 283 journal articles plus the FP evaluation reports;
- Statistical analyses of CORDA data;
- 100 In-depth interviews ;
- 50 case studies;
- Counterfactual evaluation and macro extrapolation on job creation;

As a separated document, this report is complemented by fifty case studies and a Technical Compendium to account for the sheer range and depth of the methodological, empirical, and analytical work conducted beyond the requirements of a Final Report. A transparent account of the methodological and analytical choice is fundamental for a correct use and interpretation of the findings of the study by the Commission, by the members of the Panel Expert Committee, and by the interested public. As some of the technical choices adopted are sophisticated and complex, they could hardly be illustrated in a transparent manner within the limitations of this report.

In the remainder of this section, we present the context, objectives, and evaluation questions (1.2), as well as a snapshot of the overall methodological approach and its limitations (1.3).

Section 2 presents the main findings related to participation, while section 3 covers the impact on innovation, and section 4 the impact on jobs. Relevant summary case studies are placed alongside each section in order to illustrate the findings with real life stories.

Finally, in section 5, a first set of preliminary conclusions are presented, together with some general considerations about the limits of this study and of Commission RTD evaluation in general.

1.2 Context, objectives and evaluation questions

Large companies and SMEs represent a vital source of economic growth and job creation in Europe and constitute one of the main potential sources of innovation. Firms' R&D and innovation matters are one of the major sources of productivity growth in the long run and R&D is the major driving force for technical change. Given the crucial and strategic role of R&D, the evidence that European industry does not invest enough in research and innovation when compared to US, China, South Korea and Japan, is worrisome.

Given its importance, the domain of R&D is one of the few areas where economists concur in considering public subsidies useful to address market and systemic failures. It has been evident to the European Commission for quite some time that actions are needed to fill in the aforementioned competitive gap. Starting with the Lisbon Strategy for Growth and Jobs, the European Union placed the creation of knowledge through innovation among the key engines of economic and social progress. The 2002 Barcelona European Council set the goal of raising overall research investment in the EU from 1.9% of GDP to 3% by 2010, and increasing the private funding proportion from 55% to two-thirds. In the Europe 2020 strategy, the lack of innovation and the delay in reaching the 3% target were again stressed and identified among the structural weaknesses of Europe hampering its economic and social progress. Europe 2020 sets three main objectives: a) Smart growth: developing an economy based on knowledge and innovation, and a headline target of 3% investment in R&D (% of EU's GDP); b) Sustainable growth: promoting a more efficient, greener and more competitive economy; and c) Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

Hence, it is clear that industry innovation can impact on the need to increase jobs in general, but especially in knowledge intensive sectors. It is equally clear, however, that EU funding can support this only inasmuch as industry participation is adequate, while existing evaluation point to a

consistent decline of industry participation from FP4 to FP7 (Rolf Annerberg 2010). This is fully and perfectly reflected in the two main objectives that the ToR have set for this study: (1) Analyse participation patterns understanding the underlying motivations/barriers, differentiating between large companies and SMEs and also looking at emerging patterns by comparing headline statistics for FP6 and FP7; (2) Explore quantitatively and qualitatively the impact of the FP7 with special regard to innovation and job creation.

These objectives translate into the evaluation questions listed in the ToR and reported in the next three tables. Please note that the coding used for the evaluation questions is used and will be used throughout this Report and the Technical Compendium.

Table 1 ToR evaluation questions on participation

Evaluation questions shortened as topic	Method/source & (activities)
P1. Main drivers for participation	• Main: Interviews (A2.2); Other: Secondary sources (A1.1)
P2. Effect of changing funding rates on participation	• CORDA statistics (A2.1); Other: Interviews (A2.2)
P3a. Reasons and barriers for non participation	• Main: Secondary sources (A1.1); Other: Interviews (A2.2)
P3b. Barriers in specific geographical areas	• Secondary sources (A1.1)
P4. Motivation difference large companies vs. SMEs	• Analysis by class size of interviews findings (A2.2)
P5. Effect of call clarity on participation	• Main: Interviews (A2.2); Other: Secondary sources (A1.1)
P6. Participation by best performing & innovative industries	• Main: CORDA statistics (A2.1); Other: Secondary sources (A1.1)
P7. Reasons for concentration under certain themes	• Main: CORDA statistics (A2.1) plus Secondary sources (A1.1)
P8. Technology and capital effects on participation	• Main: Interviews (A2.2); Other: Secondary sources (A1.1)
P9 Support to Participation of start-ups	• Main: CORDA statistics (A2.1) plus Secondary sources (A1.1)
P10. Participation of high-growth companies (gazelles)?	• CORDA statistics merged with external ranks (A2.1)

Table 2 ToR evaluation questions on innovation impact

Evaluation questions shortened as topic	Assessment & Method/data
I1. Share of innovative participants	• CORDA statistics merged with external ranks (A2.1) plus results of Community Innovation Survey & other sources (A1.1)
I2. Good practices of commercial valorisation of research	• Case studies (A2.3)
I3. High-tech companies more successful in the above?	• Main: CORDA/RESPIR statistics (A1.1); Other: Interviews & cases (A2.2 & A2.3)
I4. Effect of participation on technology readiness	• Case studies (A2.3)
I5. FPs and obstacles to launch innovation	• Main: case studies (A2.3); Other: Interviews (A2.2)
I6. Demand-driven/use-led innovation and FPs	• Main: Case studies (A2.3); Other: Secondary sources (A1.1)
I7. Successful exploitation of results	• Main: Same as I1 (clear overlap); Other: Interviews & case studies (A2.2 & A2.3)
I9. JTI contribution to deployment of new technologies	• Secondary sources (A1.1)
I10. Average time from discovery to market	• Case studies (A2.3)
I11 FP effect on creation of innovative ecosystem	• Case studies (A2.3)
I13. Industry combination of EU and national funding	• Interviews & case studies (A2.2; A2.3)

Table 3 ToR evaluation questions on job creation impact

Evaluation questions shortened as topic	Assessment & Method/data
E1. Job creation impact	• Counterfactual evaluation (A2.4)
E2. Economy-wide job creation impact	• Macro level extrapolation (A2.5)
E3. Contribution to research and doctoral training	• Interviews (A2.2)

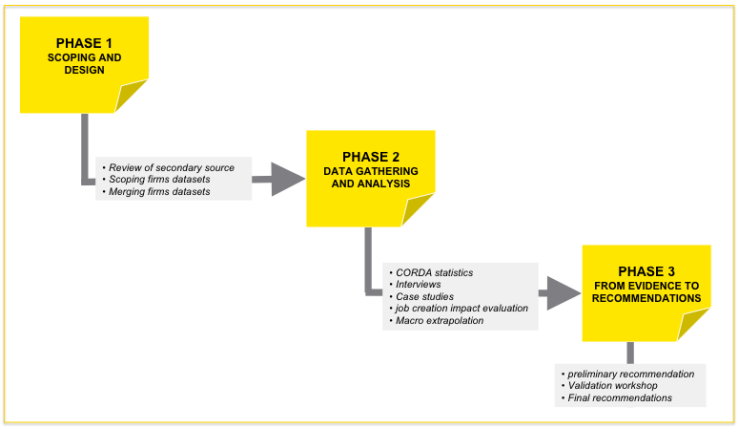
This Final Report focuses on directly answering the research questions by cross-analysing the answers provided by each method used, while the Technical Compendium is structured by methods. In order to improve readability, it follows exactly the structure of the specific research questions, which are illustrated within each section.

Under each section of this Report, we present the findings of each method used, and we provide a summary answer to the research questions.

1.3 Overall methodology and limitations

A large number of the 29 evaluation questions prescribed in the ToR, even if only implicitly, is saturated with the vocabulary of causation. Causation is, however, a 'cause celèbre' around which some of the most important disputes in science have focussed for centuries, to which this report does not enter. The reader is referred to the exhaustive discussion of causality and methods presented in section 2 of the Technical Compendium as a justification of the study's overall methodology and as a transparent disclaimer about its limitations. Below, only a very synthetic snapshot of the overall methodological approach is presented with the final disclaimer about the limitations. It can simply be anticipated here that for the overwhelming majority of the evaluation questions, the study does not claim to provide conclusive answers implying a robust causal attribution. Having clarified the above, the next four figures provide the high level picture of our general methodological approach that we briefly illustrated below.

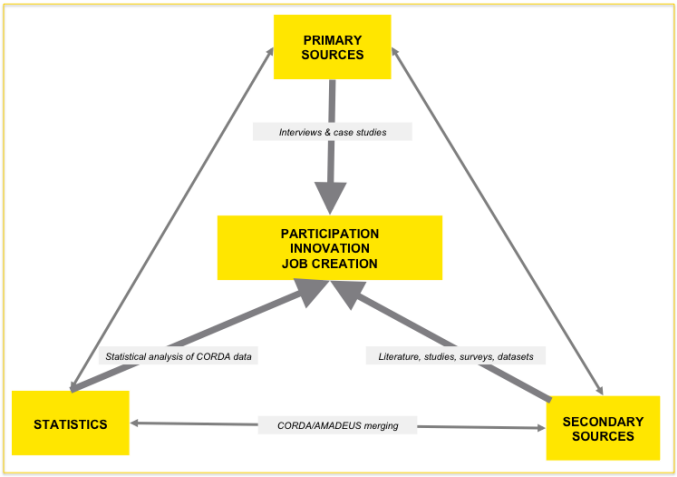
Figure 1 General approach: study phases



Source: Open Evidence

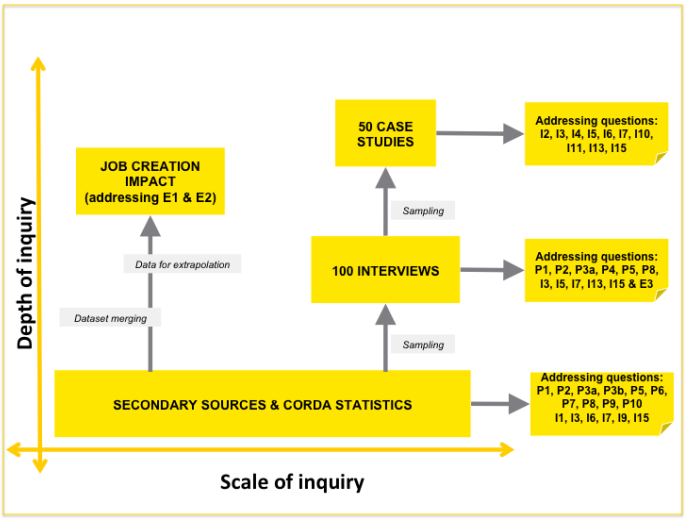
In Figure 1 the sequential split of the work into phases is presented, whereas Figure 2 conveys the idea of the triangulation of methods and sources to address participation, innovation, and job creation. This triangulation included primary sources from field work; systematised extraction of evidence from existing scientific literature and evaluation studies; statistical analyses of CORDA data, together with the gathering and analysis of additional statistics, merging of CORDA and Amadeus; recovery of the causal impact of FP7 on job creation using a counterfactual approach; and the attempt to extrapolate this impact at macro level.

Figure 2 General approach: triangulation of methods/ sources



Source: Open Evidence

Figure 3 General approach: scale and scope of analysis

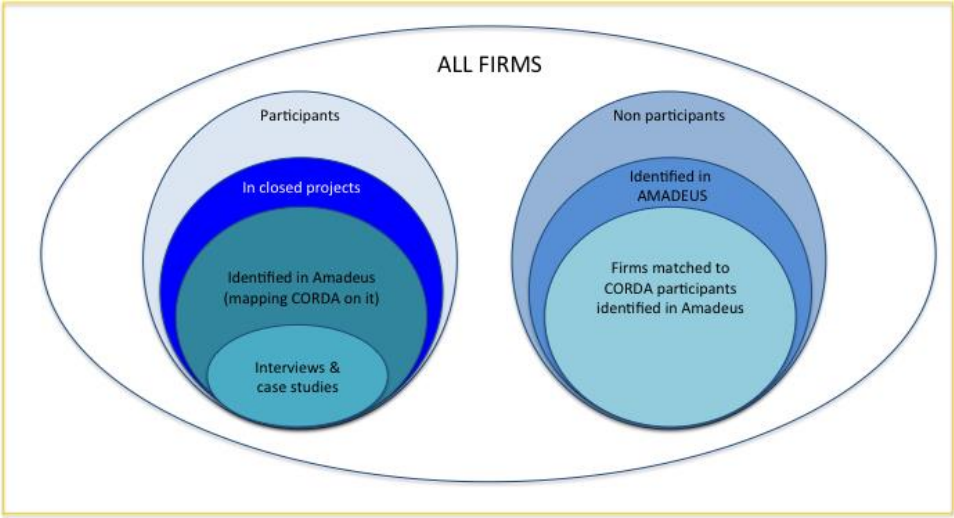


Source: Open Evidence

Figure 3 depicts how the scale and scope of inquiry changes when moving from the wider analysis of secondary sources and statistics to interviews and case studies, and to counterfactual impact evaluation and macro-level extrapolation. The figure also indicates which evaluation questions (with the same number coding used in the three tables presented in the previous paragraph) are addressed by each component.

Finally, Figure 4 shows how the various empirical components of the study were to some extent linked in the overall design. CORDA gave us the 'sub-universe' of all participating firms, from where funded firms participating to projects that have been closed at the time the work begins were selected. In parallel, there is a sub-universe of firms that one can conclude in nominative datasets such as Amadeus. By merging CORDA with Amadeus (see more on this in longer version at par. 7.3 of the TC), all firms that participated in FPs and that are included in Amadeus, and those included in Amadeus that did not participate, were identified. Finally, the sample of the firms for the interviews and cases were extracted from the total number of companies present in CORDA and matched with Amadeus.

Figure 4 General approach: selecting firms from the universe



Source: Open Evidence

Having presented the general features of the study's overall approach, this paragraph depicts the limitations of the study. These limitations can be entirely attributed to the physiological boundaries imposed by the time and budget available, as well as to shortcomings embedded in the quality of the data recorded in CORDA. In the final sections (par. 6.2), these limitations are reconsidered in the context of a general discussion of EC evaluation activities.

It is easy to notice that the 29 evaluation questions cover many levels of analysis that would require controlling for, and obtaining data on, a very large amount of variables, if quantitative and conclusive based causal attributions were to be performed in answer to them. Gathering such an amount of information was absolutely beyond the scope, time, and budget of this study. Moreover, for some of these variables, data were either not available or not possible to merge with the statistics on participants retrieved from the CORDA dataset. Therefore, the various sources and methods applied do not allow the provision of conclusive and generalizable answers based on formalised quantitative approaches on most of the evaluation questions that were addressed in the study. **Robust and quantitative evidence was recorded only for the causal impact of FP7 in terms of job creation impact. For all other evaluation questions, we triangulated sources of different kinds (CORDA statistics, secondary sources, interviews, and case studies) to provide descriptive quantitative and qualitative accounts, as well as mixed qualitatively/quantitatively- based answers to the evaluation questions**. In this respect, it is further worth stressing here the limits, as well as the advantages, of interviews and case studies. Given the time and resources available, the ToR reasonably asked for 100 interviews and 50 cases. As a result, we used a purposive sampling approach with representation (class size, sector, themes, and for case studies also a fixed quota of innovative and gazelles firms) and contrast (top and bottom firms in terms of number of projects they participated to) to ensure that interviews and cases warrant the possibility to formulate some level of interpretation and explanation beyond mere description. Nonetheless, this sample will not have the properties of a simple random representative sample and the corresponding generalisation power. As such, interviews and case studies could not by themselves answer questions such as for instance: "Do the Framework Programmes attract the best performing and innovative industries?"; "What are the underlying reasons behind the concentration of industry participation in certain thematic areas such as energy, transport and security?"; "To what extent and how have the FPs supported high-growth companies (gazelles)?"; "What is the share of enterprises participating in the FPs that have introduced innovations new to the market or new to the firm?". Since the sample is designed ex ante to include a certain number of firms from different sectors, which applied to certain themes that can be deemed innovative or fast growing, we could conclude only from interviews and cases that a specific percentage of supported firms are innovative or gazelles and answer "yes" to the first question, or explain concentration on themes. On the other hand, interviews and cases gave deeper understanding of the "why" and "how" dimensions of the above questions that can be triangulated with CORDA statistics and secondary sources to provide some non-conclusive, but evidence-based tentative answers.

2. KEY FINDINGS ON PARTICIPATION

This section presents the evidence for the questions related to industry levels of participation and the underlying reasons, summarising the findings across the different methods and providing value judgements based thereon.

The first part is devoted to objectively describing the levels of participation. We start off by presenting the overall change on participation by industry in FP6 and FP7. We then further qualify this by analysing whether FP7 has been able to attract the most innovative industries.

The second part aims to explain these participation levels by analysing the factors that affect participation: the motivations of industry, and the drivers and barriers to participation. We analyse them factor by factor and provide a summary assessment.

Finally, we present the main differences between different types of industry: SMEs, gazelles and large companies.

Table 4: Guide to the research questions on participation in this chapter

Evaluation questions shortened as topic	Method/source & (activities)
P1. Main drivers for participation	2.3 and 2/4 • 2.4.3
P2. Effect of changing funding rates on participation	2.4
P3a. Reasons and barriers for non participation	2.4.2
P3b. Barriers in specific geographical areas	2.5
P4. Motivation difference large companies vs. SMEs	2.4.1 • 2.2
P5. Effect of call clarity on participation	2.4.3 • 2.4
P6. Participation by best performing & innovative industries	2.2 • 2.2
P7. Reasons for concentration under certain themes	2.3 and 2/4 • 2.4.3
P8. Technology and capital effects on participation	2.4
P9 Support to Participation of start-ups	2.4.2
P10. Participation of high-growth companies (gazelles)?	2.5

2.1 Overall performance in industry participation

Industry participation has been an issue of concern for EU policy makers, especially as available data exhibited a constant decline in participation between FP4 and FP7 as described in the Interim Evaluation of FP7. The decline in industry participation casted doubts over the capacity of FP to generate innovation with a relevant market impact.

Our findings show that participation levels have been partly improved as final FP7 data became available, revealing an actual increase in industry participation in FP7 with respect to FP6.

Industry participation in FP programmes is typically calculated as the "share of EC contribution going to for profit organisations (PRC)" or by "share of participants belonging to industry".

The downward trend seems to have been reversed in FP7[5]. Table 5 summarises the main figures from FP6 and FP7: data show an increase from 17 to 25% in terms of EC contribution for industry, and from 19 to 30% in terms of number of contracts (single participation in a project).

[5] The notion of it "seems" has been chosen deliberately, because as we have stated elsewhere, there is a drastic reduction of the "other" type of organization participating in FP7 in relation to the previous programme. From our data, it is unclear whether this "other" category, especially in FP6, faithfully reflects organizations which are neither research organizations, nor public administrations and nor the private for-profit sector

Table 5 Industry participation in FP6 and FP7

Indicator	FP6	FP7
Total cost (M€)	28,571.4	63,687.5
Total EC contribution (M€)	16,653.9	44,917.2
Total EC contribution going to industry participants (M€)	2,848.4	11.055,5
% of EC contribution going to industry participants	17%	25%
Total contracts	76,562	133,615
Total contracts from industry	14,184	40,491
% contracts from industry	19%	30%

Overall, participation grew for both industry and SMEs in FP7.

Table 6: Comparison of the variation from FP6 to FP7 of EC contribution and contracts

	% Contracts FP6	% Contracts FP7	% Contribution FP6	% Contribution FP7
PRC	19%	30%	17%	25%
SMEs	9%	17%	6%	13%

The following table shows the variation of the EC contribution by themes and main beneficiaries between FP6 and FP7. The results reveal that there is high variation between themes, both in terms of absolute participation and terms of variation between FP6 and FP7. This variation should be interpreted with caution, due to both the existence of different themes and how the different types of beneficiaries were reported in FP6 and FP7.

Table 7 Variation FP6-FP7 EC contribution to industry by themes

FP6 Theme	FP7 Theme	FP6 EC contribution to industry	FP7 EC contribution to industry	Difference FP6-FP7	Weight over total difference
EXISTING THEMES					48%
Information society technologies	Information and Communication Technologies	644.669.505	2.633.364.813	1.988.695.308	23%
Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	Nanosciences, Nanotechnologies, Materials and new Production Technologies	400.228.221	1.189.246.692	789.018.472	9%
Food quality and safety	Food, Agriculture, and Biotechnology	43.391.002	352.907.554	309.516.552	4%
Life sciences, genomics and biotechnology for health	Health	223.877.618	990.798.006	766.920.388	9%
Aeronautics and space	Space	467.397.183	197.210.892	-270.186.290	-3%
Sustainable development, global change and ecosystems	Energy	414.246.133	803.174.364	388.928.231	5%
EXISTING INSTRUMENTS					7%
Research and innovation	Research and innovation (FP6)	15.519.140	-	-15.519.140	0%
Euratom	Fusion Energy	15.040.335	-	-15.040.335	0%
New and emerging science and technologies	European Research Council	-	79.284.684	79.284.684	1%
Specific measures in support of international cooperation	Activities of International Cooperation	6.064.039	17.848.545	11.784.506	0%
Citizens and governance in a knowledge-based society	Socio-economic sciences and Humanities	293.688	22.665.351	22.371.664	0%
Human resources and mobility	Marie-Curie Actions	62.708.190	502.790.288	440.082.098	5%
Research infrastructures	Research Infrastructures	11.084.172	165.400.633	154.316.461	2%
Science and society	Science in Society	954.081	24.893.311	23.939.230	0%
Support for the coherent development of research & innovation policies	Coherent development of research policies	390.624	1.548.423	1.157.799	0%
Policy support and anticipating scientific and technological needs	Policy support and anticipating scientific and technological needs (FP6)	17.877.291	-	-17.877.291	0%
Support for the	Coordination of research	1.149.603	-	-1.149.603	0%

coordination of activities	activities				
NEW OR CHANGED THEMES					23%
	Environment (including Climate Change)	-	274.076.176	274.076.176	3%
	Transport (including Aeronautics)	-	1.121.067.511	1.121.067.511	13%
n/a	Security	-	581.414.718	581.414.718	7%
NEW OR CHANGED INSTRUMENTS					22%
Horizontal research activities involving SMEs	Research for the benefit of SMEs	151.036.597	1.045.636.794	894.600.198	10%
	Regions of Knowledge	-	32.381.815	32.381.815	0%
	Joint Technology Initiatives (Annex IV-SP1)	-	948.888.920	948.888.920	11%
	General Activities (Annex IV)	-	7.907.237	7.907.237	0%
	Research potential of convergence regions	-	503.859	503.859	0%
	Nuclear Fission and Radiation Protection	-	62.453.006	62.453.006	1%
	TOTAL	**2.475.927.421**	**11.055.463.593**	**8.579.536.172**	**100%**

In conclusion, the reasons for an increase in industry participation by 8 percentage points can be arithmetically explained[6] both by the introduction of new instruments and themes, and by the growth in the old ones. Specifically:

- 45% of the increase is due to the introduction of new instruments and themes, some of which are especially relevant for industry. The main contributions come from the instruments JTI and Research for the benefit of SMEs, which together account for 21% of the growth between FP6 and FP7, and the new themes transport and security, accounting for 13% and 7% respectively;
- 55% of the increase is due to growth within existing instruments and themes, especially Marie Curie, whose contribution to industry grew eightfold by 440M EUR (5% of total growth), and themes such as ICT, NMP, Food and Health which represent 45% of total growth.

On the contrary, the growth cannot be explained by a greater concentration of overall EC funding towards themes with greater participation of industry in FP7: these themes grew in line or below the total EC contribution. For instance, the total budget for the fastest growing theme in terms of EC contribution to industry (ICT, NMP, Food and Health) increased less than the average growth between FP6 and FP7.

The strong differences between themes indicate that at least some of the reasons lie in factors that are theme-specific. Section 2.4 provides further analyses on these possible reasons.

In summary, there has been substantial growth in the quantity of participation of industry from FP6 to FP7. The next chapter aims to analyse whether this translated also into qualitative improvements, in terms of greater participation of most innovative industries.

2.2 Innovative industries and gazelles

This chapter addresses two research questions: the participation of high-growth companies (gazelles) and of best performing and innovative industries. The first concerns the participation at the level of individual companies, while the second addresses the level of economic sectors.

The main findings come from the analysis of CORDA data, integrated with external datasets on gazelles and on high-tech sectors in Europe.

2.2.1 Participation of gazelles

One of the goals of FPs and government programmes in general is to attract highly innovative companies by means of a sort of "cream skimming" strategy. Literature shows that broadly speaking, government R&D programmes do attract most innovative players. R&D and patent activity typically have a positive effect on participation (Afcha 2012; Hanel 2003; Busom & Fernández-Ribas 2004; Van Elk et al. 2014; Cerulli & Potì 2012).

[6] We here refer only to the analysis of growth dimensions of industry participation, not to its causes which are analyzed in section 2.3 and 2.4

Existing data for FP programmes focus only on ICT companies. When considering only the sub-segment of innovative SMEs, the study by IDC (2007) found that only 22% of innovative ICT SMEs have participated to any research/innovation programme in the previous 3 years, and 8.9% to a European programme. The evaluation of FP6 ICT notes with concern that only 5% of SMEs holding important ICT patents participated to FP6 (Aho, 2008).

The literature confirms the reluctance of young companies to apply for R&D public funding (Blasco et al. 2014; Schneider & Veugelers 2010). Public R&D programmes attract participants that are more innovative than the average, but nevertheless struggle to involve the top layer of highly innovative companies and in particular, highly innovative SMEs. However, this is not necessarily a problem: some scholars consider that the involvement of this "elite" could lead to a risk of reduced additionality by attracting firms that would have invested in innovation even in the absence of public support (Binelli & Maffioli, 2007).

The present study has performed an analysis over the presence of such highly innovative companies in the list of FP7 beneficiaries from CORDA. The definition of this "elite" is not straightforward: different studies use different definitions (innovative SMEs, dynamic SMEs, Young Innovative Firms, gazelles, unicorns, etc.) and databases.[7] In our case, we chose a well-recognized list of "gazelles", the Deloitte Technology Fast 500,[8] which gathers the fastest-growing technology, media and telecommunications (TMT) companies. Cross-analysis with CORDA data identified 66 companies from Deloitte 500 among the FP7 beneficiaries on a full database of 1346 companies (composed by aggregating Deloitte 500 across 4 years, from 2011 to 2014, and removing duplicates). This means that 5% of high growth companies participated in FP7, a figure that is in line with the data from the literature. As such, it appears that FP7 confirms the difficulties in attracting highly innovative companies.

Table 8: Key statistics on gazelles in FP7

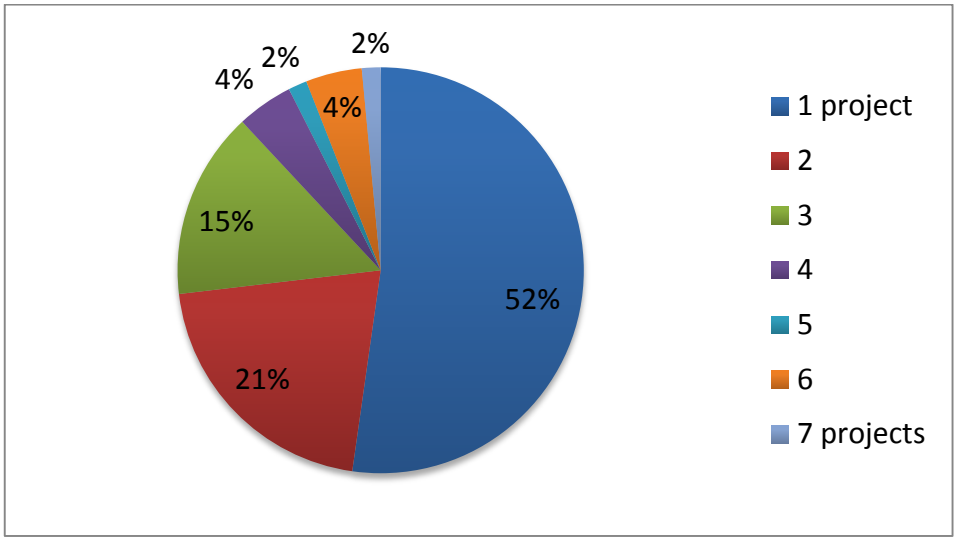
Total n. gazelles involved in FP7	67
% of gazelles involved in FP7 over total n. gazelles	5%
Gazelles participating in more than one project	32 out of 67 (48%)
Total amount received by gazelles	43M
% of total FP7 industry contribution going to gazelles	0,4%
Total n. projects participated by gazelles	135
Projects coordinated by gazelles	7 (out of 135)

The total amount received by gazelles is 43 M EUR for 135 projects. Each of this gazelle participates on average on 2 projects, and receives on average 323.357,00 EUR per project. About half of these gazelles participate in only one project. In very few cases they coordinate a project (only 7). In other words, participating gazelles tend to have a limited involvement in FP7.

[7] EUROSTAT defines gazelles as those high-growth enterprises (firms with average annualised growth greater than 20% per annum, over a three year period) that are up to five years old, they should also have at least 5 or 10 employees at the beginning of the three-year observation period. The growth can be calculated either by the number of employees or by turnover. Since we do not have microdata and the last data provided by Eurostat is old (2012), we compiled an aggregated list out of the last 4 editions of Deloitte Technology Fast 500TM EMEA report which ranks companies in the region that have experienced exceptionally fast growth. It calculates the percentage revenue growth during the last 4 years, based on fiscal year revenues. Percentage revenue growth is computed as [(FY'15 rev. – FY'12 rev.) / FY'12 rev.] x 100 (FY=Fiscal Year). All companies included in the Deloitte rankings meet the condition of annualised growth greater than 20% per annum, because the lowest growth that appears is 279% growth in 4 years.

[8] http://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/topics/technology-fast-500.html . A list of gazelles was obtained from Deloitte Technology Fast 500 rankings for EMEA in 2011, 2012, 2013 and 2014. This list of companies was matched with the ones in CORDA, in order to check which participated in FP7. Since the Deloitte reports did not provide the VAT number the matching was done by checking which had the same name. Concretely we matched, using Microsoft Access, those that started with the same first 10 characters (because the name of the company does not always appear in the exact format, for example sometimes it includes the acronyms ltd/plc and others does not). Afterwards we checked which companies had been selected and we deleted the duplicates and the ones that started with the same characters but were not the same company. Finally we cross-checked with the country of origin of the firm to ensure a more accurate matching process.

Figure 5: Distribution of gazelles by number of projects participated.



When we look at the concentration in the different themes, it appears that ICT and NMP play a leading role, attracting about half of the participation of gazelles. These data could be expected, especially as our definition of gazelles tends to be slightly biased towards technology and telecommunications. However, it is striking how gazelles have a sizeable participation also in Health, and Security, as well as Joint Technology Initiatives, which appear to have some positive impact in involving innovative SMEs as well. The high presence of gazelles in Marie-Curie Actions is a matter of particular importance and confirms the relevance of such actions for innovation and competiveness.

Table 9: Participation of gazelles by themes and instruments

Information and Communication Technologies	39
NMP	25
Marie-Curie Actions	14
Health	13
Joint Technology Initiatives	10
Security	10
Research for the benefit of SMEs	9
Food, Agriculture, and Biotechnology	8
Transport (including Aeronautics)	3
Energy	2
Environment (including Climate Change)	1
Space	1
Total	135

In summary, FP7 has not managed to substantially improve the attraction capacity of EU programmes for gazelles, which remains an exception rather than the rule. Themes such as ICT and NMP make up nearly half of gazelles participation.

2.2.2 Participation of innovative industries

When we consider the sector level, the results show that FP7 is attracting innovative industries at large, since they are overrepresented with respect to the overall economy.

To address the participation of innovative industries within the FP7, we have selected NACE codes as a first step. The CORDA database provides some information on the economic activities of the participants in line with the NACE (Statistical Classification of Economic Activities in the European Community) codes facilitated by the participants themselves. We used this data in order to divide the participants in four different groups following the correspondence established by Eurostat in the document Aggregations of manufacturing based on NACE Rev 1.1[9]:

- High-technology

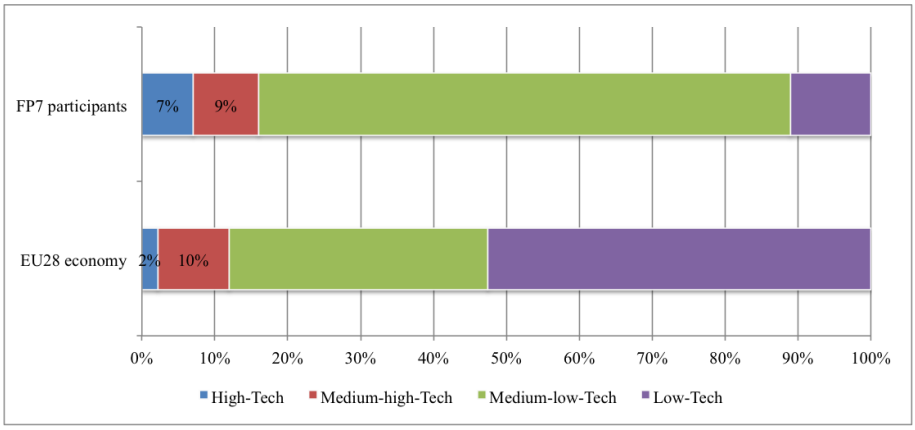
[9] NACE Rev 1.1 http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an2.pdf

- Medium-high-technology
- Medium-low-technology
- Low-technology

There are many caveats to take into account when assessing the quality of the resulting information. Firstly, not all participants provided such NACE codes: 29% of the PRC participants did not complete this information (26% in the case of SME). Secondly, as this variable is self-reported, participants may have erroneously identified their activity with a corresponding NACE code. Thirdly, the NACE classification underwent a deep revision in December 2006, right at the beginning of FP7. After conducting a random trial, we are confident that participants mostly used NACE Rev 1.1, but we cannot be completely sure that some participants erroneously use the new Rev 2 instead. Fourthly, the Eurostat equivalence itself is a very rough approximation, as many firms perform a wide array of economic activities that are difficult to synthesise in a single code, or perform activities that, while within a given code, can imply more or fewer degrees of innovation other than those stated or assumed by the Eurostat equivalence. Lastly, the NACE codes are not available for FP6 participants.

The analysis of the self-reported NACE codes shows that the High Tech sector concentrates 7% of the participants; Medium-High Tech concentrates 9% and Medium-Low Tech 73%. Only about 11% of the participants considered themselves as Low-Tech. SMEs follow similar patterns. If we compare these percentages with the overall structure of the EU28 economy in terms of number of companies, it appears that FP7 is attracting innovative industries[10] at large, since they are overrepresented compared to the overall economy (16% in FP7 vs 12% in the overall economy). The difference between EU28[11] and FP7 participants is larger in the case of Low and Medium-Low Tech sectors, than in the case of the most innovative sectors (Medium-high and High Tech).

Figure 6 PRC FP7 participants and EU28 NACE codes



In addition to the number of participants, we have analysed the EC contribution to type of participants. The results show that although the percentage of High Tech participants is not very high, the percentage of EC contribution received was substantial. In FP7 innovative companies attracted more than half of the total EC contribution (62%). Thus, while overall participation is quite similar to the EU economy, the actual intensity of participation show a much stronger orientation towards high-tech sectors.

Table 10: distribution of FP7 participants and budget between sectors

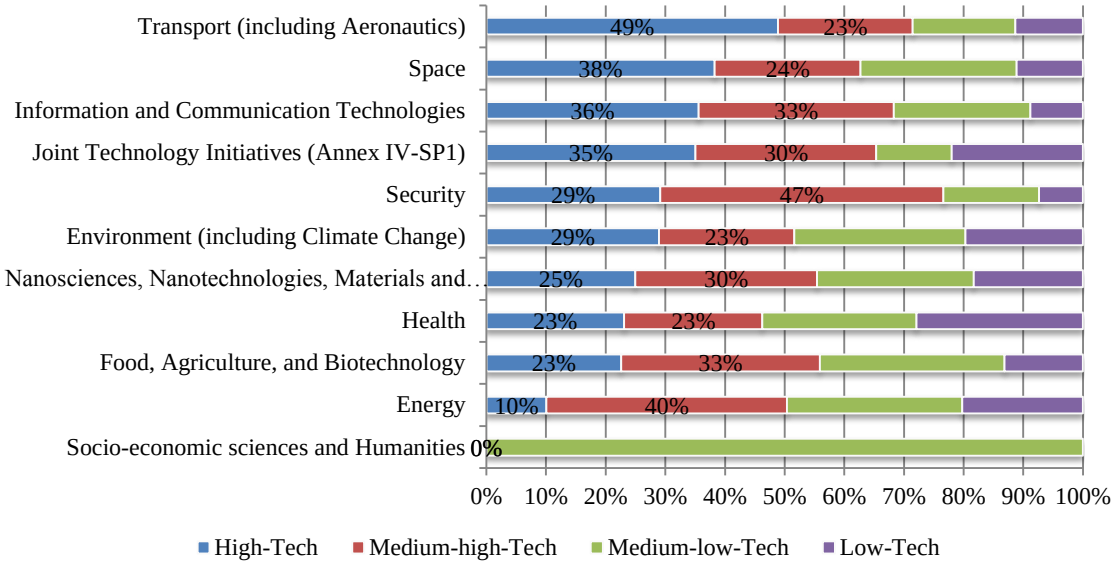
	FP7 participants	FP7 budget distribution
High-Tech	7%	30%
Medium-high-Tech	9%	32%
Medium-low-Tech	73%	23%
Low-Tech	11%	16%

The following figure shows the participants distribution by theme. The results reveal that Space (38%) and Transport (49%) are concentrating the largest percentages of High Tech participants.

[10] For the purpose of this study, 'innovative companies' are defined as High tech and medium-high tech companies.
[11] EUROSTAT code htec_eco_ent2

However, if we aggregate the High Tech and Medium-High Tech participants, Security (76%) concentrates the largest percentage of this of firms.

Figure 7 PRC participants NACE codes Themes



2.3 Motivations of participation

In this section, dedicated to question P1 (main drivers for participation), we analyse why companies decide to apply to FP programmes and what their self-declared motivations are, while in the following section we analyse other factors that affect (as positive drivers or negative barriers) industry participation beyond the original motivations.

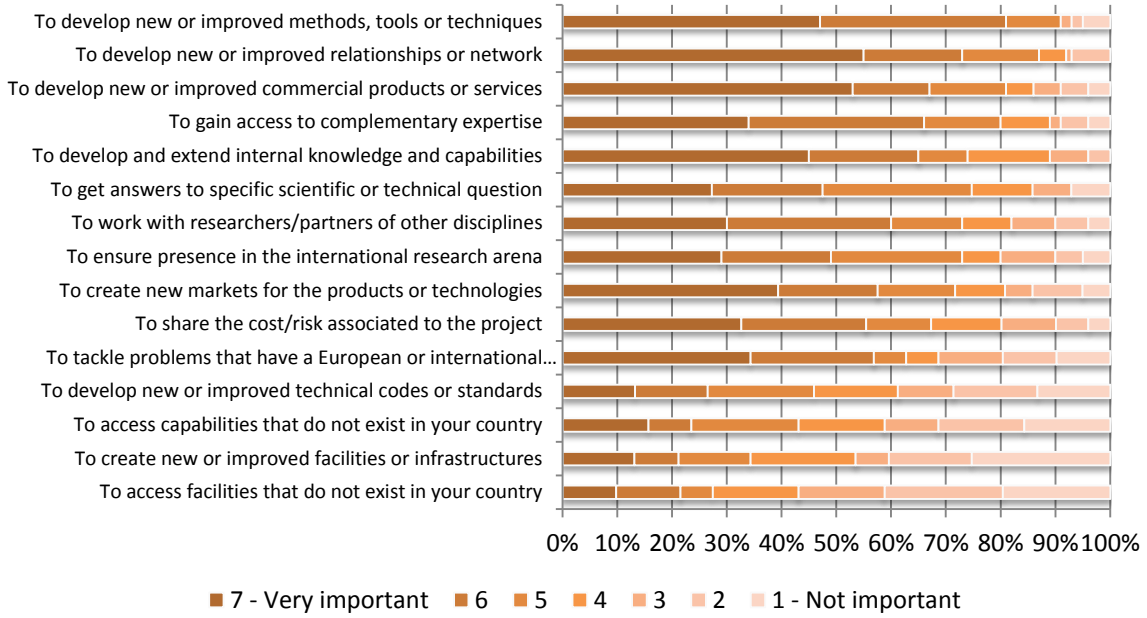
The literature identifies as set of objectives for business to apply for funding: the development of new capabilities, accessing complementary knowledge and skills, the pooling/obtaining of resources, as well as exploration of new ideas and expansion of networks.

In particular, studies dedicated to the evaluation of previous FPs found that the dominant motivations are the exploration of different technology opportunities, keeping abreast of the state of the art in technology, and accessing complementary resources and skills (Bach et al. 2014). Similarly, Veugelers (2010) finds that the main benefits from participation are exploration of new ideas, networks, and reputation, while Wing (2009) found that enhancement of R&D capabilities was the key driver for participation. On the other hand, Luukkonen (2002) holds that knowledge and commercial objectives are equally important to explain firms' participation. Moreover, SMEs appear more interested in short-term funding, and large firms in long-term network benefits.

International innovation literature confirms these assessments. In this regard, Sakakibara (1997) postulates that the single most important objective for businesses to look for funding is the sharing of complementary knowledge. This is supported by the findings of Shipp et al. (2006), who conclude that motivations for participation comprise the benefits from complementary R&D expertise, pooling of resources with other firms, and addressing technical problems common to industry.

Our interviews provide further confirmation that the main objectives for participation are to access complementary expertise, also in other disciplines, and to develop internal knowledge; to access networking activities with partners and potential markets; and finally, to reinforce the international presence and to address problems that are international in nature (Figure 8).

Figure 8 Motivations (n=84) ranked by % of respondent answering 5, 6 or 7



As regards complementary expertise, it was held that "the main driver was the possibility to work with partners with greater technological know-how in the field"[12]. One SME interviewee further pointed out that "it is an essential driver for the company to learn from other partners and seize the opportunities of collaboration and to develop a technique with commercial application"[13].

Networking is often mentioned as the main motivation, in terms of improved relationship with partners and potential clients and better integration in the ecosystem. In other words, EU funded projects allow to create trusted relationships that companies can build upon for further collaboration. For instance, one large company reported that it engaged in "collaboration with competitors and customers for the development of new systems. The company is using this collaboration for the preparation of future projects and consensus building".[14]

These networking opportunities are perceived as an innovative ecosystem: "The main drivers behind the decision to apply for most companies is networking to connect with the innovation ecosystem by creating a network of partners and engaging with it. The networking driver derives into 2 sub drivers: Building new business partnerships, where networking may result in the identification of new business partners; and Promotion, as networking is also an efficient mechanism for public affairs, serving as a channel for promotion and dissemination of the companies' capabilities and potentialities"[15]. "FPs are ideal […] they urge numerous partners to collaborate, whether they are universities, RTOs or private companies. The innovation improvement could be reached thanks to national funds, but the networking aspect of European funds is quite unique and is our main driver"[16].

In terms of the geographical scope of the companies and presence in the international research area addressing European problems from an international perspective, respondents reported predominantly positive results with regard to FP participation. One respondent held that "participation in European projects opens a great opportunity for a joint interdisciplinary co-operation with foreign research and SME units, allowing the obtaining of technical and scientific high value results, which is impossible to obtain without this cooperation. The European consortia allow us to integrate in performing research networks and to continue the cooperation in new projects"[17]

One of the large companies involved in FP7 is ENEL Green Power (GP). At the launch of a new project with FP funds, ENEL GP usually faces problems that are typical of large enterprises. The strategic priority and size of the project has to be large enough in order to have some impact on

12 Quote from SME, Medium-tech firm, Research for the benefit of SMEs, EU13, Bottom Performer

13 Quote from SME, High-tech firm, research infrastructures, EU 15, Bottom Player

14 Quote from a large company, High-tech firm, Information and Communication Technologies, EU13, Top Performer

15 Quote from SME, Medium-tech firm, Transport. EU 15, Top Performer

16 Quote from a Large company, Medium-tech firm, Information and Communication Technologies, EU15, Bottom Performer

17 Quote from SME, High-tech firm, Nanosciences, Nanotechnologies, Materials and new Production Technologies, EU13, Bottom Performer

the attention of the management, and to direct the priorities of a big organisation. On the contrary, if the project is small, it has no impact, since a large enterprise such as ENEL GP has already its own internal resources.

Box 1: Enel Green Power

Quick Facts About the Company

Country	Italy	Macro-sector	Medium-tech company
Trajectory	Operating since 2008	Sector	Energy
Class-size	Large (3,609 employees)	Last R&D budget	EUR 16 million in 2013

Summary of Enel Green Power Participation Patterns, Performance of Innovation and Job Creation

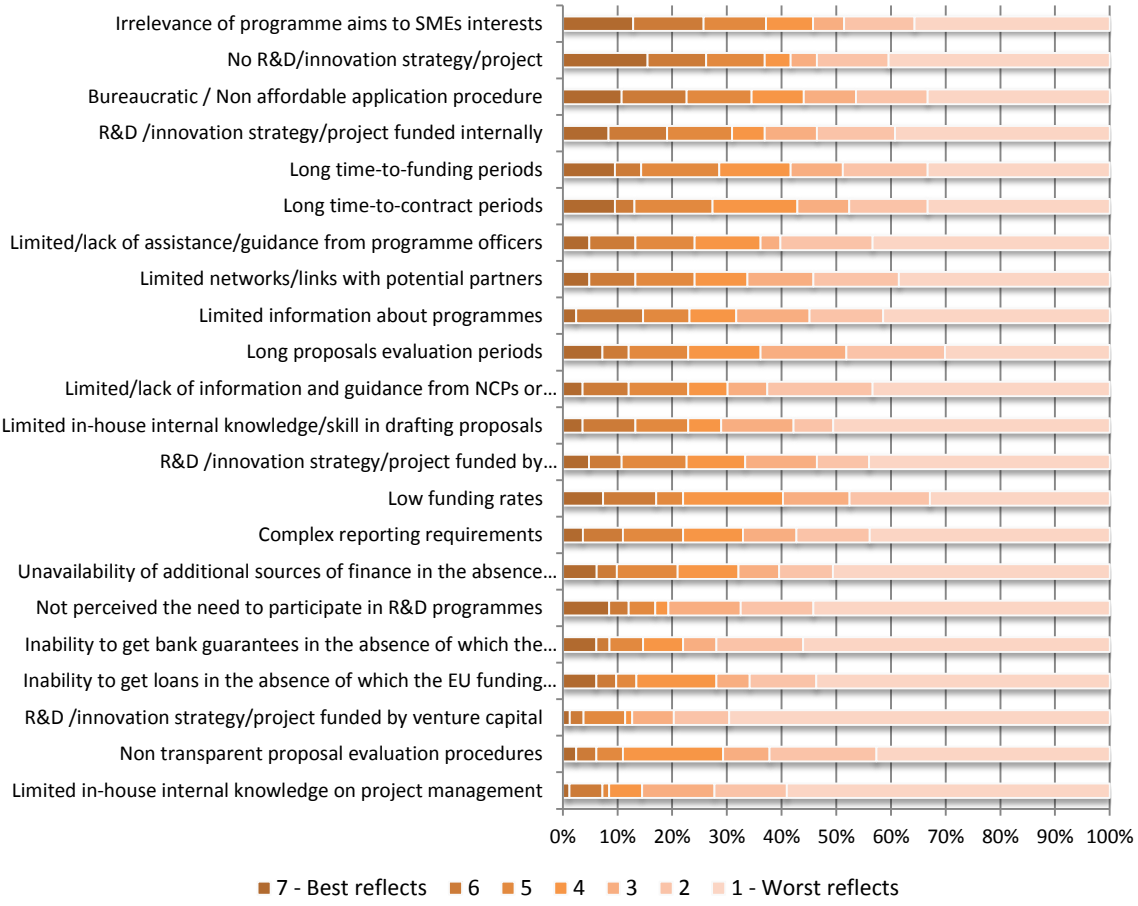
PARTICIPATION PATTERNS	Participated in…	▶ 1 FP7 project ▶ National funding schemes	Role(s) undertaken in FP projects	Coordinator	Participant	End-user
	Key drivers	▶ The main driver for participating in the ARCHETYPE SW550 project was, according to the firm strategic objective, to contribute to the development of new renewable technologies. ▶ A second reason was to develop new or improved relationships or networks.				
	Main barriers	▶ Given the strong effort required to prepare the proposal, the success rate plays a great role in determining the firm motivation to participate. ▶ Main barriers have been: the lack of clearness as concerns the contents of the call and a misalignment between the objectives of the call and the firm needs.				
	Other aspects influencing participation	▶ The evaluation process was assessed as not enough transparent and fair. ▶ Calls have become more competitive moving from FP6 and FP7.				
INNOVATION	Performance of innovation	▶ Enel GP extensively performs innovation. The firm participates in the technological evolution of the energy sector through its R&D programme, focused on the industrial production of innovations concerning all the renewable sources in which the company operates.				
	Innovation impacts	▶ The project is still ongoing, but the main research results achieved so far have been 2 publications, around 4-5 prototypes/demonstrators/pilots, between 15 and 16 new methods/techniques/processes now fully operational.				
	Technology Readiness Levels	▶ The innovation process supported by Enel GP participation in the project was mapped from TRL 1 (Idea. Unproven concept, no testing has been performed) to TRL 8 (Demonstration system operating in operational environment at pre-commercial scale).				
	End-users' involvement	▶ Enel GP is participating in the ARCHETYPE SW550 project as coordinator and industrial end-user.				
JOB CREATION	During projects	▶ The funding received has not yet been used to create new jobs within the company, but it is a possibility as far as the full implementation of the project results will require new expertise and open new job opportunities.				
	3 years after projects' completion	▶ Not applicable as the sole project concerned is still ongoing.				

2.4 Barriers and drivers of participation

Moving from explicit motivations to actual factors that play a role in the decision to apply, the picture becomes more complex. In the literature, the main barriers and drivers are identified as administrative burden and complexity of the processes, constraints derived from resources, information lacks, difficulties related to finding partners and a lack of network, as well as the long processes related to receiving public funds.

In the interviews carried out by the present study, respondents indicated that overall, most of the barriers to participation are related to the absence of need and lack of relevance of the programme, while administrative burden is referred to in bureaucratic and long processes. However, it is worth mentioning that event the most quoted barrier (irrelevance of programme to SMEs interests), is only mentioned by 37% of respondents as highly relevant (more than 4 out of 7).

Figure 9: Barriers to participate in the FP (n=92) ranked by % of high importance (above 4 out of 7)



In this section we compare and prioritize these different factors alongside:

- Demand-side factors (related to the situation of the applicant);
- Supply-side factors common across the programme, such as administrative burden and transparency;
- Supply side factors that can vary between themes, such as success rates.

2.4.1 Demand side factors

Some factors that explain the level of participation of industry relate to the specific characteristics of the applicants. There is large consensus in the literature that previous participation in FP is a key factor explaining participation, as the learning curve to understand the mechanisms is considered steep (Barajas et al. 2012; Barajas & Huergo 2010; Aschhoff 2009; Antonelli & Crespi 2013; Blasco et al. 2014; Segarra Blasco & Gombau 2013; Barak et al. 2010). Networking capacity (and lack

thereof) is frequently mentioned in the literature as a barrier to participation (Gilmore et al. 2013; Lattimore 2002; Malerba et al. 2010).

Lack of awareness, information and support is also identified as a major factor in the literature, and that low awareness drives overly negative perceptions over the administrative burden. Barak et al. (2010) show that ICT-SMEs in general do not possess adequate awareness of FP7, nor on its specificities. However, awareness is regarded a key prerequisite to project participation and when examining the differences between companies with different FP7 experiences, it was seen that the less experience a company had, the less likely it would know of calls for proposals, preceding documents, available support for proposal preparation and support to networking. Non-experienced SMEs found themselves in a detrimental position in terms of information and awareness. The study suggests further that the language used in FP7 documents differs significantly from jargon commonly used by SMEs in the ICT sector, and information structures were predominantly considered to be overly complicated. The results of the study suggest that in addition to the abundant lack of awareness of FP7 and complex information, there was also negative or poor perception of the framework programme as such, which was found to be an opinion shared by companies with or without experience in FP7. Our interviews confirm the problems related to lack of awareness, information and support, although they are mentioned by a minority of respondents and are visible around the mid-rank of Figure 9.

Veugelers (2010) indicates that the risk of excessive knowledge sharing acts as a barrier to participation in programmes. These risks of Intellectual property shared with too many partners appeared frequently in the interviews: several respondents admitted their reluctance to focus on the market phase because "*too many partners must be involved. This implies too great an accessibility of demonstration projects, and we don't want to be sharing our innovation*." For this reason, they suggested smaller consortia.

Finally, geography matters. In our interviews analysis, we aim to detect differences in the responses of companies located in so-called old (EU15) and new member states (EU13). Companies located in the EU13 are more likely to report administrative barriers than large companies and companies located in the EU15. The second dimension was related to the financial issues and funding rates. In this regard, we could not observe any differences based on the size of the company, but there are differences related to the geographical location. Once more, companies located in the EU13 reported difficulties related to acquiring additional sources of financing, difficulties to handling the funding rates or inability to get loans. The third dimension emerging from the responses points out the lack of support in terms of guidance. This barrier is not related to the size of the company, but to the geographical location. EU13 companies tend to report limited support and guidance from programme officers and NCPs or other ad hoc bodies, including limited information about programmes more often than EU15 companies. Interviewees from EU13 also mentioned limited networks/links with potential partners. Lastly, the fourth dimension covers other funding sources as an alternative to FP funds. In this regard, the analysis of the responses did not reveal a significant difference in terms of size or in terms of geographical location.

2.4.2 Administrative burden and transparency

Administrative burden, and its reduction, has emerged over the years as a major issue in the reform policy agenda[18]. In the context of research funding programmes, administrative burden and complexity of the processes are the barriers to participation most commonly mentioned across the studies analysed, although they are in particular referred to by SMEs. Most of the sources referred to EU FP programmes, but similar findings are reported by Lattimore (2002) regarding Australia. The conclusions of the Interim Evaluation of FP7 state that "industry is deterred to a greater degree than other research performers by the weight of bureaucratic burden" (Rolf Annerberg 2010). It is therefore not a surprise that simplification of procedures is very often the first recommendation throughout FP evaluation reports, to an extent that the Interim evaluation calls for a "quantum leap" in simplification.

Interviews confirm that bureaucratic application procedures are a barrier for participation, although with a minor emphasis than previous studies. It is mentioned as important (assessed more than 4 out of 7) by 35% of interviewees, less than content-related issues, such as relevance of the aims and lack of innovation strategy. 27 and 29% mention long time to contract or time to funding (see Figure 9). As most of the administrative burden lies on the coordinating partner, this role is often left to universities (Rolf Annerberg 2010) or large companies, hence limiting the role of business

[18] Study on administrative burden reduction associated with the implementation of certain Rural Development measures, CAP GEMINI, Deloitte and Ramboll, 20 July 2011; International Study: Efforts to Reduce Administrative Burdens and Improve Business Regulation, the Danish Commerce and Companies Agency, Ministry of Business and Economic Affairs , August 2003; other examples can be found at the homepage of Secretariat-General of the European Commission: http://ec.europa.eu/dgs/secretariat_general/admin_burden/meas_data/meas_data_en.htm

and in particular, SMEs in shaping the research effort. As one SME representative put it: "*Most of the administrative work is done by the coordinators. When you are preparing a project, the coordinator has to engage in a lot of work, but not so much for all the participants […]. Heavy work is required in order to prepare the proposal and manage the project. The coordinator has 10 times more work than other partners, but not enough money is dedicated to coordinators*".[19]

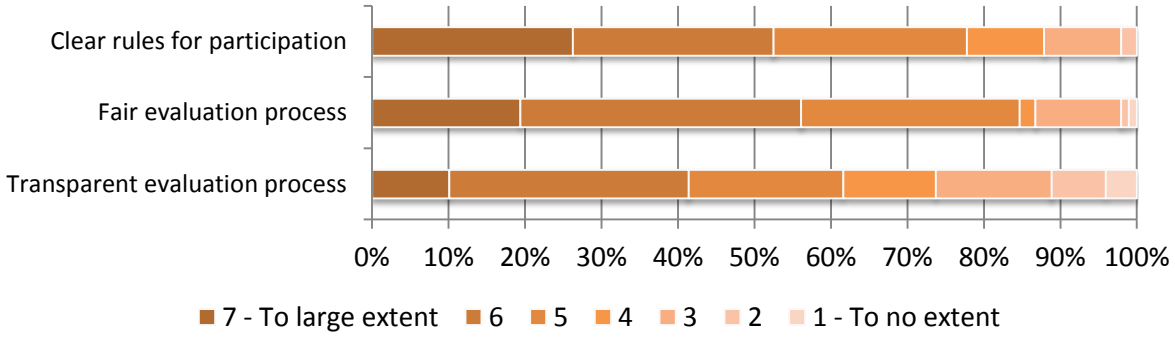
This lack of flexibility is mentioned by several interviewees: in the (French) words of an interviewee: "*Un partenaire par exemple peut faire faillite et c'est un cauchemar. Ils ont rencontré cette difficulté et cela a pris un délai de 4-6 mois pour avoir cet accord de la Commission européenne alors que c'était transparent et clair*." Or as another respondent said: "*Not anything can be planned for, as far as R&D is concerned. Format seems to matter more than core topics*." Or "*Participants are stuck with the original plan even if objectively they could have good reasons to change it. From this perspective, EU funding should be more flexible*."

Box 2: Examples of lack of flexibility

One large Italian firm, for instance, underlines that due to the long timeframe of the project, the technology developed indeed lost competitiveness with respect to other technologies while the project was still ongoing. For this reason, the research group complains about a lack of flexibility of the project terms, which should be adjustable to the project development. A large Czech firm instead thinks that more flexibility should be allowed in terms of project budget, since "sometimes it is difficult to forecast and budget all nuances prior to start research". Finally, a British SME complains of a lack of flexibility in terms of project timing. During the implementation, the project director asked the Commission to extend the project deadline, but the requested was denied. At the end, the project was cancelled due to a lack of results, but the SME has then independently solved the R&D problem that brought the project to failure. However, the company felt that this work could have been done during the project, if the EC would have had allowed the deadline extension.

When it comes to transparency of the process, FP evaluation reports typically provide a positive assessment, and our findings confirm this. Most of the individuals interviewed considered that there are clear rules for participation and that the evaluation process is fair and transparent.

Figure 10 Assessment of the participation process (n=91)



Large companies and SME perceive the existence of clear rules for participation independently from the sector, the geographical area or whether they are bottom or top performers. As one of the interviewee stated, "*publically available information is very explicit and clear (e.g. through CORDA)*"[20]. However, this clarity does not preclude the administrative burden that participants have to face when preparing the proposal: "*rules for participation were very clear, but implied too much administrative work related to the financial information required*"[21]. Especially, with less experience in the FP: "*the rules were very clear but the difficulty for an end-user partner was to overcome the high load of administrative requirements, especially the first time participating in an FP call*"[22]. In this regard, some interviewees claimed that the rules may become clearer with more experience with the FP: "*we deem the rules for participation clear […], although this might be biased because we are used to taking part in calls. We have a good knowledge of the rules and the process in general*"[23].

[19] Quote from SME, High-tech firm, Research for the benefit of SMEs, EU13, Top performer
[20] Quote from SME, Medium Tech Firm, Research for the benefit of SMEs, EU15, Top performer.
[21] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Bottom performer.
[22] Quote from Large company, Low-tech firm, Security, EU15, Bottom performer
[23] Quote from Large company, High-tech firm, Marie-Curie Actions, EU15, Top performer.

The evaluation process is perceived by most of the interviewees as fair. Responses did not reveal any contrasting situation. Participants interviewed have a predominantly positive perception of transparency of the evaluation process, which is slightly lower if compared with the clarity of the participating rules and the fairness of the process. Large companies tend to assess this characteristic less positive than SMEs. Representatives of the large companies claimed that "*the feedback the company received was sometimes contradicting and misleading*"[24], as well as "*opaque*"[25]. In this regard, one of the interviewees mentioned the possibility of a "*ranking of the proposal among others for each of the evaluation criteria. This could be useful for the firms to draft better strategies when they apply. It would also increase transparency of the process*"[26], while another one emphasised that "*companies do not get to see the progress of the evaluation process, as there is no publically available information about the internal process, only about the final results*"[27]. This idea of opening the evaluation process was also spotted by another interviewee who "*did not perceive any transparency in the evaluation processes because I just had access to the final results, no other information was available during the processes*"[28].

2.4.3 Reasons for concentration under certain themes

Industry participation varies greatly among different themes. While obviously a ICT company is unlikely to apply to a call on biotechnology, the overall propensity to apply of companies in the relevant sector can be influenced by theme-specific factors.

Table 11: variation in participation rates by theme.

FP7 Theme	FP7 %
Transport (including Aeronautics)	49%
Energy	47%
Security	45%
Nanosciences, Nanotechnologies, Materials and new Production Technologies	37%
Information and Communication Technologies	33%
Space	28%
Health	21%
Food, Agriculture, and Biotechnology	19%
Environment (including Climate Change)	16%
Socio-economic sciences and Humanities	4%

In this section we explore the possible reasons for greater industry participation under certain themes. Based on the literature, we identify two sets of reasons: more process- or more objective oriented. Process-oriented reasons refer to the costs of participation, the success rates, the level competition and therefore possibility of success, the project size and the time to grant. All these factors are recognized in the literature as possible reasons influencing the decision to participate. The last reason is objective-oriented, and refers to the alignment between the workprogramme design and the research strategy of the companies.

To analyse these hypotheses, we rely on the analysis of CORDA data in order to explore possible correlation between levels of industry participation and theme-specific factors. Needless to say, with this kind of analysis we will explore possible correlation, but not establish robust causal links. However, the triangulation of the insight with the interviews and the literature will strengthen the robustness of the findings.

Cost of application and success rates

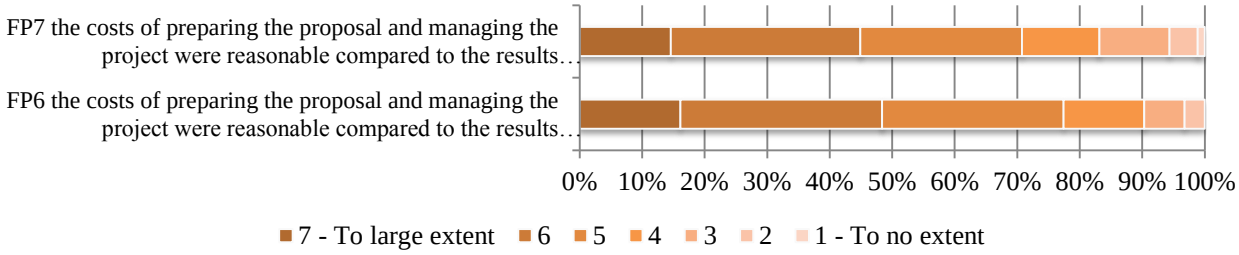
The decision to participate for industry is ultimately a business decision based on (certain) costs and (uncertain) benefits. The high cost of application is frequently mentioned in the literature as a barrier to participation, especially for SMEs: in fact, it is mentioned almost as frequently as administrative burden (Bannò & Sgobbi 2010; Barajas et al. 2012; Faber et al. 2012). Costs of applications should be considered based on the possibility of success, and this is indeed how companies decide about their participation according to (Faber et al. 2012). In particular, it has

[24] Quote from Large company, High-tech firm, Information and Communication Technologies, EU15, Top players.
[25] Quote from Large company, High-tech firm, EU15, Top players
[26] Quote from Large company, Medium-tech firm, Information and Communication Technologies, EU15, Bottom performer
[27] Quote from Large company, High-tech firm, Information and Communication Technologies, EU13, Top performer
[28] Quote from Large company, High-tech firm, Joint Technology Initiatives (Annex IV-SP1), EU15, Top performer

been estimated that for FP7 ICT "a little over 3,000 proposals were rejected at a cost to the proposers of around €175 million (equivalent to about 14% of the ICT Programme's almost €1.3 bn annual spend)". This is even more worrying since only one third of "above threshold" proposals were funded (European Commission 2010a). Paradoxically, any effort on simplification, which would lower the cost of applying, is likely to increase participation and as a consequence would lower success rates, thereby neutralising the benefits of simplification. As the (European Commission 2010a) puts it, "the preparation of proposals remained a very costly process – not least because changes in the application processes were to a large extent outweighed by the decreasing probability of having a project accepted".

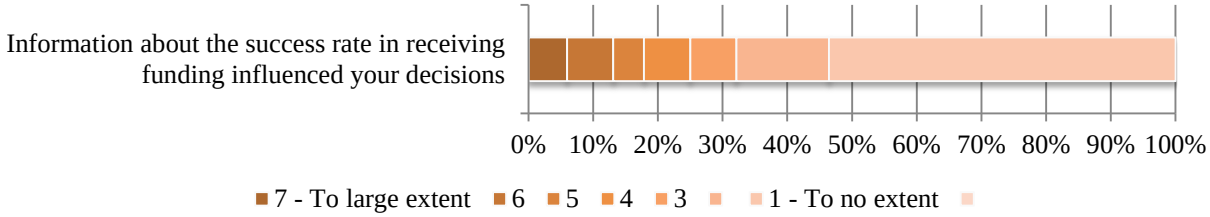
However, the results of the interviews provide a somewhat different picture. Interviewees considered the costs of preparing the proposal and managing the project reasonable compared to the results obtained/expected. Large companies, due to the type of work they performed during the project often assuming the role of coordinators, tended to consider these costs as slightly higher compared to the SMEs, with a more limited role in most of the proposals/project. This perception is not related to the geographical location of the interviewees.

Figure 11 FPs Cost-Benefit (n=89)



In contray to the findings of the literature, success rates are not considered a major factor by interviewees. About 75% of respondents declared that they have little or no influence on their decision to participate.

Figure 12: Success rate influence (n=94)



The following quote from a large company respondent provides further insight:

"*The proposal preparation is a time consuming and costly activity with a low success rate of around 15% for the telecommunications sector. Companies must assume a high upfront investment, so financially it is not a good business to participate, but there are strategic benefits. The calls should be more specific and focused to reduce the number of submissions*"[29].

One explanation for the contrasting views derived from the literature and the CORDA data on one side, and the more positive interviews, is that the latter were carried out only on those who received funding, and who obviously tend to have a more favourable perception of the cost/benefit ratio of participating.

The analysis of CORDA data confirms the moderate importance of success rate as a factor explaining the differences between themes. Based on previous evaluation (European Commission 2010a; Rolf Annerberg 2010), we would expect that businesses are keener to participate in themes with higher success rates. In fact, data show that success rate appears to have a weak positive relationship for the industry, but especially for SMEs (R2=0.210 and R2=0.387, respectively).

[29] Quote from Large company, High-tech firm, Information and Communication Technologies, EU13, Top performer

Figure 13: Success rate (y) vs. EC contribution in FP7 (x) (whole industry)

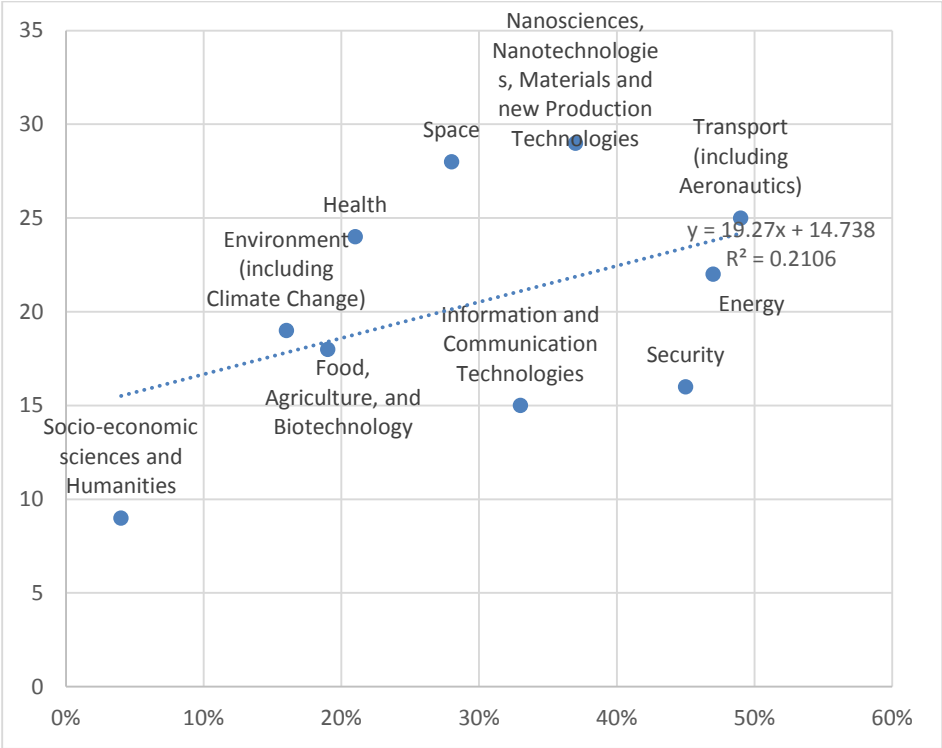
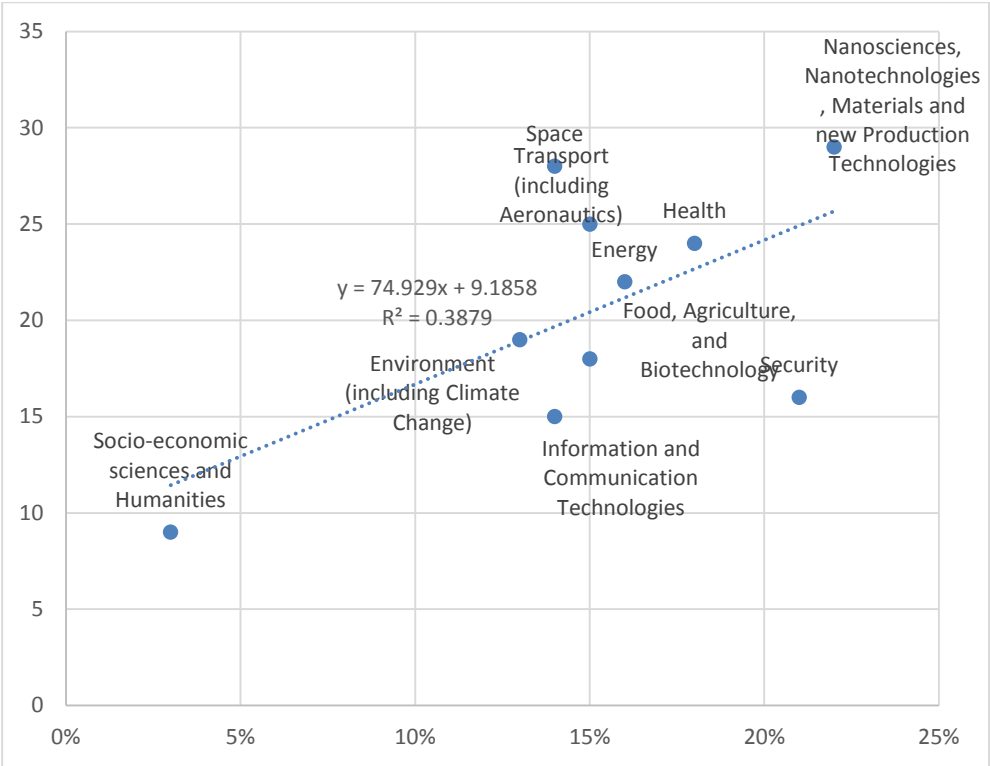


Figure 14: Success rate (y) vs. EC contribution in FP7 (x) (SMEs)



However, this analysis only shows that success rates appear not to be the most important factor when considering the differences among existing levels (in all cases except one, above 10%). It could happen that a further decline in success rates, as the one emerging from the first results of Horizon 2020 (European Commission 2014), have a rate below a minimum threshold as a consequence and thereby strongly discourage industry participation.

Level of concentration and competition

If uncertainty is a factor in the decision to participate, as the literature states, then we could expect higher participation in themes with relatively few participants (the so-called usual suspects). Data show that there is no suchlike "usual suspects" effect: instead, there is more competition in the themes with high industry participation than in those with lower levels of participation, possibly due to the fact that there are less universities then companies. Hence, themes with more academic participation are more concentrated, as the effect appears to be quite strong (R2=0.419). For SMEs, the effect also applies, with a stronger correlation, and even higher explaining power (R2=0.541).

Figure 15: Concentration of participants (y) vs. EC contribution in FP7 (x) (whole industry)

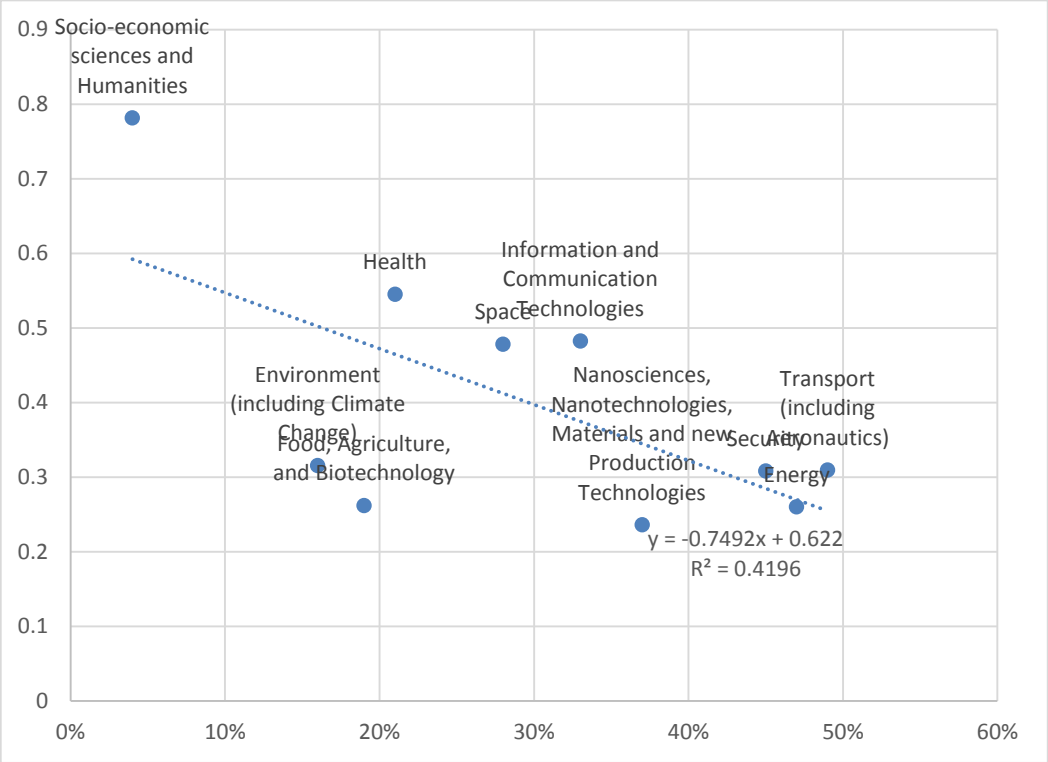
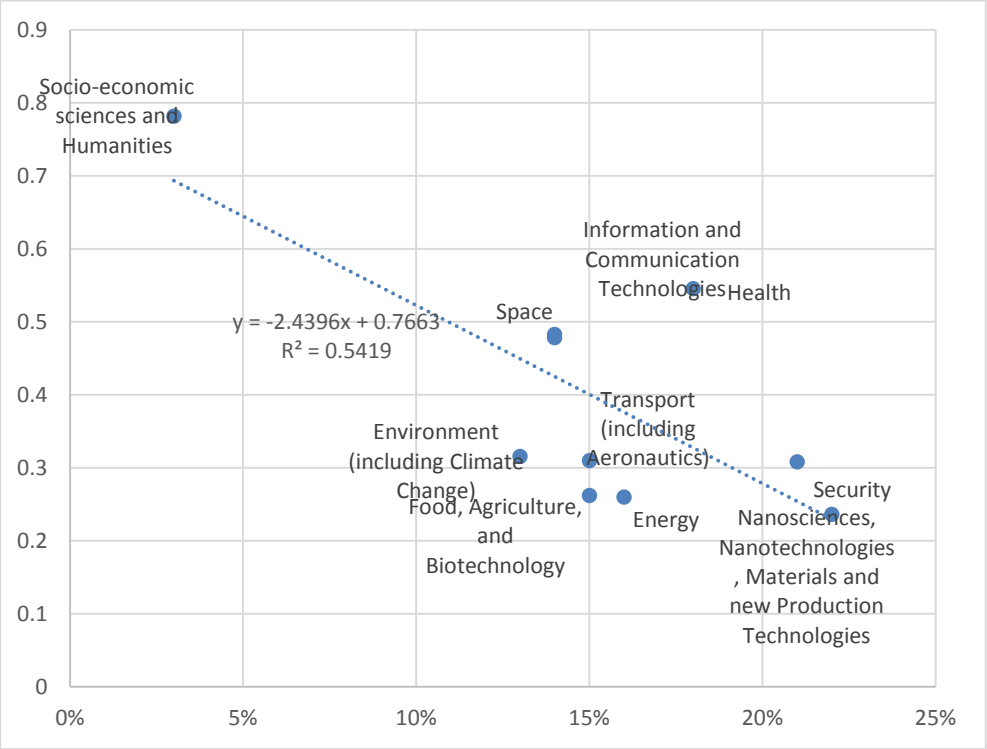


Figure 16: Concentration of participants (y) vs. EC contribution in FP7 (x) (SMEs)



Funding rates

Funding rates are deemed to be an important factor in encouraging industry participation, and in particular, low funding rates seem to discourage SMEs (Gilmore et al. 2013). From FP6 to FP7, the EU's funding share for SMEs has increased from 50% to 75% in RTD activities, and for Industry from 35% to 50% in Demonstration activities[30]. Here we assess whether this change was reflected in greater participation by industry in general, and by SME in particular. Overall, participation grew for both industry and SMEs in FP7, although proportionally slightly more for SMEs.

Table 12: Comparison of the variation from FP6 to FP7 of EC contribution and contracts

	% Contracts FP6	% contracts FP7	% contribution FP6	% contribution FP7
PRC	19%	30%	17%	25%
SMEs	9%	17%	6%	13%

The first consideration is that if funding rates played an important role, then the growth of participation would be similar across all themes, since the changes were similar. Data does not support this hypothesis. There is great variation in participation growth between themes. New funding provisions in FP7 are particularly favourable for SMEs. Hence, if funding rates are important, the growth of SMEs would be greater than the growth of industry in general. The previous table shows that SMEs participation increased proportionally more than industry participation. However, the growth is very different from theme to theme, as depicted in the table below.

Table 13: Comparison of the variation from FP6 to FP7 of EC contribution according to themes between all industry and SMEs

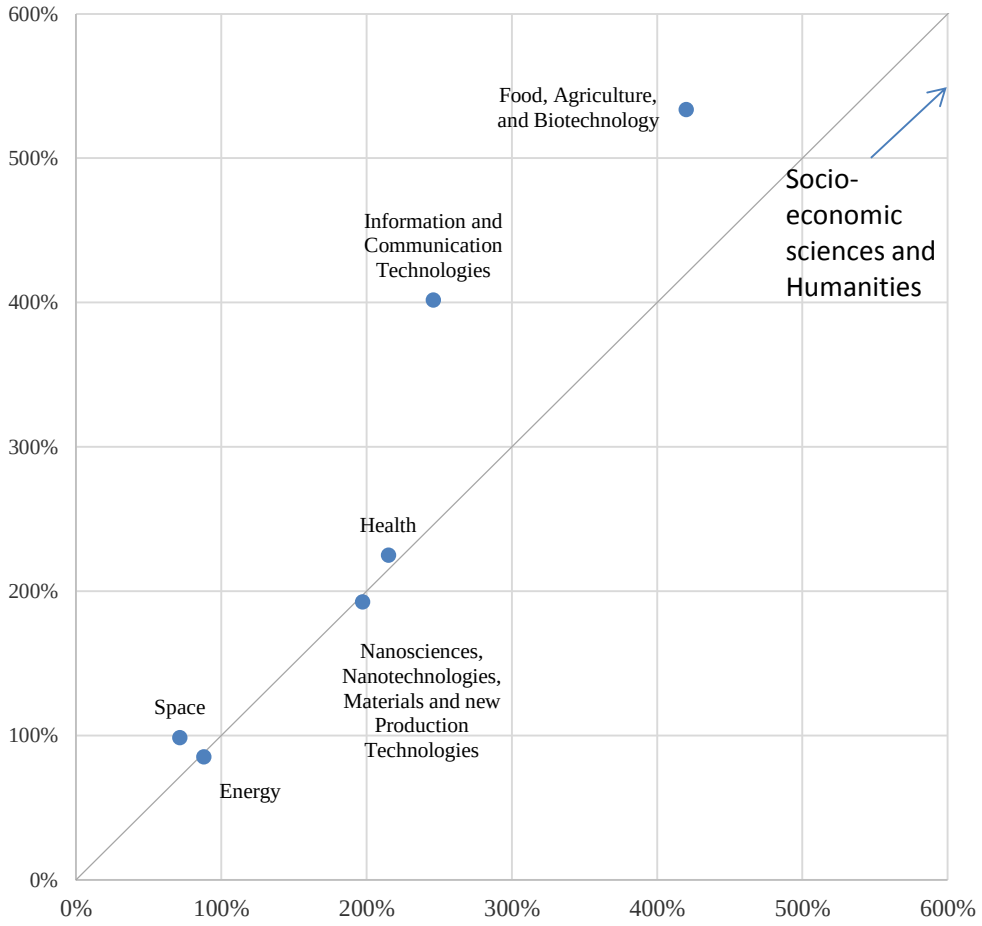
Theme	All industry	SMEs
Information and Communication Technologies	246%	402%
Nanosciences, Nanotechnologies, Materials and new Production Technologies	197%	193%
Food, Agriculture, and Biotechnology	420%	534%
Health	215%	225%

[30] Research and technological development activities (RTD) form the core of the project with a major contribution from the RTD performers. Demonstration activities are designed to prove the viability of new technologies.

Space	71%	99%
Transport (including Aeronautics)	No equivalence	
Energy	88%	85%
Environment (including Climate Change)	No equivalence	
Socio-economic sciences and Humanities	1833%	2600%
Security	No equivalence	

Evidence suggests that variations in growth were different depending on the theme at stake. On the one hand, in the themes (1) Food, Agriculture, and Biotechnology, (2) ICTs and (3) Socio-economic sciences and Humanities, SMEs grew more than the whole sector, which implies that these two themes experienced an important increase in the relative participation of SMEs compared to bigger firms. On the other hand, the themes (4) Health, (5) Energy, (6) Space and (7) NMP exhibited only minor differences, thus implying that the change in the participation rate of SMEs was not very different from the entire sector in general. Hence, the change in funding rates probably did not play a determining role since, despite similar changes in funding rates, variation in participations are very different among themes.

Figure 17: Comparison of the variation from FP6 to FP7 of EC contribution according to themes between all PRC (x) and SMEs (y)



The results of the interviews confirm these findings. Low funding rates was one of the least mentioned barriers to participation, with only 22% of respondents attributing high relevance (more than 4 out of 7).

Only 22% of respondents identify low funding rates an important barrier to participation. However, some interviewees elaborated on this point and suggested taking into account the relative costs and benefits as compared to other programmes: "*FP funding rates are considered as too low compared to other programs, and do not act as a compensation for a more costly and risky program*"[31].

Project size

There are few studies that analyse the role of project size. Large projects seem to be less attractive for SMEs, especially innovative ones, because they have shorter innovation cycles (Barak et al. 2010) and more concerns over IP sharing with a larger number of partners (as reported in section 2.4.1).

The results of our analysis reveal that industries tend to participate more in themes with larger average size, regardless of their own size. As such, it does not seem that SMEs are discouraged by the large project size, possibly because they seldom hold a coordinating role in the proposal.

[31] Interview with Large Company from EU15, top player.

Figure 18 Average EC contribution size (y) vs. share in EC contribution cost in FP7 (x) (whole industry)

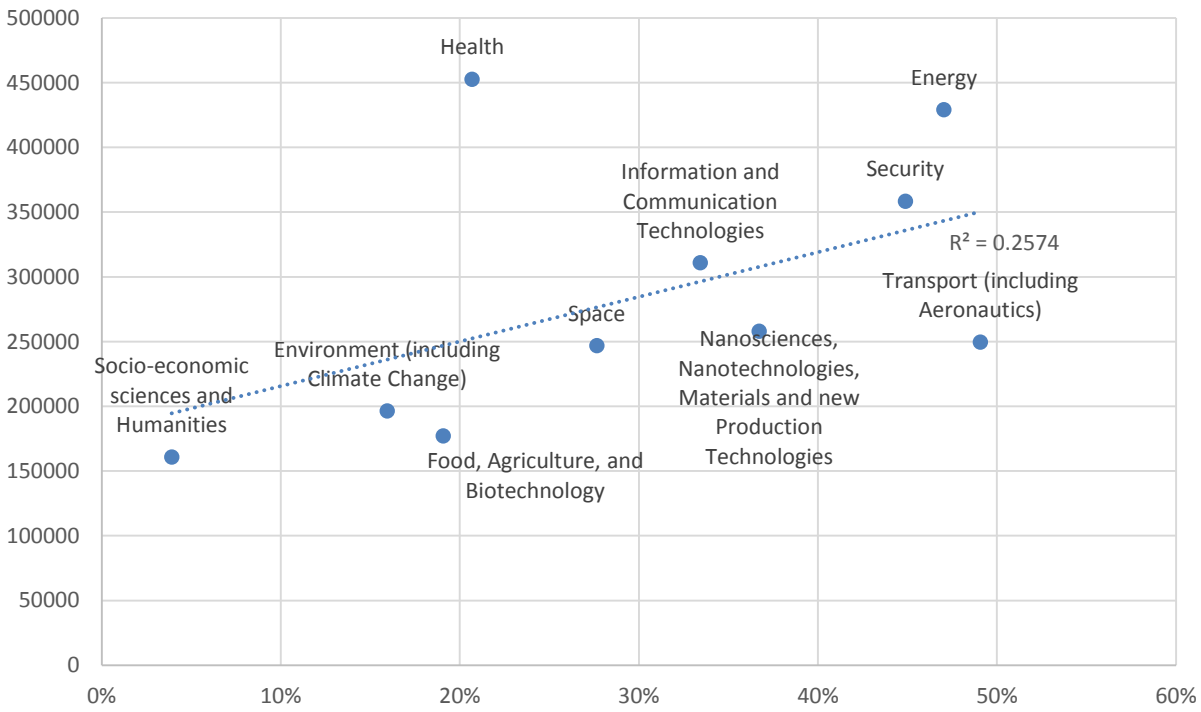
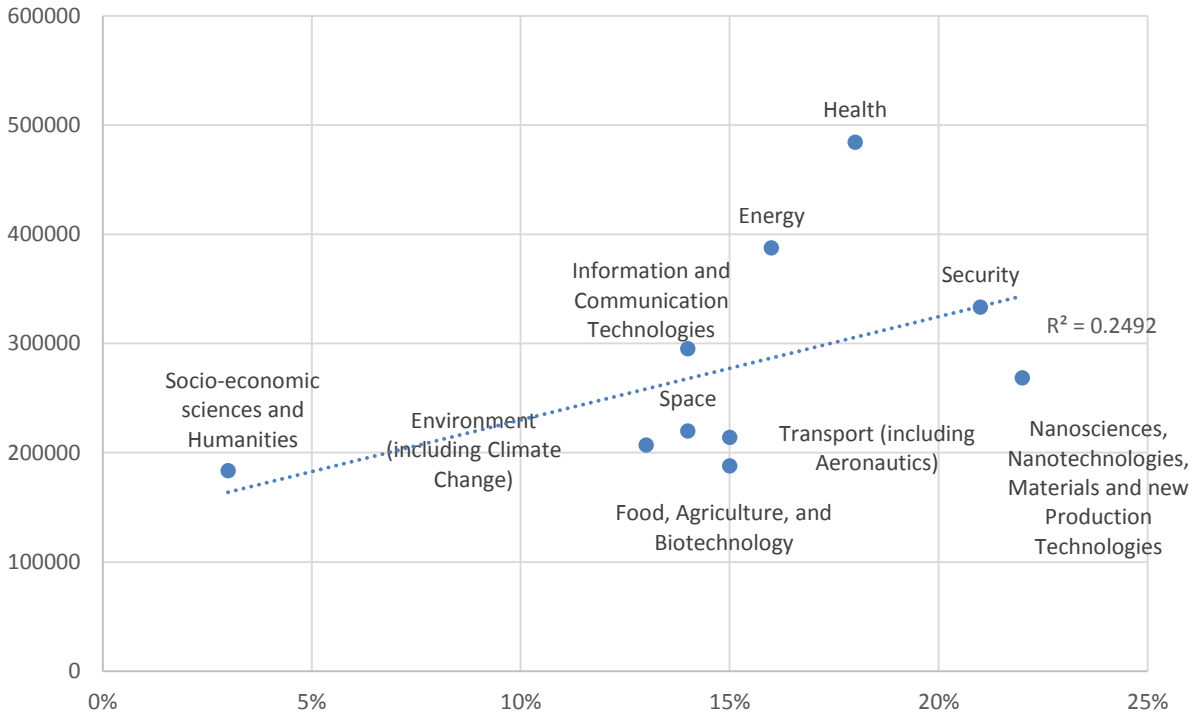


Figure 19 Average EC contribution size (y) vs. share in EC contribution cost in FP7 (x) (SMEs)

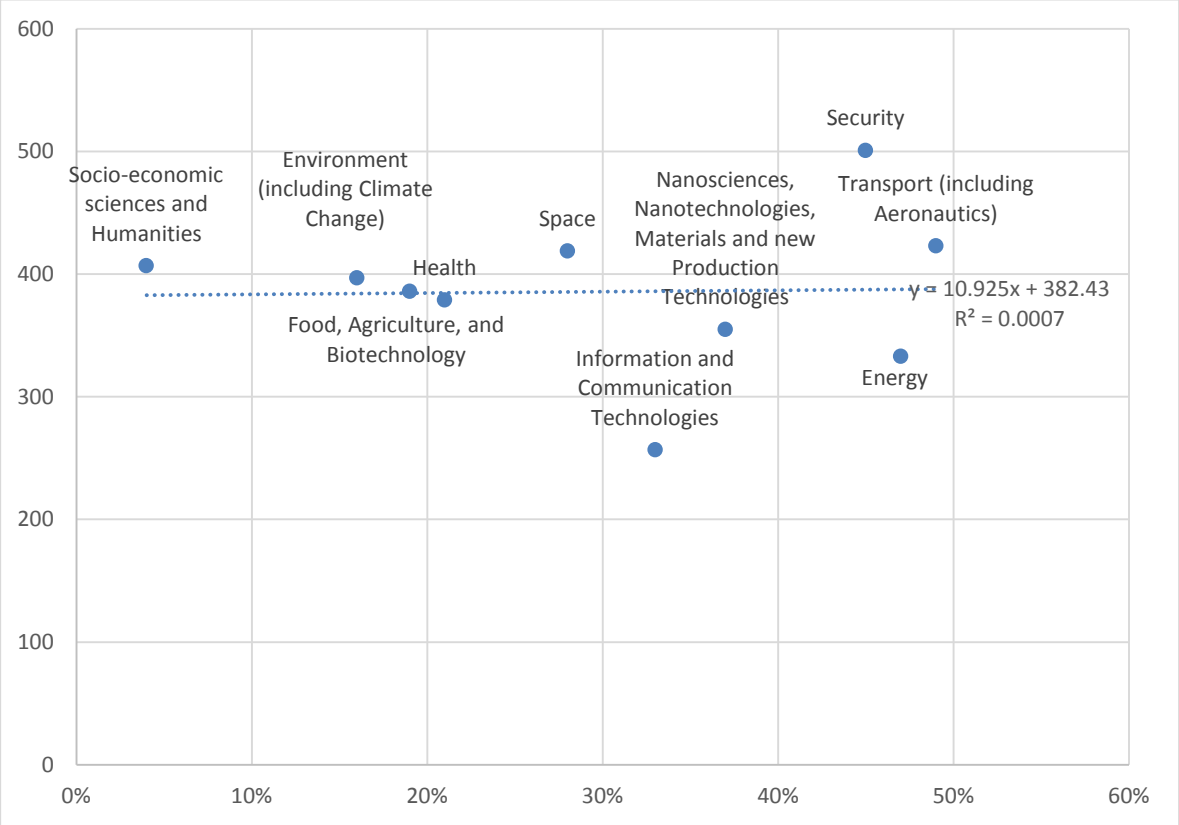


Time to grant

Long delays between the deadline of the call and the actual start of the project are frequently mentioned in the literature as a barrier to participation for industry, and in particular, for SMEs (Gilmore et al., 2013; Barak et al., 2010; European Commission, 2010c), although Faber et al. (2012) finds that the duration of the application procedure has no statistically significant effect.

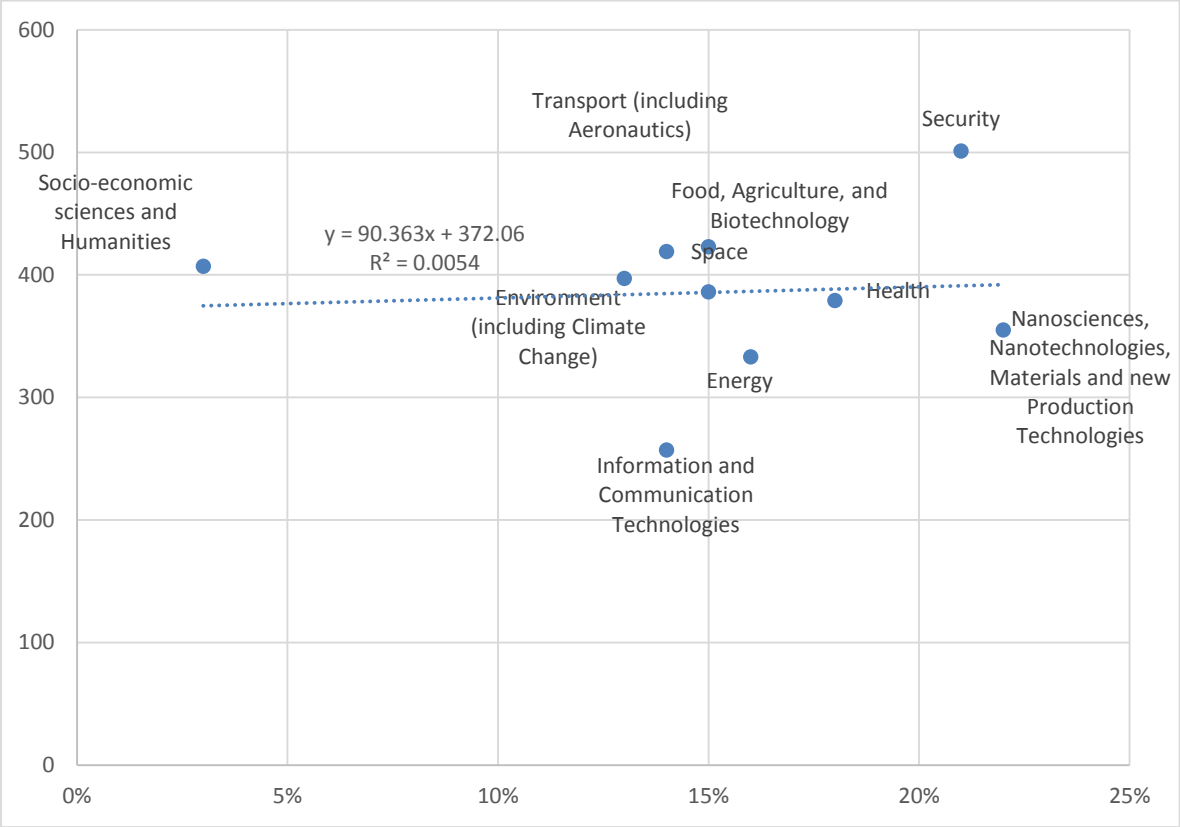
The analysis of CORDA data shows that long time to grant (TTG) is not correlated with lower industry participation. Time-to-grant does not appear to be a significant factor across theme. While TTG varies from 250 to 500 days from theme to theme, there is no correlation with industry participation (R2=0.0007). Despite the fact that it can be considered a bottleneck and an inconvenience, it is not a factor related to industry participation.

Figure 20 Time to grant (y) vs. EC contribution in FP7 (x) (whole industry)



Time to grant, though, might be more significant when it comes to the participation of SMEs. The reason for this is, however, not straightforward: while big firms have enough resources to engage in projects that are time consuming both to design and to resolve, smaller firms might be more sensitive to extensively large preparation periods. Nevertheless, the relationship is still low (R2=0.0054).

Figure 21 Time to grant (y) vs. EC contribution in FP7 (x) (SMEs)



Interviews with project participants confirm this moderate importance: only 29% of respondents attribute high importance (more than 4 out of 7) to "Long time to funding period" as a barrier to participation.

Market orientation of strategic priorities

As illustrated in section 2.3, industry participation is mostly driven by knowledge and innovation motivations. Accordingly, we can expect that the alignment of research priorities of the public programmes and business plays an important role, as confirmed by relevant literature (Lattimore, 2002). The results of previous evaluation of FPs repeatedly confirm that in general, EU programmes have made substantial progress in effectively meeting the needs of industry (European Commission, 2010a), as well as in exhibiting sufficient flexibility in adapting to changing needs (European Commission, 2010c).

To assess this hypothesis, we have analysed to what extent the deliberate market orientation in the wording of the priorities in the workprogramme was correlated to industry participation, calculated as the percentage of EC contribution going to industry in the 10 topics with greater EC contribution in each theme. To assess the market orientation, two different researchers scored each topic from 5 (participation of industry seems compulsory or essential) to 0 (no explicit mention to industry).[32]

In the following figures, we plotted the scores (Axis X) with the average EC contribution (see Figure 22) and with the Top 10 average EC contributions (see Figure 23). The results showed a positive correlation between these items in both cases. High participation of industry and in particular, of SMEs, is visible in themes and priorities with a deliberate focus on market orientation.

[32] For example, in the topic ENERGY.2012.3.2.3, the work programme stated the this call "aims at industrially led projects with minimum installed production capacity of 60,000 tons per year. The leading role of relevant industrial partners is essential to achieve the full impact of the project". Therefore, this theme scored 5. Within the same theme, in the topic ENERGY.2008.3.2.2 Bioethanol production from lignocellulosics, the work programme stated that "SMEs are expected to be important contributors to such technology development". Thus the score was 4. For the topic HEALTH.2013.0-1 PRC , the main aim of this topic was "to allow SMEs to take up health research outcomes. Leading role of SMEs in the project. The estimated EU contribution going to SMEs shall be 50% or more of the total estimated EU contribution for the project as a whole". This topic also scored 5.

Figure 22 Themes Market orientation average of % of EC contribution (all industry)

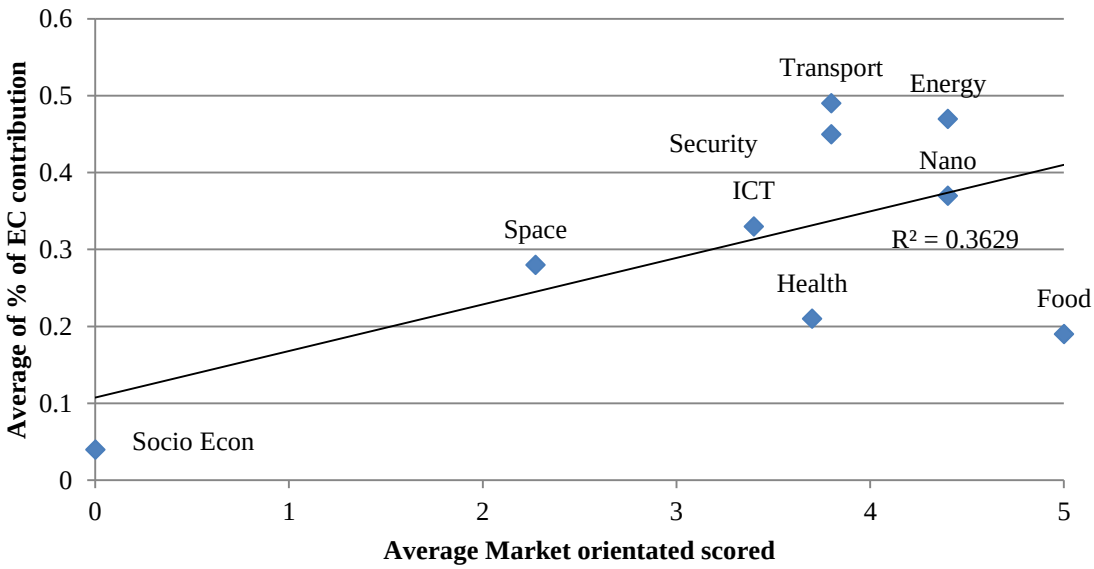
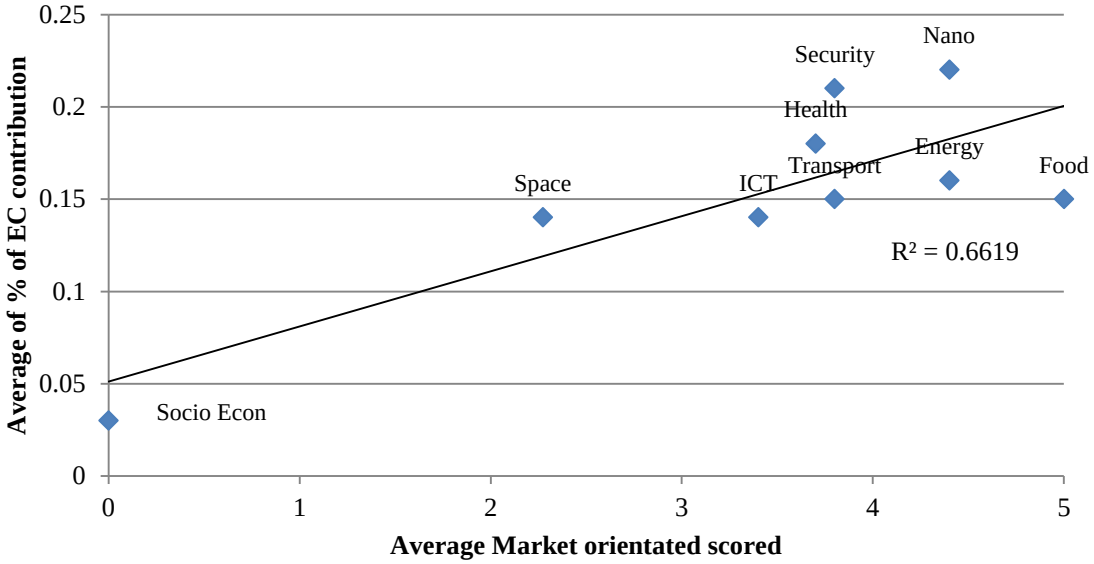


Figure 23 Themes Market orientation Top 10 projects average of % of EC contribution (SMEs)



For instance, it is worth mentioning the case of the Food theme, where the top 10 biggest projects were clearly market oriented and all the work programmes analysed clearly industry driven. On the contrary, the theme Socio-economic sciences and Humanities clearly showed no market orientation. All the topics analysed were scored 0. This also reflected in the percentage of EC contribution to the top 10 projects: only one topic reached 9% of EC contribution to industry.

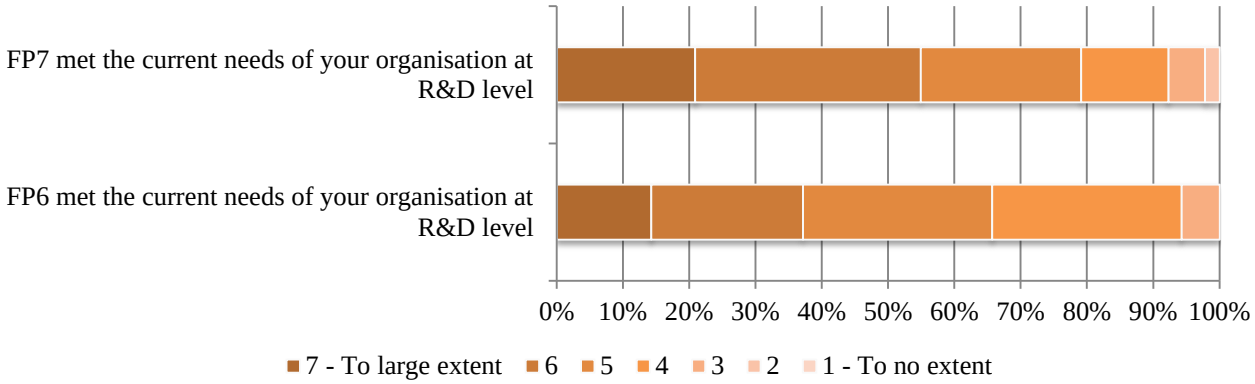
In addition, we have analysed the 10 topics with greater industry participation in each theme, including the title of the justification extracted from the work programme. As an example of the analysis, in the topic ENERGY.2012.3.2.3 (Pre-commercial industrial scale demonstration plant on lignocellulosic ethanol) PRC received 99% of the EC contribution. This is perfectly aligned with the definition of the topic that clearly stated that "*The leading role of relevant industrial partners is essential to achieve the full impact of the project*". Even in themes less oriented towards the market we can identify topics, in which PRC played a significant role. For example, in Food, Agriculture, and Biotechnology, the topic KBBE.2012.1.4-02 (Boosting the translation of FP projects' results into innovative applications in the field of agriculture, forestry, fisheries and aquaculture) allocated 80% of the EC contribution to PRC. For this topic, the work programme stated that "*proposals must fit into the overall business and innovation needs of the SMEs involved and must demonstrate clear exploitation potential and economic benefits for them; SME-targeted Collaborative Projects will only be selected for funding on the condition that the estimated EU contribution going to SME(s) is 75 % or more of the total estimated EU contribution for the project as a whole*". On the other hand, in the case of EeB.NMP.2011-(New efficient solutions for energy

generation) with 65% industry participation the workprogramme postulates that "*An appropriate balance between academic and industrial expertise and users is required*".

Therefore, even though some themes seem to be more market oriented than others, it is important to emphasize that the participation rate of industry is influenced by the definition of the topic in all cases.

This is further confirmed by the findings of the interviews, where the vast majority of respondents agreed that FPs met the needs of the company – with a visible increase between FP6 and FP7.

Figure 24 FPs objectives and R&D needs (n=93)



It is worth noting, however, that there is a possible issue for SMEs, since "*Irrelevance of programme aims to SMEs interests*" is mentioned as an important barrier to participation by 37% of respondents, more than any other issue.

Respondents underlined the importance of the strategic alignment between the priorities of the workprogramme and those of the companies. As one representative from a large company pointed out "*typically, if the firm was interested in the call, it would have applied. The main consideration was if the project seemed interesting for the firm*."[33]. Another SME interviewee reinforced this point, but from a different perspective: "*More important than the success rate was the chance to accelerate the company's business development. The most important aspect considered was the extent of alignment of the calls with the firm's objectives*"[34].

In this sense, taking part into the design of the workprogramme appears important in order to contribute with ideas that are in line with the strategic business priorities. As one large company reported: "*large companies had close cooperation with the EC […] as they were developing strategic research agendas, which were taken into account for defining the work programme. Therefore, the biggest companies were very represented in the work programmes and the objectives of FPs were very well aligned*".[35]

In summary, according to CORDA analysis and the interviews and coherently with the strategic motivation of participants, this analysis shows that the design of the workprogramme plays a major role in explaining industry participation. In other words, industry participation occurs when it is actively pursued as a deliberate choice in the context of the workprogramme and depends on the degree of industry involvement in its definition. The involvement in the workprogramme definition is in many cases an important first step towards effective participation.

2.4.4 Conclusions on motivations, barriers and drivers of participation

The literature shows that the main drivers of participation by industry are the development of new capabilities, access to complementary knowledge and skills, the pooling/obtaining of resources, as well as exploration of new ideas and expansion of networks. The main barriers identified are administrative burden and complexity of the processes, constraints derived from resources, information lacks, difficulties related to finding partners and a lack of network, as well as the long processes related to receiving public funds.

[33] Quote from Large company, High-tech firm, Joint Technology Initiatives (Annex IV-SP1), EU15, Top performer
[34] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Top players
[35] Quote from Large company, High-tech firm, Information and Communication Technologies, EU13, Top performer

The findings of the CORDA analysis, interviews and case studies, generally confirm these findings, but provide some additional insight.

Companies report as main motivations the access to complementary expertise, also in other disciplines, and the development of internal knowledge. The strategic alignment between the priorities of the company and the workprogrammes play an important role in the decision to participate, regardless of other factors such as success rates. The capacity to influence the design of the workprogramme is therefore an important first step to make participation worthwhile due to the alignment of priorities, especially for large companies. FP6 and in particular FP7, are acknowledged to have met well the needs of the companies.

Administrative burden is mentioned as an important barrier by interviewees, especially SMEs, although most concerns relate to the lack of flexibility regarding project changes. On the other hand, the process is deemed clear and transparent. On the demand side, lack of awareness, skills, network and support are important. Companies in EU13 in particular, pointed out the lack of support and information.

When we look at possible reasons to that explain the very different participation rates between different themes, the strategic importance of developing new knowledge and capabilities is confirmed: the design of the workprogramme appears as the one with the strongest correlation with industry participation. More "operational" factors, such as high success rates and large projects size, also appear to play a role, although 75% of interviewees declare that it does not play a fundamental role in their decision.

On the other hand, time to grant has no relation with industry participation in the different themes, and industry participates less in themes with low competition (expressed by the number of different partners per theme), probably because they are more science-oriented and research institutions less numerous than companies. SMEs seem to be particularly sensible to the market orientation of the theme and to the success rates.

Table 14: correlation between industry/SME participation and specific factors by theme

Correlation (R^2 values)	Industry participation	SMEs participation
Success rates	0.21	0.39
Time to grant	0.00	0.01
Project size	0.26	0.25
Market orientation of the WP	0.36	0.66

The design of the work programmes therefore plays a fundamental role in encouraging industry participation. Interviewees confirm that the overlap between the workprogramme and the company's strategic priorities plays a decisive role in the decision to participate, and priorities heavily oriented towards industrial goals show consistently higher participation rates. Workprogrammes are broadly considered positively in terms of addressing the needs of industry, although it appears that these refer mostly to large companies that are able to influence the design of the workprogramme.

The decision to participate is typically a cost/benefit analysis between the expected knowledge gains, the costs of participation and the possibility to receive the funding. The paradox is that any intervention to reduce the costs of participation, such as simplification measures, is likely to increase the number of applications and thereby lowering the success rates.

All issues related to process (administrative burden, large projects, success rates, long time to grant) appear to be particularly important for SMEs, which are particularly discouraged by all these barriers, rather than for industry in general. In summary, our results moderate literature findings

about the relative importance of process-oriented issues such as administrative burden and time to grant, in favour of strategy-oriented issues related to the importance of involvement of different industry players in the definition of the workprogramme.

However, our findings also demonstrate the significant differences between SME and large companies, as will be further illustrated in the next sections.

2.5 Differences between large companies and SMEs

The findings from literature, CORDA analysis and interviews confirm that there are significant differences across the motivations, drivers and barriers of large companies and SMEs, to the extent that sometimes recommendations are found to be contradictory for different stakeholders.

As the literature suggests, SME's motivations relate most to gaining markets opportunities rather than long-term knowledge acquisition. The CORDA analysis in the table below confirms that market orientation is more important for SMEs than for industry in general. In the interviews about motivations, SMEs tend to emphasise the importance of creating new markets and improving their commercial capacities. As one respondent held "*FP7 gave us an opportunity to grow and expand in new sectors*"[36], while another interviewee reported that its main driver was to "*explore emerging markets for the company's product with a safety net and to solve technical challenges with other partners, researchers and end users. Lastly, we want to create research results that can be taken to the market*"[37].

Meanwhile, large companies tend to be driven by the gaining of access to complementary expertise in order to answer to specific scientific or technical questions, while developing and extending their internal knowledge and capabilities. As two different large company pointed out: *"The need to collaborate is a significant driver for us: we need to include the entire spectrum of actors involved in the field, private firms as well as universities and RTO"*[38]. The aim is *"To partner with the companies and universities that could bring something interesting to the R&D lines we were already developing.*[39]

As far as drivers and barriers are concerned, literature highlights that administrative burden is particularly important for SMEs, together with cost/benefits analysis and the pursuit of medium term objectives. This is further confirmed by the greater correlation between SME participation and success rates illustrated in Table 14 above.

The market orientation of the work programme seem to be an important driver of SMEs participation, but they are less able compared to large companies to influence the design of the workprogrammes, given larger industries' deeper knowledge of policy process mechanisms.

Gazelles are different from SMEs and large companies. Similar the large companies, they are driven by knowledge-driven opportunities and strategic orientation, but rather than emphasizing the importance of alignment with the workprogramme, they request more open and flexible priority setting methods. Similar to SMEs, they are hindered by administrative procedures, costs of applications and lack of awareness and support, and these factors are self-reinforcing: those who are less aware about FP opportunities, are also more critical towards the administrative burden and therefore less prone to participate, hence reinforcing the importance of awareness raising activities.

One example of an SME that was particularly motivated by the greater market orientation of the workprogrammes is SOGESCA, described in the next box.

[36] Quote from SME, High-tech firm, Research Infrastructures, EU15, Top performer
[37] Quote from SME; High-tech firm, Nanosciences, Nanotechnologies, Materials and new Production Technologies, EU 15, Top Performer
[38] Quote from Large company, Medium-tech firm, Transport (including Aeronautics), EU15, Top performer
[39] Quote from Large company, High-tech firm, Information and Communication Technologies, EU15, Top performer

Box 3: The case of Sogesca

Quick Facts About the Company

Country	Italy	Macro-sector	Low-tech company
Trajectory	Operating since 1986	Sector	Technical consulting
Class-size	SME with 4 employees	Last R&D budget	No usual allocation of R&D budget

Summary of Sogesca's Participation Patterns, Performance of Innovation and Job Creation

PARTICIPATION PATTERNS	Participated in…	▶ 1 FP6 project ▶ 2 FP7 projects ▶ Other European funding schemes	Role(s) undertaken in FP projects	Coordinator	Participant	End-user
	Key drivers	▶ Acquiring new knowledge and competencies for the development of new services or improvement of the existent ones; ▶ Networking with potential clients and partners; ▶ Collaborating with more experienced partners with other sets of knowledge.				
	Main barriers	▶ Low success rates represented a barrier for its participation, and it was also the reason why they decided to start looking at other EU funding schemes.				
	Other aspects influencing participation	▶ The firm decision to participate was highly influenced by information about the success rates in receiving funding. ▶ FP7 was perceived as more research and innovation focused, another reason for the company to start focusing on alternative funding programmes.				
INNOVATION	Performance of innovation	▶ Innovation is primarily delivered through consultancy services and technical services. ▶ The firm offering is mainly powered by knowledge and skills, its activities are not technology-intensive.				
	Innovation impacts	▶ Awarded projects enabled the firm to gain knowledge about technological solutions that are now included in its consultancy offering, supporting companies to decide which technologies can best fit their needs.				
	Technology Readiness Levels	▶ Given that the last project the firm participated in was not technology oriented, but rather aimed at providing services to enterprises for the promotion of scientific activities, Sogesca did not produce any scientific outputs and therefore it did not advance in its technological preparedness.				
	End-users' involvement	▶ FP funding gave them the chance to test the new services in a real environment involving end-users to a very high extent.				
JOB CREATION	During projects	▶ Sogesca did not use the funding it received from the FPs to hire employees with PhDs, neither in the last project nor in other projects.				
	3 years after projects' completion	▶ However, the firm participation in FPs projects had a positive impact on the employment in the company, both during the projects as well as three years after their completion.				

3. KEY FINDINGS ON INNOVATION

Back in 1995, the Green Paper on Innovation (European Commission, 1995) identified a concept that proved very popular in innovation policy: the European Innovation Paradox, or the difficulties experienced by EU companies and academia in translating research results into marketable products. R&D funding and FP in particular, are expected to help solving this issue by bringing new products and services to the markets. In this section, we illustrate the evidence of this in terms of overall direct impact, systemic impact, types of innovation and drivers and barriers to it. Finally, we analyse to what extent companies tend to combine national and EU funding. The main sources used in this analysis are the literature review and the interviews.

One of the main determinants of the impact of the programme on innovation is the capacity to attract innovative participants. FPs have been traditionally moderately successful with this, as explained both in the literature review and the statistical analysis. Since this question pertains mainly to participation, we have presented already the main findings in section 2.2.

Table 15: Guide to the research questions on innovation impact in this chapter

Evaluation questions shortened as topic	Location in chapter
I1. Share of innovative participants	2.2.1
I2. Good practices of commercial valorisation of research	Case studies (Annex)
I3. High-tech companies more successful in the above?	Case studies (Annex)
I4. Effect of participation on technology readiness	3.1
I5. FPs and obstacles to launch innovation	3.4
I6. Demand-driven/use-led innovation and FPs	3.3
I7. Successful exploitation of results	3.1 and case studies
I9. JTI contribution to deployment of new technologies	3.1
I10. Average time from discovery to market	Case studies (annex)
I11 FP effect on creation of innovative ecosystem	3.2 and Case studies (annex)
I13. Industry combination of EU and national funding	3.5

3.1 Direct impact on innovation (input and output additionality)

The literature shows that R&D funding overall has a positive impact on innovation, in terms of input additionality, output additionality and behavioural additionality.

Input additionality measures whether or not receiving public R&D money lead firms to invest more (crowding in) or less (crowding out). None of the existing meta-reviews (García-Quevedo, 2004; Zúñiga-Vicente et al., 2012) reaches a definitive conclusion on whether public R&D spending is complementary or a substitute to private R&D. Our review is in line with this, as it found 40 papers supporting input additionality, plus 21 that obtained evidence of input additionality in some situations and in others they found that public R&D funds have either no effect or a negative effect. Most papers conclude that public R&D funding helps to increase firms' private R&D expenditure.

Output additionality concerns the proportion of outputs that would not have been achieved without public support. There are different measures to account for innovation output (publications, reports, patents, prototypes, new partnerships, new processes, new products). However, many papers use innovations new to the market or new to the firm. Most papers (29) conclude evidence of output additionality, however for some (14) this occurs only under some conditions. Crépon, Duguet, & Mairesse (1998) analysed the relationship between research, innovation and productivity for French firms using a CDM model. Their results indicate that firms' R&D efforts have a positive effect on innovation output and patents. Moreover, Bilbao-Osorio & Rodriguez-Pose (2004) uncovered a positive link between R&D activities and innovation, measured as the number of application for patents.

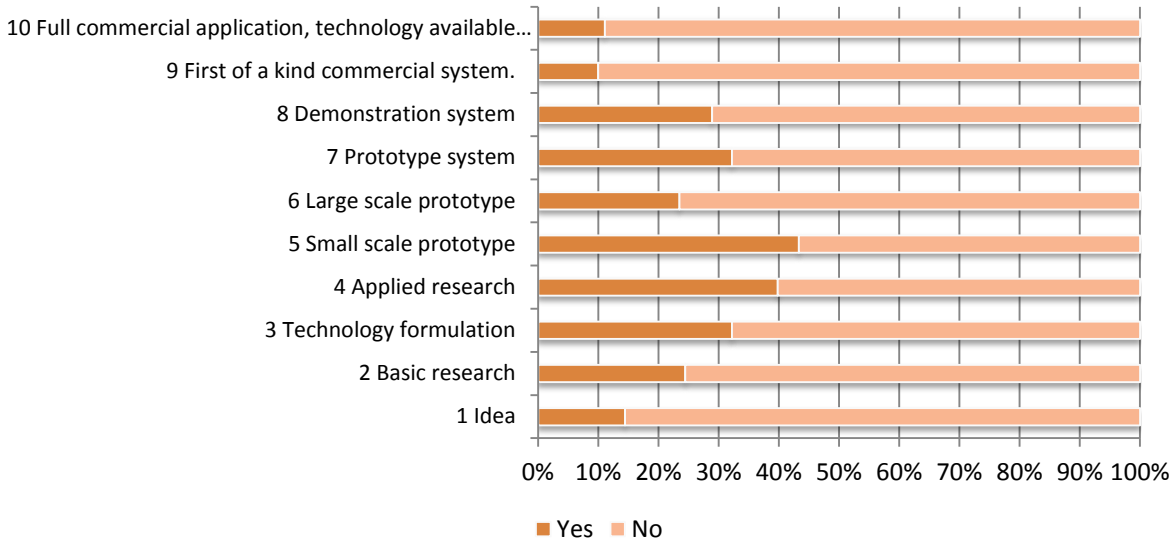
In fact, only looking at patents as output, the European Commission (2014) report on Small and Medium-Sized Enterprises' Participation in FP7 projects in the Biotechnologies Activity indicates that promising results in terms of patents have been reported for about 60% of projects, although it is still early to have a complete overview because many projects are still not finalised. At the national and regional level, Czarnitzki & Licht (2006) analyse the impact of public R&D subsidies in Germany using the Mannheim Innovation Panel and conclude that there is a large degree of additionality in public R&D grants with regard to patent applications. Alecke et al. (2012) focus on

East Germany and also conclude that subsidised firms show a higher probability of patents. This probability rises from 20% for non- subsidised firms to 40% for firms that receive subsidies.

Our findings from the interviews report positive results in line with the literature. The first analysis concerns how companies consider the innovation process supported by FP, based on standard TRL definitions. It should be noted that there were still difficulties to understand this concept as it is defined in the FPs, as 1/3 of respondents were not able to answer this question.

The majority of the interviewees define the innovation process supported by the FPs among the middle range of technology readiness (TRL 8 and TRL 4), but with greater presence of research focus (1 to 5) than of market focus (6 to 10). In particular, large-scale prototypes, first of a kind commercial systems and fully commercial applications are less present.

Figure 25: FP Innovation process technology readiness (n=97)



The wide majority of respondents state that the companies were already capable and technology driven, but several point out that FP funding enabled them to move from early stage to more advanced one: "*before EU funding the company was in TRL 3, and now after the funding it has reached a TRL 8*."

Large companies were found to be positioned more within Prototype and Demonstration system compared to SMEs. However, this gap does not exist in terms of the full commercialization of the technology available for consumers. This idea reinforces the findings illustrated in the motivations to participate in the FPs: larger companies were driven by knowledge, while SME were more oriented towards commercialization.

For instance, in terms of full commercial application, technology available for consumers (TRL 10), one SME respondent stated that the "*last FP funded project the firm participated in aimed at creating a system that could detect obstacles, persons and internal environment. The innovation process supported by the project could be mapped in TRLs 4, 7 and 10, as the project implied bringing a software solution with a restricted processing power in an outdoor environment 24 hours a day. The challenge was getting the prototype to run in real time in those harsh conditions*"[40]. Another one held that "*the innovation process supported by the project may be mapped from TRL 5 to 10. So far, the technology partners have developed a small scale prototype (TRL 5), but the overall goal of the project will be to produce a commercially viable product (TRL 10)"41. In terms of TRL 5, one SME respondent found that "the innovation process supported by the project may be mapped from TRL 5 to 10. So far the technology partners have developed a small scale prototype (TRL 5), but the overall goal of the project will be to produce a commercially viable product (TRL 10)"*[42]. Another SME respondent held that "*most of the projects the firm developed would begin in TRL 3 and would then reach a TRL5. Within the last FP funded project, the firm is engaged in*

[40] Quote from SME, Medium-tech firm, Nanosciences, Nanotechnologies, Materials and new Production Technologies, EU15, Top performer.
[41] Quote from SME, Medium-tech firm, Research for the benefit of SMEs, EU15, Bottom performer.
[42] Quote from SME, Medium-tech firm, Research for the benefit of SMEs, EU15, Bottom performer.

building a small scale prototype. [...] The firm's goal is to integrate the solutions developed in its commercial portfolio"[43].

The greater relative focus of large companies on knowledge generation far from the market could also be due to concerns about competition. One large company respondent reported that "*our company usually starts in TRL 3 and in collaborative research it usually reaches TRL 5. In FP funded projects, our company usually does not perform TRLs 6-8, because those levels correspond to activities that go too close to market launch. If the company were to develop them in a collaborative project, it would face anti-trust issues"*[44].

There are reported changes in the scope of the project during its implementation. For instance, in terms of first of a kind commercial system (TRL 9), one SME interviewee reported that "*we were offering background technology at the beginning of the project and the project did not allow them to commercialize it as we wanted to. However, it enabled us to point out shortcomings, which we tackled after the end of the project. The project was supposed to reach commercialization, but we did not manage to go anywhere near that"*[45]. Another respondents indicated for a specific project that "while the innovation started as a "*Small scale prototype" (TRL 5) at the beginning of the project, it is now closer to a working "demonstration system" (TRL 8)"*[46].

Very often, respondents report a wide range of processes covered by FP. For TRL 8, one respondent indicated that "*within the project, we participated in the technology formulation from the end-user's perspective, and also supported the technological partners by providing facilities to test the system. Activities performed were mapped in TRL 3 and TRL 8"*[47]. Another one held that *"In the FP project, our company started in TRL 2-3 and then performed TRLs 4 to 6. We built 2 prototypes and tested them in the intended environment. Another partner in the consortium performed TRLs 7-8"*[48].

Regarding additionality of FP funding, there is strong consensus (79% of respondents) that FP allows the company to carry out bigger research projects than would be the case in its absence. In particular, 61% agree that the project would have been cancelled and only 13% state that the project would have been carried out anyway.

When asked about success stories, 29% of respondents are able to mention instances when FP funding helped the firm to commercially valorising the results of R&D activities (these cases will be further explored in the case studies). For instance, a company[49] developed a concept system to store human knowledge, and managed to use the concept system technology with 3 commercial applications. Another company [50]developed an algorithm-based platform in a FP7 project to alert and prevent flash floods, which has already been used in products commercialised in Spain and (in the future) in other EU countries.

In some cases, the partnerships built during the project are maintained in the exploitation phase, highlighting the importance of networking enabled by FP, or as one respondent[51] put it: "*FP funding helped to valorise R&D commercially. Collaborating with partners was instrumental in doing this*". One company[52] developed through FP7 specialized in the development of new Titanium alloys with specific characteristics that allowed them to position themselves in a new market as the unique supplier in their country of this type of ingots. Moreover, in its own capacity the firm can produce these alloys only in small quantities, but another project partner helped easy develop the production at industrial scale. In another case, one consultancy company partner of the project[53] is helping in all its Consortium partners in exploitation of project results. Another company[54] states "*each partner in the consortium developed a piece of the system and now [company name] produces all the parts to be sold on the market*".

Those who could not mention a specific success story of valorisation, however, often refer to a more indirect impact. In some case, FPs provided access to data and knowledge about new markets such as about energy efficiency in other countries, comparison of technology, size of demand in the IT sectors, discovery of new products, knowledge in the specific domain of serious

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[43] Quote from SME, High-tech firm, Information and Communication Technologies, EU15, Top performer.
[44] Quote from Large company, High-tech firm, Information and Communication Technologies, EU13, Top performer
[45] Quote from SME, Medium-tech firm, Research for the benefit of SMEs, EU15, Bottom performer.
[46] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Top performer.
[47] Quote from SME, Low-tech firm, Security, EU15, Bottom performer.
[48] Quote from Large company, High-tech firm, Information and Communication Technologies, EU15, Top performer.
[49] Quote from SME, High-tech firm, Information and Communication Technologies, EU15, Top performer
[50] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Top performer
[51] Quote from SME, Medium-tech firm, Security, EU15, Top performer
[52] Quote from SME, Medium-tech firm, EU15, Top performer
[53] Quote from SME, High-tech firm, EU15, Bottom performer
[54] Quote from SME, High-tech firm, EU15, Top performer.

games. As one respondent puts it "*The knowledge the firm has acquired has generated new business opportunities that have not been directly linked to the research results of the FP funded projects*".

Another widely mentioned impact is in terms of legitimacy and visibility. FP7 acts as a kind of "quality certification", directly and through the actives it entails, such as publications. As one respondent put it: "*The image of the company has also been improved by its participation to FPs FP enabled us to gain the respect of big companies. This fostered cooperation at a higher level"*.

Precisely indirect impacts fall under what is termed "behavioural additionality" and are further explored in the next section.

Box 4: The case of EnviroChemia

The project AQUAFIT4USE aimed the development and implementation of new, reliable and cost-effective technologies, tools and methods for sustainable water supply, Secondly, the use and discharge in the main water-consuming industries in order to significantly reduce water use, mitigate environmental impact and produce and apply water qualities in accordance with industrial own specifications from all possible sources. The key outputs include 2 pilots and 2 commercial products currently sold in the market by EnviroChemia, a large Polish firm. FP funds have been largely used for the testing and piloting of the research product in "real-life", also involving end-users. This testing phase was only possible thanks to FP funds that, according to a representative of the firm, had a positive impact on the commercialisation of research results. AQUAFIT4USE enabled to commercialise two products that could not have been launched onto the market without the FP7 funds.

3.2 Systemic impact and behavioural additionality

Europe's under-performance of research and innovation does not lie only in the weaknesses of specific components at EU, national and regional levels, but in "*the failure of many of these system components to function or link effectively together*" (European Commission, 2010b). There is a substantial body of literature on the importance of networks and cooperation to generate innovation. For instance, Barber & Scherngell (2012) state that interactions between firms, universities, and research organisations are crucial for successful innovation, whereas Aarikka-Stenroos, Sandberg & Lehtimäki (2014) add that networks contribute both to R&D and commercialisation.

This section addresses long-term behavioural benefits that the organisation will retain for its R&D activity from participating to FP influence the creation of innovative ecosystem outside and inside the company. Behavioural Additionality (BA) broadened the traditional additionality concepts by looking at permanent changes in the conduct of a company, possibly mirrored in a more formal institutionalisation of innovation and R&D- activities. Although less tangible, this concept looks at social returns (general competence building and networking included) that may lead companies to spend more resources on innovation and R&D-projects in the future and also contribute to innovation systems growth beyond the firm level (Georghiou, 1997, 2002; Georghiou & Roessner, 2000; Luukkonen, 2000; Papaconstantiou & Wolfgang, 1997; Sakakibara, 1997). It deals with "*the difference in firm behaviour resulting from the intervention*" (Georghiou, 1997, p. 37). As mentioned before, the concept of behavioural additionality is less tangible and, thus, more difficult to measure. However, one aspect of behavioural additionality that can be assessed is network creation. In this section we therefore focus in particular on the additionality related to networks creation.

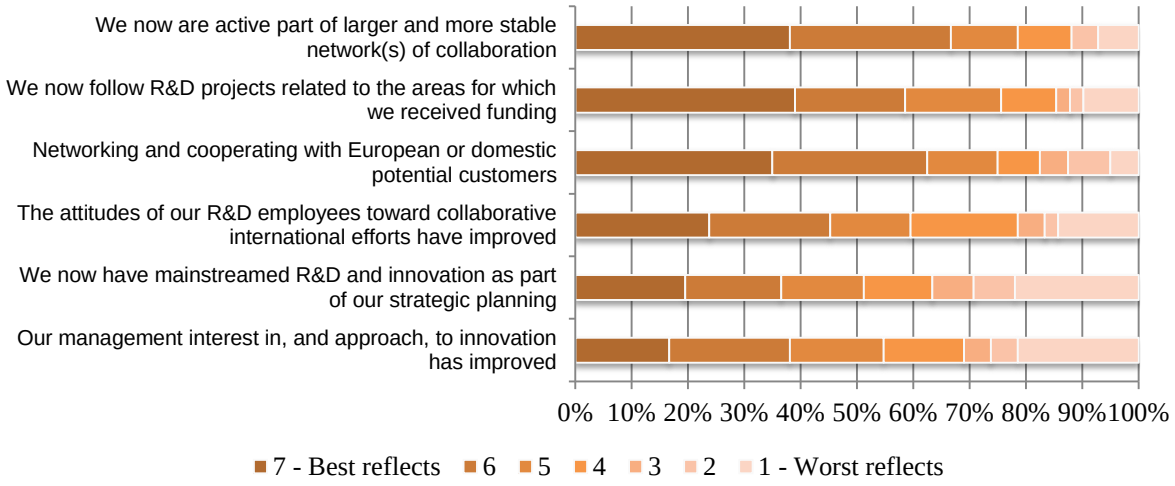
In our literature review, several studies (12) found that public R&D support had a positive impact on firms' networks and cooperation activities. Busom & Fernández-Ribas (2008) indicate that public support significantly increases firm's chances to cooperate, especially with a PRO (public research organisation). They add that public R&D programmes trigger a behavioural change in firms' R&D partnerships, alleviating barriers to cooperation.

Busom & Fernández-Ribas (2008) also indicate that public support significantly increases firm's chances to cooperate, especially with a PRO (public research organisation). They add that public R&D programmes trigger a behavioural change in firms' R&D partnerships, alleviating barriers to cooperation.

The interviews confirm these findings. Being part of larger and more stable network of collaboration, follow-up R&D projects and networking and cooperation with potential customers were quoted as the main potential long-term benefits that the companies will retain for its R&D

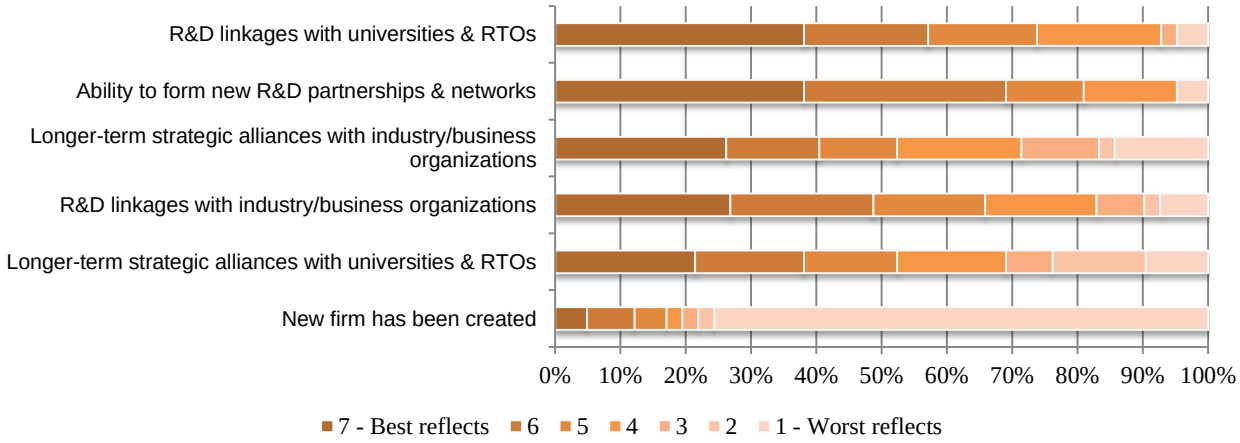
activity from participating to FPs. These benefits are clearly related to the company's capacities to build an innovative ecosystem of stakeholders. The interviewees also perceive the internal consequences of FP participation within their companies as long-term effects. R&D employees' attitudes, including R&D and innovation as part of the strategy and improvements in the managerial approach to innovation, have been mentioned as important potential benefits. The analysis of the responses reveals that SMEs perceive both internal and external benefits as more positive than large companies.

Figure 26 Potential long-term benefits (n=89)



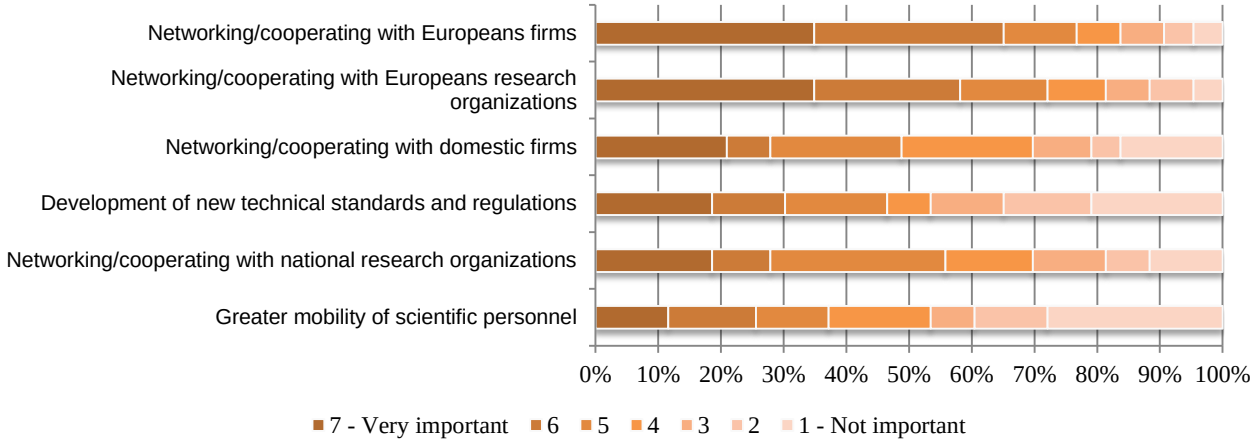
If we focus on the impacts of participating to FP on the R&D team and the organisation's R&D capabilities to foster an innovative ecosystem with other stakeholders, we can see a clear trend pointing out the positive influence of FPs on fostering collaboration between companies and universities and RTOs, as well as among other companies. However, the possibility of creating new firms has been mentioned by very few interviewees. In this regard, large companies perceive these opportunities slightly better than the SMEs' respondents.

Figure 27 Impacts of participating to FP on R&D capabilities (n=98)



Lastly, interviewees were asked about the impacts of participating to FPs on networking activities. Large companies and SMEs share a positive perception of these impacts, especially in terms of networking/cooperation with European firms and research organisations and to less extent also with national firms and research organisations.

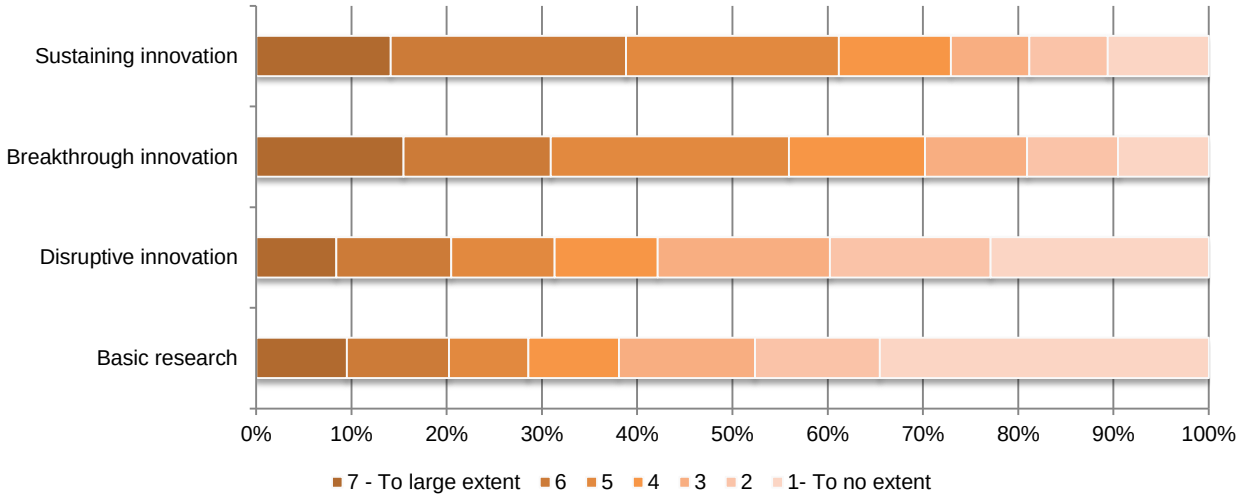
Figure 28 Impacts of participating to FP on networking activities (n=98)



3.3 Types of innovation

In this section we consider the type of innovation output produced by the project, based on self-assessment of the interviewees. SMEs are more oriented than large companies to consider their innovation as breakthrough. One SME respondent noted that "*our research results are mainly considered a breakthrough innovation as they represent a leap in technology. Some of the pieces that make part of the solution are currently being developed by other companies, but there are no similar solutions currently available in the market*"[55], while another SME respondent stated that "*Our company is a pioneer in knowledge and prototypes. It is very disruptive a company. As a consequence, we are involved in all types of research and innovation, especially in breakthrough innovation than we can sustain and consequently achieve sustaining innovation*"[56]. Larger companies referred to their innovation processes as breakthrough innovation to a less extent than SMEs. Nevertheless, one respondent reported that "*As our company is a significant player in the automotive industries, FP projects aimed at 2 different goals: implementing sustaining innovation in order improve the existing technology, and releasing a breakthrough innovation through research, which will be a completely new product from what is existing on the market* "[57].

Figure 29 Type of innovation (n=85)



In terms of sustaining innovation, one larger companies' respondent stated that "Sustaining innovation received the highest rating because the company's objective within the FP project is to take to the market the results of the research"[58], while another one held that "the innovation

[55] Quote from SME, High-tech firm, Information and Communication Technologies, EU15, Top performer.
[56] Quote from SME, Marie Curie Actions, EU15, Top performer.
[57] Quote from Large company, Medium-tech firm, Transport, EU15, Top performer.
[58] Quote from Large company, High-tech firm, Joint Technology Initiatives, EU15, Top performer.

process was mainly described as basic research and sustaining innovation, as the company was able to market new products related to electro-mobility"[59].

In addition, the analysis of the responses shows that high-tech companies are more oriented towards breakthrough and disruptive innovation than medium and low tech companies. In this line, one high-tech SME respondent stated "we have been involved in disruptive innovation. We are not really concerned with basic research anymore. However, breakthrough innovation is difficult to achieve, and it is even harder to sustain innovation"[60], while another one found that "the innovation processes undertaken by the company within the FP project may all be categorized to a large extent as disruptive, breakthrough and sustaining because all outputs represented significantly improved or new applications of technology"[61].

To quote a medium-tech company respondent, it was in turn held that the innovation process of the company can be considered as the "development of a sustaining innovation as it is a study aiming at implementing dissemination and transfer of knowledge"[62].

Lastly, it is worth pointing out that only a few interviewees mentioned the involvement of end-users in their innovation process.

3.4 Drivers and barriers to innovation

The majority of respondents (60%) state that FP7 has helped the firm to address the obstacles usually encountered when launching a new product, technology or service on the market. The main benefit has been the capacity to network with other players, in particular universities and large companies (as partners and end users). Funding acted as a catalyst: "*they would not have been able to have an agreement on the project with partners if they had not had the funds*." Many mention the importance of accumulating knowledge that while not directly applicable to the market, has been later used in the context of exploitation. Among those that provide a negative response, the majority states that simply the project did not aim at commercialization.

The vast majority of respondents consider that the lack of technological readiness of the company is not the main factor for lack of exploitation of the research results. Instead, follow-up funding is often mentioned as a bottleneck. For instance, one company states that[63] "*We could simply not exploit our results as we need much more money to go the next step which was from lab to pilot plant. Now we need much more money to go from pilot to production*."

Finally, we can consider the main bottlenecks that are present in FP7 to the exploitation of research activities as provided by the respondents. To do so, we abstract from the results of question I29, which asks "what changes are needed". After considering the answers, we can safely assume that the suggested changes refer to "removing obstacles" to research commercialisation.

The comments refer to a set of issues.

- Follow-up support: many respondents report that there is no support for "what happens after the project ends". In their words: "The EC should have a structure, a system to help exploit the results at the end of the project."[64] "When a project actually bears fruit, there is no structure to work with on the results obtained."[65] Some claim the EC should have a more "hands on" approach, to engage more in order to bridge the gap. Another respondent mentions that "[if the agency] had a stronger hand on the management, the project could have been redirected." One respondent suggests having physical events where companies could showcase the results of FP. Another one suggests "include support from experts in private equity, venture capital, intellectual property, as well as business plan experts in order to better turn research results into commercially viable products".[66]
- Design of the calls. The calls should "*focus more on prototyping and fund such research late stages*"[67]. Project proposal should have greater emphasis on the demonstration/marketing phase. One suggests introducing "*at least two mandatory project milestones regarding market*

[59] Quote from Large company, High-tech firm, Information and Communication Technologies, EU15, Top performer
[60] Quote from SME, High-tech firm, Research for the benefit of SMEs, EU15, Top performer.
[61] Quote from SME, High-tech firm, Research Infrastructures, EU15, Bottom performer.
[62] Quote from SME, Medium-tech firm, EU13, Bottom performer.
[63] Quote from SME, High-tech firm, Security, EU15, Top performer
[64] Quote from SME, High-tech firm, Nanosciences, Nanotechnologies, Materials and new Production Technologies, EU15, Top performer
[65] Quote from SME, High-tech firm, Security, EU15, Top performer
[66] Quote from Large company, Medium-tech firm, EU15, Top performer
[67] Quote from SME, Medium-tech firm, Transport, EU13, Bottom performer

introduction."[68] Another one mentioned the provision of greater support to communication and marketing, which is much weaker than the US companies.

- Dissemination of information, in particular to SMEs: the EC should help companies understand "*in which projects their capabilities could be best exploited*"[69]. Also, more targeted information would help. Communication and information available for SMEs should be improved.
- Flexibility in project management: it should be easier to change direction when running a project. In the words of an interviewee: "*Not anything can be planned for, as far as R&D is concerned. Format seems to matter more than core topics*." Or "*Participants are stuck with the original plan even if objectively they could have good reasons to change it. From this perspective, EU funding should be more flexible.*"
- Project officers' role: the rotation of personnel is seen as a problem, as it hinders proper follow-up of the projects. As one respondent puts it: project officers do not have enough time to ensure an efficient follow-up. They rely on deliverables to assess the work done. They do not necessarily correspond to the truth. More implication of the project officers is needed."[70]
- Intellectual property shared with too many partners: several respondents admit their reluctance to focus on the market phase because "*too many partners must be involved. This implies too great an accessibility of demonstration projects, and we don't want to be sharing our innovation*." For this reason they suggest smaller consortia. However, expert state that this is often just a case of misinformation by participants, and point to support measures enacted by JTI IMI which includes training and face to face meetings.

However, we should mention that many respondents very favourably referred to the modifications introduced in Horizon 2020. As one respondent noted:"*Horizon 2020 seems to have solved all major problems that FP7 presented for SMEs (in particular, with the creation of the SME Instrument and all related activities and support services). At this point, there would be no more changes needed, it only remains waiting to see how well it works*."[71]

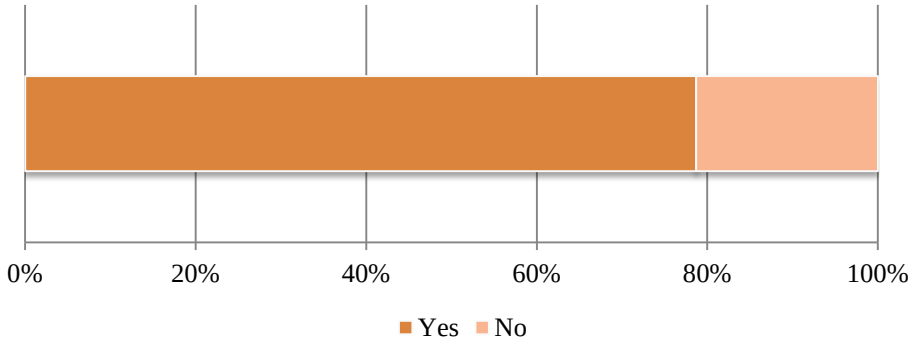
3.5 Combination of EU and national funding

EU funding is only one of the several government funding instruments for R&D, and regional and national funding is actually larger than EU funding in terms of absolute value. According to the literature analysed, both European and Member States' innovation policies have benefits, and that they can be more or less effective depending on the situation (Horst et al., 2006). European policy generates more benefits in areas that involve economies of scale and external effects, for example, protection of intellectual property and development of standards. On the other hand, national policies can be useful to deal with heterogeneity in social economic objectives between Member States and when there are no economies of scale or external effects, for example for innovation policies targeted at SMEs. Bayona-Sáez, Cruz-Cázares & García-Marco (2013) analyse how the type of funds affect firms' R&D strategy. The results suggest that EU funding is having more effect as an incentive to perform in-house R&D, either exclusively or as a complement to technology outsourcing. They review some previous studies and indicate that following an in-house R&D strategy is usually associated with higher innovative results. State and regional funding seem to encourage a make-buy strategy (combination of in-house and outsourcing).

Results of the interviews suggest that most of the respondents combine EU and national funding. This co-existence is perceived as a possible problems by experts participating to the workshop: there is the risk that the same research is funded twice. For this reason, it's necessary to implement better coordination measures between funding agencies to ensure synergy and avoid redundancy: one good example is the IMI activity on the coordination of research on antimicrobial resistance, where it was decided (through face to face meetings with national and international funding agencies, also in US) that IMI will focus on late stage clinical trials. However this is not a universal and systematic approach, but rather applied on a case to case basis. It should become much more common.

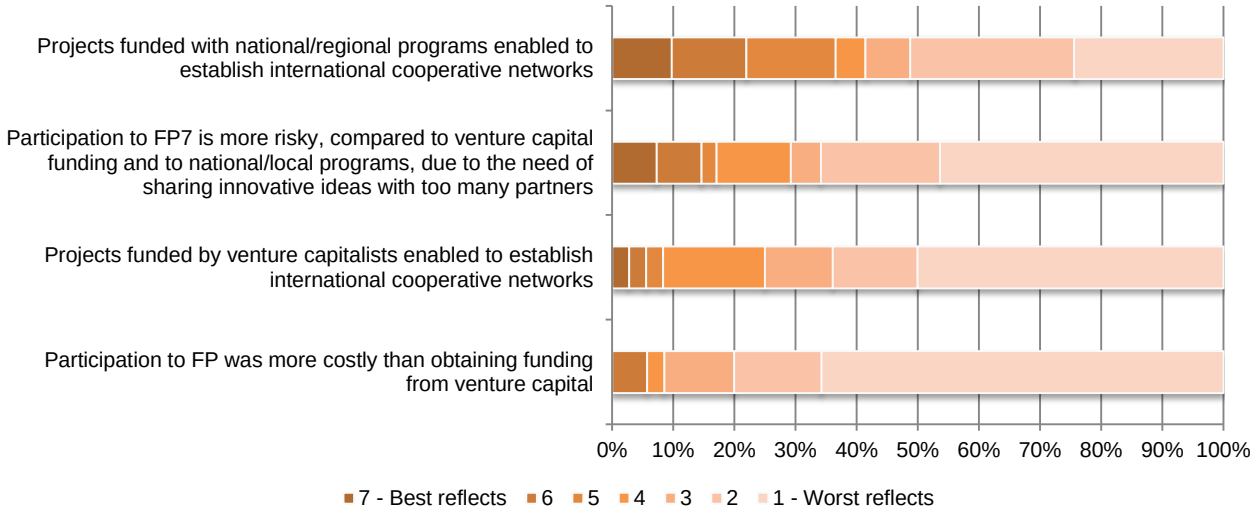
[68] Quote from SME, Medium-tech firm, Research for the benefit of SMEs, EU15, Bottom performer
[69] Quote from SME, Low-tech firm, Environment (including Climate Change), EU15, Bottom performer
[70] Quote from Large company, High-tech firm, EU15, Top performer
[71] Quote from SME, High-tech firm, Information and Communication Technologies, EU15, Bottom performer

Figure 30 Combination of EU and national funding (n=94)



Interviewees from South Europe and EU15 mentioned that the difficulties to obtain national funding due to the economic crisis have forced them to compete at EU level. This is perceived as an opportunity to reinforce the positive externalities obtained mentioned in section 2.3. Very few respondents agreed that national funding or venture capital were more effective for network building and less costly to obtain.

Figure 31 Impacts of participating to FP on networking activities (n=85)



In summary, our findings confirm that EU research funding has a positive impact on innovation and helped companies positioning themselves closer to market in the TRL scale. In line with the literature, the results appear more visible in terms of behavioural additionality and systemic effects such as networking and learning, than in visible outputs and commercialisation of new products. This is probably also related to the difficulty in engaging gazelles, illustrated in section 2.2.1. According to interviewees, the main bottlenecks to innovation lie in the need for more market-oriented workprogrammes, better orientation in the preparation phase and support after the project ends, greater flexibility in the projects. These findings are fully aligned with the drivers and barriers to participation identified in section 2.4.

One company that used FP funding to move forward in the TRL status is Novocaptis, from Greece, illustrated in the next box.

Box 5: The case of NOVOCAPTIS

Quick Facts About the Company

Country	Greece	Macro-sector	High-tech company
Trajectory	Operating since 2010	Sector	ICT Engineering
Class-size	SME with 6 employees	Last R&D budget	Year 2014: EUR 100,000

Summary of Novocaptis Participation Patterns, Performance of Innovation and Job Creation

PARTICIPATION PATTERNS	Participated in…	▶ 4 FP7 projects ▶ Other European and international schemes	Role(s) undertaken in FP projects	Coordinator	Participant / End-user
	Key drivers	▶ Novocaptis' participation in Framework Programme 7 was primarily driven by the company interest in having access to the grants aimed at funding R&D projects. ▶ Secondarily, the firm participated for the opportunity to collaborate in a consortium with high expertise in the company field of interest, hence gaining exposure to further innovative opportunities.			
	Main barriers	▶ Success rates along with the costs related to proposal elaboration and project management of large projects represented the main barriers for participation.			
	Other aspects influencing participation	▶ The probability of receiving funding was taken into consideration together with other criteria, such as the characteristics of the funding scheme as well as the composition of the consortium the company would be participating in.			
INNOVATION	Performance of innovation	▶ Innovation is paramount in the company mission, which is: *"To provide innovative products and services that aim to solve key social needs, protect the natural and social environment and to free people from repetitive daily tasks, allowing them to have more free time."*			
	Innovation impacts	▶ The DARWIN Project — Dextrous Assembler Robot Working with Embodied Intelligence — was showcased by the company as a good practice of FP funding contributing to commercially valorise research results. ▶ The technology developed within the project is being implemented by the company through several of its product lines, namely the educational software, knowledge management systems and enterprise search systems. ▶ FP funding helped the company to create the technology but it did not help them to introduce it to the market.			
	Technology Readiness Levels	▶ The funds helped the firm to develop and explore new technologies and to improve its technological readiness. ▶ Before receiving the funds the company operated in TRL 3[1], and after the funding it advanced its technological readiness to a TRL 8[2].			
	End-users' involvement	▶ The firm has prioritized testing the demand side through the involvement of end-users in all the projects it participated in.			
JOB CREATION	During projects	▶ The company used the grants to hire employees with PhDs, both in the last project as well as in other projects, as it was necessary to populate the project teams.			
	3 years after projects' completion	▶ Novocaptis has not observed any impacts on the employment in the company 3 years after the projects' completion.			

[1] TRL 3: Technology formulation. Concept and application have been formulated

[2] TRL 8: Demonstration system operating in operational environment at pre-commercial scale

4. KEY FINDINGS ON JOB CREATION

The evaluation questions related to the impact of participation to FP6 an FP7 on the job creation are the following:

Table 16: Guide to the research questions on jobs impact in this chapter

Evaluation questions shortened as topic	Location in chapter
E1. What is the impact on direct job creation as a result of participating in the FPs?	4.1 and 4.2
E2. What is the economy-wide contribution to job creation by companies that participate in the FPs?	4.2
E3. Through which channels does the industry aim at contributing to the development of research and doctoral training and what do they expect from such contribution?	4.3

In this chapter we will provide an answer to these questions building on the results of the literature review, the interviews and the counterfactual analysis. Because of the strong interrelation between the research questions, and the major importance of the counterfactual method in addressing these questions, the chapter is organised differently from the others: it starts off with a summary of the findings in the literature, presents the results of the counterfactual analysis (E1) and extrapolation (E2) and finally presents the additional insight from the interviews regarding E3.

4.1 The impact on job creation of R&D programmes

Concerning the impact on direct job creation and employment as a result of public funding, 38 articles were identified that dealt with this subject, with a majority of them revealing that funding in general had a positive effect on job creation. Evaluating the benefits of the innovation programmes on the development of innovation-based competitiveness of supported companies through a survey among supported firms, Čadil (2009) conclude that supported firms created numerous jobs at national level. Also Castillo et al. (2014) suggest that process and product innovation arising from public funding increased employment and wages to a significant extent in Argentina. In addition, it was found that product innovation support had a larger effect on wages than process innovation support. Positive effects were also found by Afcha & García-Quevedo (2014), who examined the impact of subsidies granted at national and regional levels on a set of R&D employment variables and, specifically, seek to identify the existence of behavioural additionality effects of these public subsidies on firms' R&D human resources. The results show that R&D subsidies increase the number of R&D employees. However, no increase was found in the average level of qualification of R&D staff members in subsidised firms. Benavente, Crespi, & Maffioli (2007) analysed the effectiveness of a Chilean Technology Development Funds (the FONTEC programme). In terms of performances, it was found that although FONTEC increased the sales, employment and export opportunities, it did not significantly foster productivity. In the absence of randomized experiments, they estimated these impacts through a quasi-experimental approach that combined difference-in-difference and propensity score matching techniques. Czarnitzki & Lopes-Bento (2013) reviewed the effects of a specific government-sponsored commercial R&D programme from various angles. Using a back-of-the envelope calculation, they estimate that, on average, five R&D jobs are created (or maintained) per supported project in the Flemish economy. Similarly, Link & Scott (2012b) describe several performance characteristics of the Small Business Innovation Research (SBIR) programme. Their data show that firms receiving SBIR funding are able to overcome the initial technology-based hurdles that small, entrepreneurial firms face on a frequent basis, thus facilitating a more permanent and possibly longer-term employment growth. Wang (2013) makes use of firm-level balanced panel data in order to examine the effect of publicly-supported R&D subsidies on firm growth in Taiwan. The results suggest that a higher ratio of publicly-supported R&D subsidies to total project expenditures would contribute to a firm growth of both sales and employment. By contrast, it also results in a decrease in the growth rate of employment in R&D. Also, Madrid-Guijarro, Garcia & Auken (2009) conclude that public policy that encourages innovation can enable firms to remain competitive and survive, which have direct implications for employment. Similarly, Einiö (2014) identify a significant positive impact of public funding on employment. More specifically, positive impacts on R&D investment, employment, and sales among the participants who were granted an R&D subsidy as a result of additional aggregate R&D support funding in their region were found, although there are no instantaneous impacts on productivity, the study provides evidence of long-term productivity gains.

Similar to Bogliacino & Vivarelli (2012), who hold that R&D expenditure fostering product innovation has a job-creating effect, Justman and Zuscovitch (2002), analysed the economic impact of subsidised industrial R&D in Israel, suggesting that subsidies to selected industrial R&D

projects increased industrial employment by about 10% and increased also GDP. Electronics, broadly defined, received roughly half the subsidies, while accounting for nearly two thirds of the gains, whereas small firms that received one sixth of the subsidies contributed over a quarter of the gains.

Merito, Giannangeli & Bonaccorsi (2010) estimated the impact of R&D subsidies on firm performance by providing recent micro-evidence from Italy. Results show that the innovative performance improves only temporarily and no significant differences between grant recipients and non-recipients emerge as far as labour productivity and sales growth are concerned. Rather, a growth in qualified employment could be observed among SMEs. Stucchi et al. (2014) seek to estimate the spillover effects of the FONTAR program in Argentina through impact evaluation. Their findings show that the programme increased employment, wages, and the exporting probability of both direct and indirect beneficiaries. Other positive impacts on employment, albeit limited or conditional, where found by Link & Scott (2013), who found that the impact of Public R&D subsidies on employment growth can be higher if there are outside investors providing additional R&D funding, an exceptional amount of intellectual property is generated, or if small firms have commercial agreements with other firms. The results of Kaiser & Kuhn (2012) indicate that there is a positive effect on employment derived from public funding that materialises after one year. Likewise, Criscuolo et al. (2012), Kuhn (2010) and Mouqué (2012) conclude that public support increased SMEs employment but had no impact on large firms. Bondonio & Greenbaum (2007) found that programmes positively affected the gross flows of employment, sales, and capital expenditures accounted for by new establishments. However, the policies benefited new establishments at the expense of established businesses that closed or moved which entails that the effects are rather inconclusive for existing ones. Also Koski & Pajarinen (2012) hold that there is a positive employment effect of R&D subsidies, but conclude that this effect is only short-term, in the sense that R&D subsidies further contribute to the firms' employment for one year after the reception of subsidies. In another study, Koski (2008b) stipulates that participant firms did not have greater employment growth than others, but rather that employment has grown in those firms that have received public funding for the R&D projects targeted to the new business areas.

As for previous studies on the impact of participation to FPs on employment, Wing (2009) conclude that the overall programme was found to have led to some major impacts on the majority of the SMEs involved. The FP provided SMEs with valuable technology input, knowledge, and learning opportunities, setting the basis for their further RTD activities. The European Commission (2010c) acknowledged that SMEs can in general be regarded as the primary source of net job creation. SMEs are regarded as both performers of research, especially in some of the leading-edge 'new' economy sectors, and consumers of it, which becomes apparent in the engagement of SMEs in cooperation and in the specific programme capacities with the sub-programme of research for the benefit of SMEs. Van Elk et al. (2014) indicates that SMEs participating in the framework programmes scored significantly better than the control group with regard to employment growth and operating revenue for FP7 and for FP6. Also participating SMEs reported a range of impacts that have a positive effect on their competitiveness, such as more cooperation, new knowledge, and improved innovation competences. Finally, Technopolis (2014) conclud3e that the newly introduced PPP content of the programme had an overall very positive effect on quality and flexibility. However, only to some extent, the case studies reported second-order economic impacts such as increased productivity, competitiveness, and employment and revenue growth. The SME participants, as compared to larger firms, reported higher improvements for improved flexibility, revenue growth and employment growth.

By contrast, two articles revealed that there is a weak effect of funding on job creation (Link & Scott, 2012a; Wolff & Reinthaler, 2008) and another two found no significant effect (Cioni & Conforti, 2007; Inoue & Yamaguchi, 2014).

4.2 Counterfactual analysis and extrapolation

The results on direct job creation resulting from the participation to FP6 and FP7 are confirmed by the counterfactual impact evaluation. In this analysis, we applied the following two different dynamic statistical matching methods combined with a difference in difference scheme: dynamic Propensity Score Matching (PSM) and dynamic Exact Matching (EM), on both of which a Difference in Difference (DiD) scheme is superimposed as part of introducing a dynamic approach. Combining broadly defined matching with DiD represents a very robust and reliable identification strategy. Whereas the matching approach handles the observable source of potential heterogeneity (sector, size, geographical location), the DiD deals with the unobservable sources of heterogeneity such as brand values, management capabilities, and market positions, since these can be reasonably assumed not to change in the course of a very limited time frame. The combination of matching with DiD is by nature possible only if we have data on the outcome variable for several pre-post intervention years.

The time span of the analysis was ten years, ranging from 2004 to 2013. The analysis has been carried out for companies from three groups of countries:

- EU6: France, Germany, Italy, Spain, the Netherlands, and United Kingdom.
- EU14: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.
- EU26: Austria, Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden, Spain, Romania, and United Kingdom.

In Table 17, the results of the estimation for the two dynamic statistical matching methodologies employed for the three groups of countries considered are reported.

Table 17 Results of the estimation

Group of countries	Additional jobs created per firm		Cost of job created	
	EM	PSM	EM	PSM
EU6	2.52	2.21	79,497	90,859
EU14	2.10	1.89	98,958	110,093
EU26	1.98	1.70	97,991	114,118

As we can be seen the average impact per firm, i.e. the average number of job created per firm causally attributable to the funding received in either FP6 or FP7, is positive for both the two methodologies adopted and for all the country aggregates considered, with only a slight difference between the two methodologies. On average, the impact estimates summarized in Table 17 show that within the EU6 countries, receiving support from either FP6 or FP7 programmes generates between 2,21 and 2,52 additional jobs per treated firm, compared to what would have happened in the absence of the FP programmes. Within the EU14 and EU26 countries, such impact estimates lie between 1,89 and 2,10 additional jobs and between 1,70 and 1,98 additional jobs, respectively. In other words, each company receiving FP funding creates on average 2 additional jobs because of FP participation and these jobs last at least one year after the project end.

These findings can be analysed in light of existing evidence on the employment impact of enterprise support policies and R&D investments: a large number of studies on this research topic show a general positive employment effect of R&D investments, albeit with caveats.

When the monetary value of the EU contribution devoted to the FP6 and FP7 support is considered, the average cost (in term of public EU money) of generating each additional job ranges from €79.400 to € 90.800 thousand, within the EU6 countries, from about €99.000 to €110.000 thousand within the EU14 countries and from about €98.000 and €114.000 for the EU26 countries. It must be noted that this metric is provided as a rough benchmark only, and should not be interpreted simplistically to rush to the conclusion that such costs are too high. In fact, suchlike conclusions would assume the provided funding produced only additional employment as an impact. In reality, although it was not possible to estimate, it is likely that other impacts were also produced (e.g. patents, commercialisation of new products, increased revenues). Again, the simple division of the total funding by the number of additional net jobs created (net of those that would have been created also in absence of funding) must be taken simply as a rough metric of reference and should not be used as the main criteria for a conclusive judgement. As a matter of fact, such metric is calculated for the sake of comparing our results with those of other studies (see *infra*). The results summarized in Table 17 clearly highlight how the support offered by FP6 and FP7 is capable, on average, to generate some positive additionality with respect to employment outcomes.

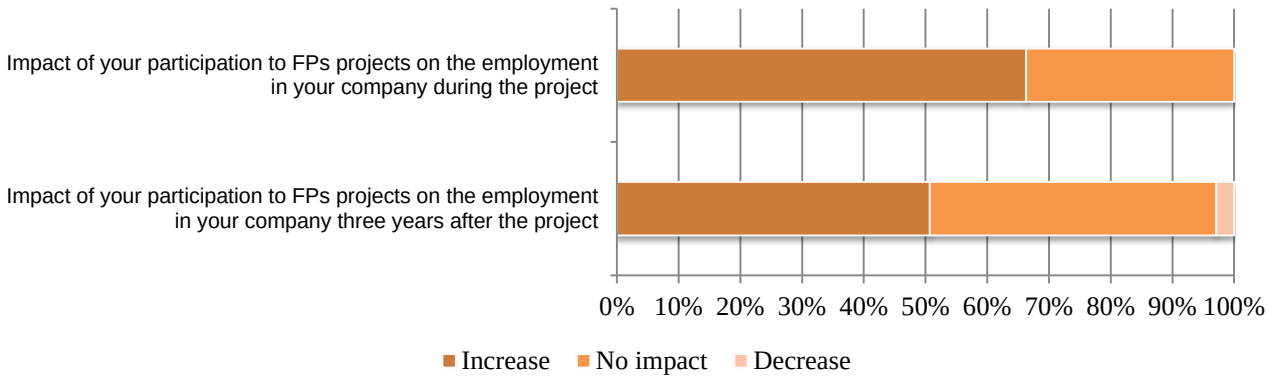
Regardless of this rule of thumb comparison, in practice the best benchmark of our finding come from looking at studies where the cost per job created can be calculated. For instance our findings can be compared with those of Bondonio and Martini (2012) who carried out a counterfactual impact evaluation of national and regional enterprise support in Italy using very similar exact matching and propensity score matching models. At the national level their focus was on "Law 488/92", a large-scale very generous programme supporting industrial firms investments in physical capital through non-repayable grants assigned via open competitions implemented on a regional basis. The impact of the policy was assessed between 2000 and 2008. On the other hand at the regional level the focus was on a single Italian region, Piedmont (a NUTS 2 region of 4.5 million people in Northern Italy), for which it was possible to build a unique database on the entire spectrum of 25 different investment support measures available to SMEs ("SME-Piemonte"). The investments were subsidized between 2005 and 2009. The results of the analysis are quite in line

with our findings in terms of employment impact estimates, with an average of 1,82 additional jobs per firm generated by the "Law 488/92" intervention. However, because the "Law 488/92" programme granted to the supported firms very large non-repayable investment grants, the average cost in terms of public money of generating each additional job (€231.000 per job) is quite higher than that for the FP6 & FP7 programmes. To the contrary, the 25 different regional enterprise support and innovation support programmes (most of which under the form of repayable assistance) available to the SMEs of the Piedmont region are estimated to generate an average of 0,32 additional jobs, but at a much lower cost of public resources (with an average cost of € 33.300 to generate each additional job). In another study, Bondonio (2014) investigated the specific impact of the major support to innovation programme offered by the Piedmont Region to medium and small enterprises. The results of such study, implemented with an exact statistical matching procedure, coupled with a difference in difference scheme, show a somewhat weaker employment boost than our estimates (+1 additional job per assisted firms, compared to the 1.70-2.5 range of additional jobs in our estimates). Because of the repayable nature of the Piedmont Region programmes, however, its corresponding cost per additional job (in terms of Gross Grant Equivalent of public expenditure) is somehow lower (€55,000/job) than the cost per job of the FP6 and FP7 support investigated in our analysis. In the same way the jobs created in other two national schemes for the German region of Turingia (GEFRA & IAB) and for Poland (Trzciński, 2011) are substantially higher than those we have calculated for the FP6 and FP7, whereas no statistically significant job impacts was found for a support scheme in Denmark (Kuhn, 2010)

For what it concerns the employment impact of R&D investments, our estimates can be compared also to a broader set of studies: e.g. Bogliacino & Pianta, 2010; Bogliacino et al., 2012; Greenhalgh et al., 2001; Hall et al., 2008; Harrison et al., 2008; Lachenmaier & Rottmann, 2011; Mansury & Love, 2008; Piva et al., 2005; Piva & Vivarelli, 2005. The bulk of these studies shows a general positive employment effect of R&D investments with the following caveats. Bogliacino et al (2012), for instance, found that that an increase in R&D expenditure by 1% stimulates employment in the business sector by about 0.15%, yet they also showed that this applies for the high-tech sector and services but it is not significant in traditional manufacturing. The evidence is robust and consistent at micro-level, although it was found that positive employment impact of product and process innovation at the firm level disappears at industry level since at this level only new products lead to new jobs (Greenan & Guellec, 2000).

The positive impact of participation to the FPs on direct job creation found in the literature has been confirmed in the interviews performed in the project. More in particular, as regards the impact of participation to FP projects on the employment of the companies during the last projects, the responses revealed that for a majority of companies, the number people hired increased, while for about one third of respondents, no impact on employment was perceived ("*the FP had impact on the employment*"[72]).

Figure 32 Job creation (n=87)



Moreover in terms of impact of participation to FPs on the employment of companies three years after the project, approximately half of the respondents claimed that their participation has "No impact" (*Employees were temporary and employed for the projects*"[73]) and the other half reported an increase of employees: "*because [FP participation] helped the company keep their employees instead of firing them*"[74].

[72] Quote from Large company, Medium-tech firm, Information and Communication Technologies, EU15, Bottom performer
[73] Quote from SME, Medium-tech firm, n/a, EU13, Bottom performer
[74] Quote from Large company, High-tech firm, Information and Communication Technologies, EU15, Top performer

Starting from the results of the counterfactual impact evaluation, we will now estimate the contribution to job creation by companies participating to FP6 and FP7. In particular we will build on the results from the average job impact per firm estimated through propensity score matching, which allowed recovering the causal impact through a counterfactual exercise. The concept of causality which is implicit in this approach to impact evaluation is a standard secessionist formulation, having its origins in Hume (Bogliacino et al., 2015). It is simply a formulation of a *ceteris paribus* proposition: cause precedes and covariates with effect, and alternative plausible explanations are excluded.

Nevertheless, the estimation of a treatment effect is a different thing from identifying a structural parameter. To understand this difference we may recur to a simply example: the experimental and quasi experimental methods are focused on identifying the causal description that associates flicking a light switch with turning the light on, while a causal explanation would require identifying the structure behind an electric circuit (i.e. allowing to understand while in presence of a burned bulb the light will not turn on). This is something one should take into account in forecasting and extrapolating from this kind of exercises. A robust estimation would require identification other mechanisms at work and how they could affect and be affected by the change in policy, and of course to what extent the evidence that is provided by this policy could be generalized (the standard problem of external validity).

Having these caveats in mind, we are also pretty confident that the kind of forecast that we performed could be considered as a sort of lower bound for two main reasons:

- There is a multiplier from public R&D to total R&D because existing literature show that the additionality effect of R&D subsidies is positive. As a result, we may expect a further employment effect indirectly caused by this process;
- There is a productivity effect of R&D (Ortega Argiles et al., 2010), which increases competitiveness and, indirectly, employment.

In Table 1 we report the result of some simple back of the envelope calculation. We consider per each country the Business Enterprise Research and Development - BERD (as share of GDP) for two years, 2010 (pre Eurocrisis) and 2012 (full Eurocrisis). The years should be interpreted respectively as representative of a normal long run policy scenario (i.e. in a growth scenario) and anti-cyclical policy (or recovery policy).

We consider the distance from the Europe 2020 target for BERD, which is 2% of GDP. Since Finland is already investing more, we consider an increase by half a percentage point.

The two scenarios that we compute are the following: 1) the European Union is financing the accomplishment of the target according to the a share which is given by the share of companies financed – i.e. share of CORDA companies over total companies – ("Actual Proportions" scenario); 2) the European Union is financing the accomplishment of the target according to the a share which is given by twice the share of companies financed – i.e. twice the share of CORDA companies over total companies – ("Doubling" scenario).

We calculate the amount of expenditure in subsidy in the column Financing of the target (as share of GDP) and we report the change in total number of employee. The variation is computed using the average treatment on the treated estimated from counterfactual evaluation exercise. As a result, this number refers to the causal impact of the subsidy and not the total impact of the R&D increase (which of course will be much larger since only a very small part is financed).

As can be seen the larger impact would be in Ireland, Cyprus, Netherland and UK. The cycle effect would be minimal. The average cost for the EU28 would be 0.08% of GDP and the average impact on employment would be 0.06%. The estimated elasticity is 0.68, implying that a 1% investment in R&D through subsidies would increase the employment by 0.69%.

This is much higher than the employment elasticity of R&D estimated by Bogliacino & Vivarelli (2012), which is a further support for the policy action.

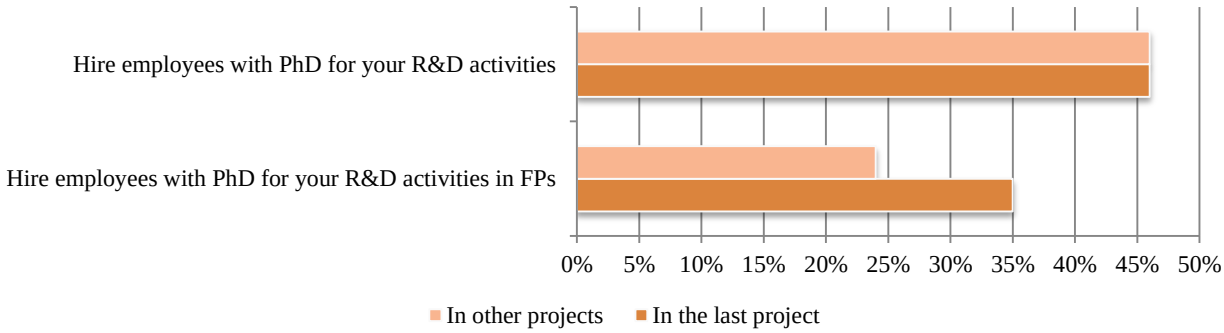
Table 18 The employment impact of FP financing, under two different scenario of reaching the Europe 2020 BERD target

			FINANCING OF TARGET				DELTA EMPLOYMENT			
	BERD		ACTUAL PROPORTION		DOUBLING		ACTUAL PROPORTION		DOUBLING	
COUNTRY	2010	2012	2010	2012	2010	2012	2010	2012	2010	2012
AT	1.24	1.24	0.13%	0.13%	0.25%	0.25%	0.11%	0.11%	0.22%	0.23%
BE	1.18	1.35	0.09%	0.07%	0.19%	0.15%	0.09%	0.08%	0.19%	0.15%
BG	0.10	0.13	0.07%	0.07%	0.15%	0.15%	0.01%	0.01%	0.02%	0.02%
CY	0.06	0.05	0.33%	0.33%	0.67%	0.67%	0.20%	0.21%	0.39%	0.42%
CZ	0.55	0.65	0.04%	0.03%	0.07%	0.07%	0.01%	0.01%	0.03%	0.03%
DE	1.78	1.90	0.03%	0.01%	0.06%	0.03%	0.02%	0.01%	0.04%	0.02%
DK	1.80	1.81	0.04%	0.04%	0.08%	0.08%	0.05%	0.04%	0.09%	0.09%
EE	0.69	1.11	0.23%	0.16%	0.46%	0.31%	0.07%	0.06%	0.15%	0.11%
EL	0.22	0.21	0.10%	0.10%	0.20%	0.20%	0.06%	0.06%	0.12%	0.12%
ES	0.58	0.58	0.10%	0.10%	0.21%	0.21%	0.07%	0.07%	0.14%	0.15%
FI	2.47	2.16	0.08%	0.08%	0.17%	0.17%	0.08%	0.08%	0.15%	0.16%
FR	1.17	1.24	0.05%	0.05%	0.10%	0.09%	0.05%	0.04%	0.09%	0.09%
HR	0.29	0.29	0.08%	0.08%	0.16%	0.16%	0.03%	0.03%	0.05%	0.05%
HU	0.55	0.60	0.06%	0.06%	0.12%	0.12%	0.02%	0.02%	0.04%	0.03%
IE	0.85	0.79	0.26%	0.27%	0.52%	0.55%	0.28%	0.31%	0.56%	0.63%
IT	0.55	0.56	0.07%	0.07%	0.13%	0.13%	0.05%	0.05%	0.11%	0.10%
LT	0.25	0.24	0.09%	0.09%	0.17%	0.17%	0.02%	0.03%	0.05%	0.06%
LU	0.66	0.55	0.19%	0.21%	0.38%	0.41%	0.26%	0.29%	0.51%	0.58%
LV	0.23	0.16	0.06%	0.06%	0.12%	0.13%	0.02%	0.02%	0.03%	0.04%
MT	0.34	0.39	0.14%	0.14%	0.28%	0.28%	0.07%	0.07%	0.14%	0.14%
NL	0.86	0.95	0.15%	0.14%	0.30%	0.28%	0.13%	0.12%	0.27%	0.25%
PL	0.18	0.29	0.04%	0.03%	0.07%	0.07%	0.01%	0.01%	0.02%	0.02%
PT	0.67	0.63	0.06%	0.06%	0.11%	0.12%	0.03%	0.03%	0.05%	0.05%
RO	0.15	0.17	0.08%	0.08%	0.16%	0.16%	0.01%	0.01%	0.03%	0.03%
SE	1.85	1.88	0.02%	0.01%	0.03%	0.02%	0.02%	0.01%	0.03%	0.03%
SI	1.20	1.60	0.11%	0.05%	0.21%	0.10%	0.05%	0.02%	0.10%	0.05%
SK	0.22	0.31	0.04%	0.04%	0.08%	0.08%	0.02%	0.02%	0.03%	0.03%
UK	0.74	0.74	0.17%	0.17%	0.33%	0.33%	0.13%	0.14%	0.25%	0.28%

4.3 Development of research and doctoral training

To answer the question on development of research and doctoral training, we take into account the interviews performed in the project. In terms of recruitment of PhD's for R&D activities, respondents reported an equal increase in the number of employees with PhD's hired in the last project and in other projects. Respondents reported that people were hired because "*high level of specialization was needed to perform the firm's activities*"[75], while one interviewee reported that "*the firm hired PhDs for two reasons: 1) we needed one more employee with such high level of expertise to perform the project, 2) a part of our consultancy work is related to collaborations with universities, for which it is an advantage to have consultants with PhDs*"[76].

Figure 33 PhD recruitment (n=86)



However, in terms of number of PhD's hired specifically in FP's, the number of respondents that indicated the hiring of personnel with PhD qualification in the last project was higher than for other projects. In general, PhD qualifications are highly valued: one interviewee held that "*their experience in research is very valuable for us. We hired less than ten employees with PhDs, not specifically for European projects. One of them stayed with the firm even though the project ended. Consequently, FP funding had a positive impact on our company in terms of employment*"[77]. Another respondent noted that "*if the company had not received FP funding, we would most likely be employing fewer people for their R&D activities*"[78].

Nevertheless, one SME interviewee postulated that "*we are keener on taking employees with commercial experience rather than with PhDs. However, we have hired employees with PhDs because of project requirements*"[79], while another interviewee stated that "*the firm does not require employees with PhDs to perform the usual activities carried out. Academic qualifications are not considered as long as candidates possess the desired skills*"[80]. A number of respondents reported that there was no need to hire additional personnel with PhD qualification. As one respondent held, there was no need to hire employees with PhD for the R&D activities in FPs "*Because the firm already had access to highly qualified personnel through collaboration initiatives with research institutes*"[81]. In a similar stance, another respondent noted that "*the skills needed to perform their usual projects are already present in-house*"[82]. It is important to notice that large companies tend to value more positive PhD employees than SMEs.

One SME that systematically hires PhD in the context of EU funding, and which increased its employment over the last years, is IRIS. The SME is described in the box below and more in detail in the Case Studies.

[75] Quote from SME, Medium-tech firm, Nanosciences, Nanotechnologies, Materials and new Production Technologies, EU15, Top performer
[76] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Top performer
[77] Quote from Large company, Medium-tech firm, Information and Communication Technologies, EU15, Bottom performer
[78] Quote from Large company, High-tech firm, Energy, EU15, Top performer
[79] Quote from SME, Medium-tech firm, Health, EU15, Top performer
[80] Quote from SME, Medium-tech firm, Information and Communication Technologies, EU15, Bottom performer
[81] Quote from SME, High-tech firm, Research for the benefit of SMEs, EU15, Top performer
[82] Quote from SME, Low-tech firm, Transport, EU15, Top performer

5. CONCLUSIONS AND RECOMMENDATIONS

In this final section we draw conclusive judgements based on the abundant evidence presented so far, taking into account the different findings from each method. The conclusions do not follow the same logical structure of the study, but rather the typical policy logic: it illustrates first why an intervention matters, and then outlines how it should be implemented. Therefore, rather than starting from participation and concluding with the impacts, we start off with the evidence related to the benefits of industry participation in FP – the impact on innovation and jobs – that constitute the rationale for the investment. We then illustrate industry participation rates and its drivers and barriers, in order to detect the main levers that could be used to achieve greater quantity and quality of industry participation.

Conclusions

1. *Participation analysis: key findings*

In terms of participation, FP7 certainly achieved positive results, reversing the decline visible since FP4 and achieving a strong improvement with respect to FP6 (the part of the overall EC contribution that went to industry grew from 17 to 25%). Similar growth rates could be found for SME participation, which grew from 6 to 13%. These data represent a clear improvement over FP6 and the main reason lie in the increase in industry participation in specific themes, such as ICT and NMP, accompanied by the high participation in new themes (e.g. Transport) and new instruments (e.g. JTI) and SMEs. These statements are to be taken with care, however, given the biases and erroneous measurements in FP6, especially in this specific sector. In this sense, another important achievement of FP7 is the improvement of data quality.

The evidence is consistent in identifying the main motivations of participation of industry in the networking activities aimed at improving or creating relationships with partners so as to develop new methods, products or services and the achievement of complementary expertise the companies can acquire when participating in FPs. SMEs tend to emphasise the importance of creating new markets and improving their commercial capacities (short/medium term), while large companies tend to be driven by gaining access to complementary expertise in order to answer to specific scientific or technical questions (medium/long term).

This focus on strategic objectives is further confirmed by the analysis of the drivers and barriers. The main driver for industry participation (for large companies, SMEs and gazelles alike) lies in the alignment of the strategic priorities of the workprogramme with those of the company. As such, influencing the definition of the workprogramme is important, and large companies devote substantial effort to it. Moreover, FP7 is found to meet the needs of industry, even better than FP6. We found that participation of industry in certain themes, and in particular of SMEs, correlates with the degree of market-orientation of the workprogrammes. In other words, industry participation happens when it is actively pursued as a deliberate choice in the definition of the workprogramme.

Demand side factors, such as lack of awareness, lack of previous experience, lack of networks and support, are found to be important barriers for SMEs, gazelles and companies in new Member States (EU13).

Other factors that the literature identifies as important barriers were found to be less relevant or to be relevant only for some type of industry participants. Administrative burden, costs of application and low success rates appear important, but not decisive for industry, although they are particularly important for SMEs. The lack of flexibility during the project and the heavily structured top-down process are barriers for all participants, but particularly for gazelles. Time to grant is not correlated with participation rates, although mentioned as a barrier by gazelles.

Regarding funding, large companies obviously seem to participate more in themes with larger projects. The change in funding rates does not seem to have played a major role, although the evidence is far from conclusive.

In conclusion, in terms of drivers and barriers we see major differences between large companies, SMEs and gazelles. Despite the increased participation of large companies and SMEs, the involvement of gazelles remains in the same order of magnitude of FP6. Large companies are motivated by medium/long term goals of knowledge and networking, are not too impacted by administrative burden, lack of flexibility, costs of application and success rates. Their participation is motivated with the strategic alignment with the workprogramme.

SMEs are more motivated by short/medium-term commercial goals, networking and funding. Lack of awareness and lack of networks, administrative burden, success rates, costs of application and

funding rates play a significant role in their decision to participate. Their participation is strongly correlated with the market orientation of the workprogramme (R^2= 0.66).

Gazelles are motivated by medium/long term knowledge and market goals. Lack of awareness and information is a major barrier, such as administrative burden, but especially lack of flexibility, long time-to- grant and large consortium. The design of the workprogramme is perceived as too prescriptive and jargon- rich to enable them to participate.

Table 19: overview of motivations, barriers and drivers for different types of companies.

	Large companies	SMEs	Gazelles
Main motivations	Knowledge networks	Funding and market opportunities	Knowledge networks and market opportunities
Strategic alignment	Very important, should be aligned with company objectives	Very important, should me market oriented	Very important, should be more open
Cost reduction and simplification	Important	Very important, esp. admin burden	Important, esp. flexibility and size of consortiums

Based on the evidence gathered, it appears that the balance between continuity and innovation (old and new themes, old and new instruments) from FP6 to FP7 has been effective in increasing industry participation. Moreover, the design of the workprogramme seems to be a particularly important factor in determining industry participation, for both large companies and SMEs. It remains an important challenge, therefore, to ensure involvement of SMEs, and particularly innovative SMEs, in providing input in the workprogramme.

2. Innovation impact: key findings

FP7 is heavily oriented towards innovative companies, defined as companies pertaining to high tech or medium high tech NACE sector, according to Eurostat classification. The percentage of High Tech and Medium-high-tech companies participating in FP7 (16%) slightly higher than overall percentage of High Tech and Medium-high-tech companies present in the EU economy (12%). These companies attracted more than half of the total FP7 contribution (62%). However, despite the overall growth in industry participation and the overrepresentation of innovative sectors, participation of gazelles[83] remains as low as in FP6. 5% of the companies included in Deloitte's "FAST 500" list in the last four years participated in FP7 (67 out of 1346); 52% of them participated in one project only. The main barriers to participation for gazelles lie in the long time between application and project start, in the lack of flexibility to adapt the goals of the projects and in the excessively prescriptive design of the workprogramme.

[83] EUROSTAT defines gazelles as those high-growth enterprises (firms with average annualised growth greater than 20% per annum, over a three year period) that are up to five years old, they should also have at least 5 or 10 employees at the beginning of the three-year observation period. The growth can be calculated either by the number of employees or by turnover. Since we do not have microdata and the last data provided by Eurostat is old (2012), we compiled an aggregated list out of the last 4 editions of Deloitte Technology Fast 500TM EMEA report which ranks companies in the region that have experienced exceptionally fast growth. It calculates the percentage revenue growth during the last 4 years, based on fiscal year revenues. Percentage revenue growth is computed as [(FY'15 rev. – FY'12 rev.) / FY'12 rev.] x 100 (FY=Fiscal Year). All companies included in the Deloitte rankings meet the condition of annualised growth greater than 20% per annum, because the lowest growth that appears is 279% growth in 4 years.

In terms of impact on innovation, our study confirms the findings of the literature that public funding stimulate additional R&D investment by companies (input additionality) and has positive effects on innovation output, measured in terms of generating new products and to apply for patents (output additionality). However the majority of the interviewed companies define the innovation process supported by the FPs among the middle range of technology readiness. In particular, large-scale prototypes, first of a kind commercial systems and fully commercial applications are less mentioned.

The study confirms also the literature findings that public R&D programmes trigger a behavioural change in firms' R&D partnerships, alleviating barriers to cooperation: being part of larger and more stable network of collaboration is the main potential long-term benefits that the companies will retain for its R&D activity from participating to FPs, declared as important by 78% of companies.

The majority of respondents (60%) state that FP7 has helped the firm to address the obstacles usually encountered when launching a new product, technology or service on the market. However, obstacles to innovation remain present and frequently mentioned: there is insufficient flexibility to accommodate for changes in the project, which are considered an exception rather than the rule. Changing project goals require in depth knowledge and understanding by project officers; unfortunately the increasing number of projects per officer and their rotation make it difficult to ensure a sufficient coverage of each project, leading to a formal rather substantial approach to changes.[84] Another frequently mentioned challenge is the lack of follow-up funding necessary to bring solution further the TRL scale, in particular when it comes to large-scale pilots and mass production, which require substantial additional investment beyond the scope of the project.

3. Job creation impact: key findings

There is strong consensus in the literature that innovation is the main driver of productivity growth, of the creation of new products and market and hence of job creation in the medium term. However this study brings an additional perspective: R&D funding also helps creating jobs in the short term. The vast majority of the 38 studies subject to the systematic review concluded that public funding stimulate job creation. This result is also confirmed by the counterfactual impact evaluation. On average, the impact estimates revealed that within the EU6 countries, receiving support from either FP6 or FP7 programmes generated between 2.21 and 2.52 additional jobs per subsidized firm, compared to a situation in which funding through FP programmes was absent. In the same way in EU26 (all the Member States except Ireland and Cyprus), participating to FP6 or FP7 programmes generates between 1.98 and 1.70 additional jobs per subsidized firm. In other words, FP6 and FP7 programmes appear to be capable of generating the same kind of employment additionality than the more traditional national investment support policies directly tied to sales and employment improvement objectives. These findings prove to be of tremendous policy relevance, as in the current EU economic stagnation scenario, research and innovation support programmes - such as FP6 and FP7 - often compete with programmes more directly tied to employment and sales outcomes in order to draw public resources from tight regional and national budgets. In this scenario, the empirical evidence produced in this study can be of significant importance to guide EU policy makers towards considering support to research and innovation projects a viable tool to boost EU employment, instead of considering it a policy competitor of more traditional investment support programme designs.

Finally our extrapolation shows that if Europe would double the share of companies financed (i.e. doubling the share of CORDA companies over total companies) in order to reach the 2020 target for BERD (i.e. 2% of GDP the European Union), the average cost for the EU28 would be 0.08% of GDP and the average impact on employment would be 0.06%. The

[84] Moreover, according to experts participating to the workshop, there are unrealistic expectations. While in reality innovation project have low success rates (around 10%), the vast majority of FP projects are formally delivering successful results and they are stopped only in extreme situations.

Recommendations

In 2010, economists Carmen Reinhart and Kenneth Rogoff released the paper "Growth in a Time of Debt" (Reinhart & Rogoff 2010). They concluded that "*growth rates for countries with public debt over 90 percent of GDP are roughly one percent lower than otherwise*". In other words, 90% was the maximum level of possible public debt to enable healthy economic growth. The results of the study have been now recognized as false, but what matters here is that there was for some time a perceived optimal threshold for growth.

In the case of industry participation to FP, there is no evidence in the literature for an optimal threshold of industry participation. We do not know if the 25% achieved by FP7 is a sufficient percentage, or if an increase should be further pursued. The topic of industry participation became prominent because a continuous decline was detected from FP4 to FP7 (interim data), and industry participation is considered obviously as an important prerequisite to ensure translation of research results into marketable products. Since this decline has been reversed, our consideration is that the urgency on promoting industry involvement as such could be reduced and the priority steered towards the quality of this participation.

A second word of caution is that as we write these policy recommendations based on results of the analysis of FP6 and FP7, many fundamental changes in the design of the instruments and strongly related to the object of this study have already been implemented within Horizon 2020, such as:

- The creation of dedicated instruments for SMEs based on a 2 stage evaluation process;
- The introduction of bottom-up measures such as inducement prizes;
- The extension of the scope of funded activities, with the inclusion of innovation activities, closer to market.

As such, any recommendation produced by this study should be further assessed against the results of the innovation introduced in Horizon 2020.

The evidence presented so far, firstly, reinforces the need for EU R&D funding as a policy measure to stimulate both growth and jobs. EU funding provides unique added value in terms of knowledge creation and networking, and has a visible impact on job creation.

In relation to the actual changes in the funding instruments, our findings seem to have a different emphasis than existing evaluation literature insofar they indicate the need to act more on the way the workprogramme is designed and less on the "stick and carrot" incentives related purely to administrative burden, success and funding rates. Administrative burden appears in some case to be an easy "scape goat", while the reality of industry participation is more complex. These recommendations at this stage have to be considered as initial and developed mainly to stimulate the discussion in the forthcoming workshop.

Streamline and open up the processes for the definition of the work programme. There is symmetry between involvement in the definition of the workprogramme and participation in projects, and so far it appears that large industries are more active in shaping the workprogramme. In order to ensure greater participation of SMEs and gazelles in particular, it is necessary to stimulate their participation not only through dedicated funding lines and incentives, but also in the definition process of the workprogramme. Managing large-scale collaborative efforts in drafting the workprogrammes is a challenge in terms of processes, methodologies and tools to be used, but it is a unique opportunity to broaden the appeal of EU funding. This transparent community-led priority setting effort is widely recognised as a major asset of EU programmes and delivers benefits in itself in terms of community building; it is therefore important to build on this strength to promote greater experimentation in collaborative priority setting exercise using state of the art methodologies and tools, both online and offline.

Continue experimenting and introducing new mechanisms. The introduction of themes and instruments proved useful in stimulating industry participation, as proved by SME instruments and JTI. Different types of business respond to different type of funding mechanisms, hence diversity is useful in stimulating participation. At the same time, the risk of excessive diversity that further increases participation costs should be taken into account. Any experimentation should be accompanied by a strong dedicated effort of evaluation of the instruments. The new instruments should be designed around the need of different target groups; for instance, gazelle claim for more open and bottom-up instruments with shorter duration.

Enhance flexibility in projects: innovation require change and adaptation, and failure has to be considered normal. Changing the scope or the organisation of the project should not be an exception to be treated with suspicion, but a normal part of the innovation process which should actually be made easier. However, in order to understand and steer changes, a more hands-on approach from the project officers needs to be ensured, which is currently very difficult to achieve in view of the high number of projects managed. This flexibility should be extended to the increased possibility to close projects after one year, which should be perceived as a normal practice in innovation. Workshop experts agree that the most important issue is to apply the "try fast fail fast principles". It should become the norm that project try an innovative approach, fail and are closed, without any stigma attached. Too many project continue pursuing the original objectives even when it's clear they will not be attained. There should be an initial trial period to assess if the idea works, and follow-up funding in positive case. This is different from the current 2-stages approach, where the first stage is basically a feasibility study. The first stage should already include actual research and innovation.

Provide better awareness and support measures Low awareness is connected to higher perceived administrative burden and application costs. Providing proactive information and support would encourage high quality participation. This effort, however, should not only be devoted to EU funding, but to innovation funding in general. Companies typically apply in different programmes, and different programmes are effective in different objectives. Awareness raising and support should adopt a systemic approach related not only to the innovation ecosystem, but to the ecosystem of innovation funding. As a particularly important aspect, feedback on proposals evaluation should be much more elaborated in order to ensure maximum learning and opportunities for improving the proposal, as well as to ensure accountability of the process.

Maintain the focus on better and open data. Evaluation traditionally struggled to deliver results because of data cleaning and limitation. The progress in the quality of CORDA data is visible with respect to FP6. Moreover, the publication of participation data on the EU open data portal proved very successful, as participation datasets are the third most downloaded. This is a major achievement that should be maintained and improved, because administrative data are an invaluable resource for evaluation and provides immense additional benefits with respect to ad hoc surveys, as proved by out counterfactual analysis on jobs impact.

As mentioned above, traditional burden reduction measures remain important. Our recommendations on this topic are listed below.

Continue the effort towards simplification included in all existing recommendations. Administrative burden and lack of flexibility negatively affect all stakeholders, and in particular SMEs. While they do not result as insurmountable barriers, they raise participation cost in particular for new entrants. New, multi-stakeholder tools such as PPP and JTI face particular challenges in terms of governance and administration. Greater flexibility after the project starts in terms of easier processes to introduce changes of partnership and plans is also important.

Consider mainstreaming the 2-stages evaluation process throughout all themes. Success rates and high upfront cost are significant barriers, although not decisive. Early data from H2020 point at a strong oversubscription and reduction in success rates, which could bring them below the "critical level" where companies stop applying. Moreover, any simplification effort is likely to encourage applications and therefore to lower success rates, which appear already to have lowered substantially in Horizon 2020. While our findings underplay the importance of success rates, the literature provides evidence of its importance and we identify a high possibility that this factor will become more important in the future.

In conclusion, we should emphasize that our findings do not contradict existing literature, but provide additional insight that suggests a change in relative weight of the priorities rather than a dramatic reversal of priorities. At the same time, a suchlike????? switch is in line with the global trend towards a "smarter" innovation policy mix (Nauwelaers 2007).

REFERENCES

Afcha, S., 2012. Analyzing the interaction between R&D subsidies and firm's innovation strategy. *Journal of Technology Management and Innovation*, 7(3), pp.57–70.

Aho, E., 2008. *Information Society Research and Innovation: Delivering results with sustained impact. Final Evaluation FP6 ICT*,

Antonelli, C. & Crespi, F., 2013. The "Matthew effect" in R&D public subsidies: The Italian evidence. *Technological Forecasting and Social Change*, 80(8), pp.1523–1534. Available at: http://www.sciencedirect.com/science/article/pii/S0040162513000577 [Accessed October 22, 2015].

Aschhoff, B., 2009. The effect of subsidies on R&D investment and success: do subsidy history and size matter?

Bach, L., Matt, M. & Wolff, S., 2014. How do firms perceive policy rationales behind the variety of instruments supporting collaborative R&D? Lessons from the European Framework Programs. *Technovation*, 34(5-6), pp.327–337. Available at: http://dx.doi.org/10.1016/j.technovation.2014.02.008.

Bannò, M. & Sgobbi, F., 2010. Firm participation in financial incentive programmes: The case of subsidies for outward internationalisation. *Journal of Policy Modeling*, 32, pp.792–803.

Barajas, A. & Huergo, E., 2010. International R&D cooperation within the EU Framework Programme: empirical evidence for Spanish firms. , pp.1–31.

Barajas, A., Huergo, E. & Moreno, L., 2012. Measuring the economic impact of research joint ventures supported by the EU Framework Programme. *The Journal of Technology Transfer*, pp.917–942.

Barak, N., Crockett, J. & Heilingbrunner, K., 2010. *Study on Non FP Participation by Innovative SME. Reasons and Steps Forward. Final report*,

Blasco, S., Teruel, M. & others, 2014. *Young Firms and R&D subsidies in Catalonia*,

Busom, I. & Fernández-Ribas, A., 2004. Firm Strategies in R&D: Cooperation and Participation in R&D Programs.

Cerulli, G. & Potì, B., 2012. The differential impact of privately and publicly funded R&D on R&D investment and innovation: the Italian case. *Prometheus*, 30(10), pp.113–149.

Van Elk, K. et al., 2014. Performance of SMEs within FP7 An Interim Evaluation of FP7 components. , I.

European Commission, 2010a. Catalysing European Competitiveness in a Globalising World. Panel Report of FP7-ICT Interim Evaluation. Report of the Evaluation Panel to European Commission. *Development*, (June).

European Commission, 2010b. *Commission Staff Working Paper: A rationale for action*, European Commission.

European Commission, 1995. *Green paper on innovation*,

European Commission, 2014. *INITIAL LESSONS LEARNED FROM THE FIRST CALLS OF HORIZON 2020*,

Faber, J., Dijn, J. Van & Rijnsoever, F. Van, 2012. Lagging SME Participation in European Research Programs : An empirical assessment of its determinants for the Netherlands. *Working Paper*.

García-Quevedo, J., 2004. Do public subsidies complement business R&D? A meta-analysis of the econometric evidence. *Kyklos*, 57, pp.87–102.

Gilmore, A., Galbraith, B. & Mulvenna, M., 2013. Perceived barriers to participation in R&D programmes for SMEs within the European Union. *Technology Analysis & Strategic Management*,

25(March 2015), pp.329–339. Available at: http://www.tandfonline.com/doi/abs/10.1080/09537325.2013.764987.

Hanel, P., 2003. Impact of Government Support Programs on Innovation by Canadian manufacturing firms Paper for the International Conference : Evaluation of Government funded R & D Activities , from ZEW (Germany). A . Bourezak provided competent computer work . The usual. *International Conference: Evaluation of Government Funded R&D Activities*, (May), pp.15–16.

Horst, A. van der, Lejour, A. & Straathof, B., 2006. Innovation policy; Europe or the member states? *CPB Document*. Available at: http://ideas.repec.org/p/cpb/docmnt/132.html [Accessed October 22, 2015].

IDC, 2007. *Study on Innovative ICT SMEs in Europe (EU 25) FINAL STUDY REPORT*,

Lattimore, J.R.R., 2002. Statistical analysis of the use and impact of government business programs.

Malerba, F. et al., 2010. *Trends and Evolution of the EU ICT Research and Deployment Landscape*,

Nauwelaers, C., 2007. Monitoring and analysis of policies and public financing instruments conducive to higher levels of R & D investments : The " Policy Mix " project Case Study Flanders. , (December).

Reinhart, C.M. & Rogoff, K.S., 2010. Growth in a time of debt. In *American Economic Review*. pp. 573–578.

Rolf Annerberg, 2010. *Interim Evaluation of the Seventh Framework Programme*, Available at: http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/fp7_interim_evaluation_expert_group_report.pdf.

Sakakibara, M., 1997. Evaluating government-sponsored R&D consortia in Japan: who benefits and how? *Research Policy*, 26(4), pp.447–473.

Schneider, C. & Veugelers, R., 2010. On young highly innovative companies: why they matter and how (not) to policy support them. *Industrial and Corporate Change*, 19(4), pp.969–1007. Available at: http://icc.oxfordjournals.org/content/19/4/969 [Accessed October 21, 2015].

Segarra Blasco, A. & Gombau, V., 2013. Young innovative firms and R&D strategies: is the Spanish case different? *Working Papers*. Available at: http://ideas.repec.org/p/urv/wpaper/2072-222200.html [Accessed October 21, 2015].

Shipp, S. et al., 2006. Behavioural additionality of the US Advanced Technology Programme. *Government R&D Funding and Company Behaviour Measuring Behavioural Additionality: Measuring Behavioural Additionality*, p.219.

Veugelers, R., 2010. Why Firms (Do Not) Participate in EU Funded R&D Consortia.

Zúñiga-Vicente, J.Á. et al., 2012. Assessing The Effects of Public Subsidies on Firm R&D Investements: A Survey. , p.42. Available at: ideas.repec.org/p/cte/werepe/we1215.html%E2%80%8E.

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The study analyses industry participation in FP6 and FP7, based on an extensive literature review, the analysis of CORDA data corroborated by a counterfactual evaluation, interviews with participants, case studies and feedback from an expert workshop. The results show that industry participation has increased with respect to previous programmes, for both large companies and SMEs, with a particular concentration on high-tech sectors. The key factors for participation, as well as the reasons behind the different levels in different themes, appear to be more related to the strategic alignment of the programme and companies' priorities, than to operational issues such as administrative burden, success rates and participation costs. The study then presents the impact of FP on innovation, in terms of direct, indirect and behavioural additionality, and the related barriers, mainly related to the lack of flexibility during the project implementation. In terms of job creation, based on a counterfactual impact evaluation the results show that FP helped to create on average 2 new jobs per each company. Finally, conclusions and policy recommendations are presented, taking into account the innovations introduced by H2020.

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