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Analysing FP7 from a Systemic Perspective What Role for the Delineation and the Set up of the Sub-Programmes?

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1 Introduction

The Seventh EU Framework Programme for Research and Technological Development (FP7) was one of the world's largest support programmes for research and development even though the sum of national research budgets in the EU is still higher. More than € 55bn, the third largest section of the European budget, have been invested in knowledge, innovation and human capital with the declared objective to increase the potential for economic growth and to improve European competitiveness. In this effort, FP7 covered not only different themes and disciplines but addressed different stages of the innovation process and multiple, heterogeneous stakeholders.

In the most general terms, the 7th Framework Programme, as its predecessor, was adopted as an instrument to support the integration of a "European Research Area" (ERA) (Chou, 2012), a "system of research programmes integrating the scientific resources of the European Union", one "in which researchers, scientific knowledge and technology circulate freely" and suitable to "strengthening [the Union's] scientific and technological bases" (European Commission, 2000). It is defined as a clear complement to national research policy while at the same time addressing the same resources and people – to build a robust, overarching innovation system of strong players with complementary capacities, well networked across national borders.

In recent years, following FP7's formal conclusion, various evaluation studies have been published, which come to an overall favourable assessment of the programme's achievements. Without doubt, these are relevant, valid and this very paper builds substantially on the many findings that they have established. Until now, however, the internal structure of what we refer to as "the Seventh Framework Programme" remains underexplored. Despite the fact that it has now already been notably adapted for Horizon 2020, little empirical evidence is available on the extent to which its different lines sub-programmes complemented each other, resonated with national efforts and, in so doing, led to satisfaction or frustration among their consortiums of beneficiaries.

As the basis for such analysis, it is useful to recognize that a Framework Programme is *per se* little more than a budgetary umbrella under the remit of DG Research and Innovation that can be given different strategic orientations. Comparable units of analysis would be the budget and strategy of e.g. the U.S. National Science Foundation or any European Member State's Research Ministry. From this point of departure, it becomes clear that the key to designing a systemically efficient research policy does not only lie with the definition of suitable overall objectives for a European Framework Programme, but, just as much, with the strategic clarity, match and complementarity of its composite parts. In light of this, the overall objectives have to be translated into a conscious strategy of defining and arranging specific sub-programmes both vis-a-vis each other and

existing national programmes – and in line with the High-Level Expert Group's recommendation to "integrate the key components of the Framework Programmes more effectively" (High-Level Expert Group, 2015).

Moreover, individual sub-programmes have to be technically designed to be attractive to and generate satisfactory outcomes for beneficiaries. So far, the potentials and challenges of this systemic level of strategic framework programme development have been less commonly discussed than FP7's overall impact. In this specific regard, Borrás and Radaelli's (2011) finding that the architecture of EU Research Policy remains a somewhat "neglected field of study" may thus still be appropriate.

As many have outlined, the transfer of theoretical insights from academia into research policy is difficult (Caracostas, 2007) not only as, on a time scale, it depends on 'windows of opportunity' (Kingdon, 1984) but also as the whole process is constantly subject to non-conceptual factors of influence (Edler, 2014, Jensen and Slapin, 2012). Still, the authors believe that a theoretically informed empirical analysis of FP7 experiences can serve as a solid foundation to put in perspective the structural changes in sub-programmes that have been introduced in Horizon 2020 as well as to inspire further thoughts on future Framework Programme design.

To that end, this paper will reflect on FP7's objectives in the light of existing findings from different literatures. Subsequently, it will analyse of a comprehensive set of survey data, collected in the course of a recent FP7 evaluation. It will identify FP7's sub-programmes' factual profiles, their mutual delineation and contribution to the Framework Programmes overall objectives. Following that, it will conclude with an assessment and contextualisation of recent changes in the strategic set-up of EU research policy.

2 Conceptual Section

Beyond doubt, the internal structure of FP7 was rather heterogeneous, not only in terms of measures and actions, but also in terms of its objectives. A case in point is that, at first sight, the four FP7 sub-programmes appear to have little in common.

The sub-programme "Ideas" refers to block funding allocated to a self-governing entity, the European Research Council, whose mission it was to allocate funding for the support of excellence-based, and often, blue-sky research. Typically, these are awarded to single researchers. The sub-programme "People" referred to a number of programmes that were meant to support researcher mobility, so-called "Marie Curie Actions", again, often awarded to single beneficiaries. The sub-programme "Cooperation", in contrast, subsumed different, in their majority network-based support actions that, by outsiders,

would be most commonly identified as "Actions of the European Framework Programme". The heading of the "Capacities" sub-programme, finally, covered a diverse array of different actions relating to research infrastructures, research for the benefit of SMEs, regions of knowledge, and research in Convergence Regions (European Commission, 2015). Of the four FP7 sub-programmes, "Capacities" was by far the most heterogeneous in its organization and objectives (High-Level Expert Group, 2015). Arguably, parts of the current set-up result from historic evolution and political compromise as much as from than overarching strategic considerations (Edler, 2014).

Despite this diversity in actions and sub-programmes, the European Commission's Directorate-General for Research and Innovation suggested that all support efforts under FP7 were meant to relate to one same catalogue of common objectives:

- promoting excellence in research,
- fostering competitiveness and economic growth,
- contribute to solving social challenges,
- strengthen human potential and researchers' mobility, and
- fostering trans-national research collaboration.

To acknowledge the inherent challenges of the Seventh Framework Programme's overall target system, it is instructive to make passing reference to the fairly general strategic visions that it is based on, like that of a "European Research Area" or that of a "Innovation Union" (van den Hove et al., 2012; Chou, 2012; De Elera, 2006; European Commission, 2000). As both seek to address various ambitions like the 'free movement of researchers', 'competitiveness' and 'excellence' in parallel (Cerna and Chou, 2014), it is inevitable that this multifaceted target system became reflected in the architecture of the Framework Programme.

At the same time, however, the EU's research and innovation landscape remains characterised not only by diversity but also by substantial disparities (Kroll et al., 2009, Kroll and Stahlecker, 2009). Obviously, therefore, it is far from trivial to devise overarching policy strategies that not only pursue different objectives but also address a highly diverse set of beneficiaries.

On the one hand, the Framework Programme's key objectives thus succinctly summarise the overall task of European Research Policy and provide a suitable framework of reference for it. On the other hand, there are obvious tensions among several of the objectives, which cannot be reconciled within single actions and constitute a substantial challenge for the Seventh Framework Programme as a whole.

For example, the academic literature suggests that in order to strengthen fundamental discovery and to make science systems more productive as measured by standard

metrics of science, Europe must promote the emergence of hubs of excellence (Dosi et al., 2006; Balconi et al., 2010), even though such concentration needs to be handled with care and should not be overdone (von Tunzelmann et al., 2003). To be productive, such central research groups should focus exclusively on fundamental research. In their objectives, an applied perspective should not be overemphasized (Schubert, 2014). Certainly, some of them should allow disciplinary experts to draw on already shared knowledge bases. At the same time, however, an interdisciplinary orientation has to be encouraged to allow new fields of science to emerge, even at the price of potential short-term productivity losses (Darbellay, 2015; Buanes and Jentoft, 2009; Bruce et al. 2004). Across Europe, all able researchers should be allowed to gravitate (Oliver, 2012) towards these hubs which, among each other, should be networked across national boundaries.

With regard to innovation, by contrast, the key objective is to provide as many actors as possible, across sectors and countries, with access to knowledge and technology (Lundvall, 1992; Nelson, 1993; Patel and Pavitt, 1994; Edquist, 1997). While by definition knowledge generating, related consortia need not focus on formal scientific productivity to the same extent than hubs (Schubert, 2014). Not only as the science system is fragmented per se, but also as there is an obvious spatial imbalance between locations of excellent science and locations of innovative business (Kroll et al., 2009, Kroll and Stahlecker, 2009), a need for more connectivity in specific topics is obvious even among leading member states (Kroll and Stahlecker, 2010). In the meantime, a number of weaker countries will have to be connected to this system through capacity building (Kroll et al., 2012).

Conceptually, therefore, the main challenge in supporting the emergence of a both viable and sustainable European Research Area and Innovation Union thus arguably lies in the acknowledgement that the ambitions of individual support policies can be conflicting and need to be carefully orchestrated and calibrated to a achieve a good balance. Furthermore, it has to acknowledge which parts of this bigger puzzle are already provided through national policies and institutions and how Europe can provide added value by 'closing gaps'.

In the following, the inherent challenges and potential conflicts are elaborated for each of the key objectives based on available studies' existing findings.

Firstly, the promotion of *research excellence* is neither necessarily suitable to promote growth and competitiveness in the short- or even mid-term (Balconi et al., 2010) nor is it needed (Kline and Rosenberg, 1986). While fundamental research is indeed the basis for later economic prosperity (Mazzucato, 2013; Dosi et al., 2006; Bush, 1945) it is not per se the key to resolving the "European paradox" (European Commission, 1995) or the EU's current state of "Innovation Emergency" (European Commission, 2016).

Connected to this is the issue of size. While there is ample evidence for increasing returns to scale in research (Glass et al.1995; Dundar and Lewis, 1998), many studies also find that over a certain threshold, these effects diminish (Brandt and Schubert, 2013) or may not at all be generally present (Bonaccorsi and Daraio, 2005; Cohen, 1991). Finally, it is politically contentious, in particular when connected to large-scale investments (Jacob and Hallonsten, 2012). Excellence based allocation of funding would, within a Union with very uneven capacities (Kroll et al., 2012) often favour those already strong and further weaken the weakest and approach which is only under certain framework conditions political viable (Jensen and Slapin, 2012).

Secondly, fostering *competitiveness and economic growth* on the basis of science is an increasingly common (Elzinga, 2012), yet independent objective that depends on improving diffusion and adaptation processes rather than boosting discovery (Partha and David, 1994; Kline and Rosenberg, 1986). Even if scientific discovery is translated into patent these may often be directly relevant for industry (Henderson et al., 1998). Importantly, competitiveness and growth thrive on learning by doing (Arrow, 1962), learning by using (von Hippel, 1986), learning by interaction (Andersen and Lundvall, 1988) rather than technology transfer alone. Hence, support for research can often only contribute indirectly, e.g. by raising absorptive capacity (Cohen and Levinthal, 1990) by promoting science-industry collaboration (Balconi and Laboranti, 2006; Cohen et al., 2002). Politically, this is per se attractive for different Member States (Kroll et al., 2012). For technological leaders, however, it can in practice become less attractive once the diffusion of own technologies to others outweighs the mutual learning aspect too strongly.

Thirdly, research contributing to solving *social (or even societal) challenges* comes with transaction costs that can reduce the effectiveness of not only knowledge creation but also knowledge diffusion. In many cases, concrete social aspects are not part of the object of investigation per se, even if they may be part of the project's objectives. To reach beyond performing research in 'societally relevant areas' and actually make contributions to society, additional, conscious investment in outreach and stakeholder involvement will be required in many projects (Ryan, 2015). In a similar sense than the objective of competitiveness, the objective of societal relevance has an impact on researchers' autonomy and consequences for the orientation of proposals admissible under the Framework Programme. To an extent, it may be incompatible with the objective of promoting research on the basis of a "conventional definition of excellence" (Wickham, 2004) while, at the same time, societal relevance does not per se imply relevance for competitiveness and economic growth.

Fourthly, the promotion of *researchers' mobility* (Chou, 2012) aims to, on an aggregate level, generate added value for Europe as a whole (Cerna and Chou, 2014). At the same time, however, it tends to lead to a further concentration of human resources in attractive locations that already receive most excellence based funding from national and European research councils – as has been unambiguously demonstrated by existing evaluations (High-Level Expert Group, 2015). Like excellence based funding, therefore, it tends to improve overall output to the detriment of the broad-based diffusion of benefits and value created. Also, there is a danger that taking researchers out of a working environment they know and are productive in may weaken output in the short term as while they have to invest in learning and adaptation and overcome administrative obstacles (Chou, 2012; Oliver, 2012).

Finally, fostering trans-national research collaboration is an objective fraught with political expectations (Tamtik and Sá, 2014; Jensen and Slapin, 2012). Conceptually, there is no specific argument why a trans-national cooperation project should per se be more beneficial for other aspects of innovation system performance than a merely national one. The argument often made, that more collaboration, both within and across nations, helps overcome structural fragmentation ("loneliness problems", cf. von Tunzelmann et al., 2003), leverage synergies and create critical mass between groups (Brandt and Schubert, 2013) is valid, but in practice at jeopardy of becoming highjacked by political interests or being bogged down by inter-state bargaining problems (Jensen and Slapin, 2012) and again lead away from excellence based considerations to specific national ones (Lepori et al., 2007).

In light of the abovementioned tensions with a view to achieving all stated objectives at the same time, European Research Policy will have to support research undertakings and consortia with the following, in part rather irreconcilable profiles

- consortia with sufficient critical mass in fundamental research to produce substantial formal output in terms of publications and at the same time give rise to new lines of research,
- research consortia that aim at developing and diffusing application oriented solutions by involving a substantial amount of relevant business partners,
- research consortia reaching out into society to involve those partners needed to successfully address grand challenges with relevant mission-oriented research,
- research groups that attract excellent researchers from across the European Union and beyond to form the best possible research groups,
- research consortia that gather research partners from various Member States and beyond to leverage network synergies.

3 Research Questions

While the European Commission maintained that FP7 with its four different sub-programmes formed a strategically coherent system, the specific role of each sub-programme within this system was rarely explicitly addressed or defined. While FP7's lead objectives are clearly defined, their attribution to sub-programmes remained unclear as did the sub-programmes' mutual relations and overlaps. The Commission avoided to singularly attribute individual objectives to one sub-programme, e.g. excellence to ideas. At the same time, however, the particular character and thrust of the individual sub-programmes was emphasised, implying that their specific contribution to the overall FP7 lead objectives could not possibly be alike.

Against this background, this study will pursue the aim of clarifying the underexplored issue of the different sub-programmes positioning within the framework programme as well as with regard to other support efforts at the level of the national states.

Hence, the subsequent sections of this paper will address the following research questions:

1. How do the four sub-programmes differ with regard to their general orientation?
2. How do the four sub-programmes differ from national level programmes?
3. Do the four sub-programmes display distinctive profiles with a view to the abovementioned overall FP7 objectives?
4. To what extent are there commonalities among the four otherwise distinct sub-programmes?
5. To what extent did the sub-programmes meet the participants' expectations?
6. If differences occur: Why did some more commonly meet participants' expectations?

4 Methodology

Two years after the Seventh Framework Programme's conclusion, it is now possible to conduct an ex-post analysis of FP7 projects' orientations and (perceived) outcomes. Rather than simply asserting that the internal coherence of actions and stated objectives was less than clear, it has become possible to establish an empirical picture of the system of sub-programmes with regard to not only their orientation but also the factual contribution that they have made to the overall FP7 headline objectives. Against that background, the factual strategic coherence of the FP7 support effort can be assessed and put in perspective. Additionally, the satisfaction of project participants can be taken into account and put in perspective of specific approaches towards implementation.

In that sense, the present paper attempts an analysis of FP7 sub-programmes not necessarily as they were meant to but as they have turned out to operate across the 2007-13 support period and, against this background, to draw further conclusions for future research policy.

The paper builds on a unique dataset, which is based on a survey of FP7 participants from all four main sub-programmes that was conducted between 19/05/2014 and 16/06/2014. The survey was part of the "Study on Network Analysis of the 7th Framework Programme Participation".

A sample of around 8,000 potential respondents was compiled based on a full set of raw CORDA data provided by the European Commission's services. To remove distortions by conceptually very specific programmes, all other information relating to activities outside the perimeters of the four main sub-programmes (EURATOM, JRC direct actions, etc.) as well as all information relating to Networks of Excellence and ERA-Nets was removed from the dataset. This left data on 21,969 projects and 116,032 participants in the dataset, defining participants as distinct in the context of projects, i.e. allowing for multiple answers if there were multiple participations. In cases with more than one scientific contact, one was selected on a random basis. FP7 Associated Countries were excluded from the population.

Following extensive data cleaning, a representative yet fully random sample was drawn, using a stratified approach that took into account the three core dimensions 'start date of the project', 'country affiliation of the participant' and 'FP7 sub-programme'. The final sample size amounted to 8,448, of which 7,591 respondents could actually be reached (i.e. their emails did not return error messages). 2,595 of the addressees started to answer the questionnaire (34% response rate) and 1,929 completed it in full (25%). Of those, 1,508 could be identified as funded under Cooperation, 154 under the Ideas, 503 under People programme, and 426 under the Capacities programme. This distribution is, as Table 1 illustrates, much in line with the action specific lines' overall share of FP7 participants listed in official documentation.

Table 1: Distribution of Survey Answers across Sub-Programmes

	budget total (in bn €)		participants total		answers in survey	
Cooperation	28.336	63.6%	87,623	66.6%	1,508	58.2%
Capacities	3.772	8.5%	19,047	14.5%	426	16.4%
People	4.777	10.7%	19,515	14.8%	503	19.4%
Ideas	7.673	17.2%	5,405	4.1%	154	5.9%

Source: own analysis

In the following, the main research questions outlined above will be addressed by means of responses that have been extracted from different sections of the original survey questionnaire, recombined and analysed in a more differentiated perspective. Concrete reference to the respective survey question will in the following be made wherever necessary. In all other cases, the question can be assumed to stand in obvious, self-explanatory correspondence to the evidence provided. In detail, the following questions have been taken into account:

RQ1: How do the four sub-programmes differ with regard to their general orientation?

- stated overall orientation of project (fundamental vs. applied research),
- stated contribution to "Grand Challenges".

RQ2: How do the four sub-programmes differ from national level programmes?

- stated reasons to undertake project in FP7 rather elsewhere.

RQ3: Distinctive profiles with a view to FP7 objectives?

- stated production of scientific results (by type),
- stated result in terms of innovations (by type),
- stated contribution to transfer from science to the market,
- number of newly-hired researchers during/after project,
- attraction of internationally renowned researchers,
- stated contribution to collaboration with global researchers,
- stated establishment of links with other organisations.

RQ4: To what extent are there commonalities among the distinct sub-programmes?

- stated contribution to the development of a new line of research,
- stated contribution to collaborations with different inst. Sectors,
- stated contribution to transfer from science to society,
- stated contribution to collaborations with researchers from different nations,
- stated establishment of links with other organisations (outreach).

RQ5: To what extent did the sub-programmes meet the participants' expectations?

- benefits and Costs of participation in the FP7 project,
- degree of satisfaction with direct outputs of the FP7 project,
- degree of satisfaction with long term outcomes of the FP7 project.

Table 2: Descriptive Statistics

	N	min	max	mean	std. dev.
dummy Capacities	2,587	0	1	0.16	0.37
dummy People	2,587	0	1	0.19	0.40
dummy Ideas	2,587	0	1	0.06	0.24
dummy Cooperation	2,587	0	1	0.58	0.49
contribute to fund. research	2,077	0	1	0.65	0.48
contribute to applied research	2,055	0	1	0.66	0.47
contribute to appl. fund. research	2,040	0	1	0.36	0.48
health, demographic change	1,758	1	5	3.62	1.45
food, agriculture, bioeconomy	1,703	1	5	4.11	1.31
secure, clean, efficient energy	1,690	1	5	4.19	1.25
smart, green, integrated transport	1,682	1	5	4.31	1.17
climate, resource efficiency	1,708	1	5	3.86	1.40
inclusive, innovative, reflective	1,677	1	5	4.18	1.26
to reach critical mass	2,140	0	1	0.55	0.50
to support interdisciplinarity	2,140	0	1	0.45	0.50
to bring ideas to the market	2,140	0	1	0.20	0.40
to connect science and society	2,140	0	1	0.21	0.41
linkages to excellent int. partners	2,140	0	1	0.64	0.48
enhance int. visibility of research	2,140	0	1	0.39	0.49
output (pub, pat, awards)	1,328	0	8	4.10	1.79
innovations (product/process)	1,963	2	4	3.43	0.75
transfer from science to market	1,481	0	4	2.30	0.87
transfer from science to society	1,581	0	4	2.43	0.92
outreach to policy makers	1,968	0	1	0.21	0.41
outreach to PNP organisations	1,968	0	1	0.12	0.33
outreach to civil society	1,968	0	1	0.10	0.30
outreach to healthcare	1,968	0	1	0.09	0.29
post-docs recruited	1,972	0	150	0.99	4.38
Ph.D. students recruited	1,972	0	88	0.88	2.54
attracting researchers from...					
...leading economies	1,935	0	1	0.24	0.43
...from emerging economies	1,935	0	1	0.14	0.35
strengthen links to EU researchers	1,903	1	5	2.22	1.00
strengthen links to global researchers	1,770	1	5	3.21	1.38
establish res. infrastructures	1,282	0	4	2.09	0.95
establish res. infrastructures	1,282	0	4	2.09	0.95
outreach to industry	1,968	0	1	0.34	0.48
a new line of research	1,928	1	5	2.65	1.13
links with universities	1,968	0	1	0.44	0.50
links btw institutional sectors	1,754	0	4	2.33	0.95
transfer from science to society	1,581	0	4	2.43	0.92
filing of patent applications	2,002	0	1	0.12	0.33
if again, more SMEs	1,295	0	3	2.04	0.85
if again, more PNP orgs.	987	0	3	1.62	1.07
cost-benefit relation	1,834	1	5	2.05	0.96
direct outputs	1,911	1	4	2.02	0.75
long-term outcomes	1,906	1	4	2.09	0.80
structural variables					
nr_partners	2,010	1	70	7.59	9.18
nr_partners (sq)	2,010	1	4,900	141.80	380.85
building on FP6 projects	1,505	0	5	2.23	1.47
share companies	2,050	0	100	20.20	28.86

Source: own analysis

As can be seen in Table 1 on the descriptive statistics, most of the variables to be analysed are either dichotomous or ordinal on Likert 4 or Likert 5 scales, with the exception of some composites built from more complex questions. To address Research Questions 1-5, a first suitable step to present and interpret findings are therefore standard cross-tabulations. Concluding, a multivariate regression will be conducted to address Research Question 6 and to corroborate and complement earlier findings. Hence, the following table also includes a number of structural variables that will be used in this regression.

5 Results

With regard to Research Question 1, how the four sub-programmes differ with regard to their general orientation, the survey reveals that the sub-programmes can be divided in two groups, each having a distinct focus. In terms of both orientation and activities, Ideas and People placed a strong emphasis on fundamental research while Capacities and Cooperation predominantly focused on applied research.

On a thematic level, too, the survey results show the distinct orientations of the two groups. A relatively high share of Capacities and Cooperation projects were stated to contribute to at least one of the Grand Challenges that FP7 was designed to address. As to be expected, however, the orientation towards Grand Challenges played a smaller role for projects under Ideas and People. Unlike those under Cooperation or Capacities, they were usually not tendered with a specific thematic focus on predefined "key themes". The survey results thus correspond nicely with the officially stated objectives of the individual sub-programmes.

At the same time, there is notable overlap. Some Grand Challenges such as 'Health and Demographic Change' played an important role for Ideas and People as much as for Cooperation and Capacities projects. Moreover, some of the latter focused to a considerable degree on fundamental research. Thus, Cooperation's and Capacities' applied focus is a lot less pronounced than that of Ideas' and People's focus on fundamental research.

Table 3: General Objectives of Projects by Sub-Programme

type of research effort	Ideas	People	Capacities	Cooperation	avg.
purely fundamental research	**64%**	**44%**	16%	13%	22%
applied basic research	**35%**	**45%**	**47%**	**55%**	50%
purely applied research	1%	8%	**29%**	**28%**	23%
Grand Challenges tackled	Ideas	People	Capacities	Cooperation	avg.
Health, Demographic Change	**27%**	**26%**	23%	36%	27%
Climate, Resource Efficiency	14%	18%	**33%**	**28%**	26%
Food, Water, Bioeconomy	4%	17%	**23%**	**21%**	20%
Energy Production	10%	13%	**21%**	**17%**	16%
Inclusive, Reflective Societies	13%	14%	**25%**	15%	16%
Transport	2%	8%	9%	**19%**	14%
Freedom and Security	7%	4%	9%	10%	8%

Source: own analysis

With regard to *Research Question 2*, the four sub-programmes' added value opposed to national support, the findings suggest clear unique selling points for FP7 actions. Yet, the profile of distinction, as well as its clarity, differs notably between the four sub-programmes. Interestingly, these differences with regard to 'unique selling points' are even more pronounced those with regard to the sub-programmes overall orientation.

The main issue that distinguishes the Ideas programme from alternative support actions at national or regional level was its interdisciplinary orientation, which, to a lesser extent, also mattered for Cooperation. Apparently, the respondents found it easier to gain funding for multidisciplinary research at the EU level than in their respective home countries.

For projects supported under People, Capacities and Cooperation, critical mass appears to have been the main factor for the respondents' decision to submit applications under the FP7, confirming a common perception that FP7 provides a unique opportunity to fund large scale research projects, involving a high number of partners. The improvement of linkages with excellent international research partners, by contrast, appears to have plaid a much lesser role. Apparently, the opportunity for networking was not *per se* a priority for the funded researchers. Likewise, the enhancement of the international visibility of existing lines of research was typically not considered a critical factor for the submission of proposals under FP7.

Finally, the ambition to bring ideas to the market played a remarkably important role, if only for the more application-oriented sub-programmes. In part, it surpassed the de-

gree to which the aim to transfer science to society was cited as motivational factor. At the same time, both ambitions existed side by side, in all but the Ideas programme.

Table 4: Motivation for choice of FP7 rather than national funding (by Sub-Programme)

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
to better connect science and society	35%	43%	39%	38%	39%
critical mass / resources needed	22%	**58%**	**60%**	**72%**	**64%**
interdisciplinary complementarity	**82%**	42%	47%	**59%**	**55%**
to bring new ideas to the market	13%	35%	41%	**53%**	**45%**
linkages with excellent international partners	4%	20%	25%	22%	21%
enhance international visibility of existing research	5%	9%	26%	24%	20%

Source: own analysis

Concerning *Research Question 3*, whether the four sub-programmes display distinctive profiles with a view to the overall FP7 objectives, the findings suggest that although there are notable differences in emphasis between projects supported under the four sub-programmes, there is by no means a simple 'division of tasks' between them.

Projects supported under the Ideas and the People programme generated substantially higher outputs in terms of high-quality academic results. Evidently, these sub-programmes have been most successful in creating outstanding hubs of basic research that received awards for their achievements. Nonetheless, publication activities in the Capacities and the Cooperation programmes were notable as well.

Table 5: Scientific Results of Projects by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
award for contribution to fields	**43%**	12%	9%	13%	14%
peer-reviewed articles	**99%**	**86%**	54%	73%	75%
other academic publications	**68%**	51%	44%	52%	52%
development of new methodologies	**66%**	49%	39%	50%	49%

Source: own analysis

At the same time, Capacities and Cooperation projects have contributed more to the second FP7 objective of fostering competitiveness and economic growth. Specifically, they did not only make general contributions to 'transfer knowledge from science to the market', which was also claimed by a number of Ideas and People supported projects. More notably, they were also on average two to three times more likely to develop tangible instruments (e.g. pilot plants) or to produce product or process innovations.

Evidently, therefore, contributions to competitiveness and economic growth in the short- to mid-term resulted almost exclusively from projects under the Capacities and Cooperation programmes. In contrast to the less than pronounced differentiation with regard to research output, a more or less clear 'division of tasks' can in this regard be identified.

Table 6: Applied Results of Projects by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
science to market transfer	15%	22%	**38%**	**37%**	33%
new instrument type (tangible)	12%	12%	**31%**	**19%**	19%
product innovations	8%	15%	**30%**	**28%**	25%
process innovations	8%	21%	**45%**	**37%**	33%

Source: own analysis

With regards to the third FP7 objective of contributing to solving social challenges, Capacities and Cooperation projects displayed a higher degree of interconnectedness to societal actors and policy makers. Overall, Ideas projects were least connected in terms of societal outreach, underlining that societal relevance does not equal societal contributions. Remarkably, moreover, the 'Science in Society' action under the Capacities programme did not result in an improvement of that sub-programmes' summary outreach to social actors.

Regarding the fourth objective, the strengthening of human potential and researchers' mobility, the strongest contribution was made by the Ideas and the People programmes. Here, the average number of researchers prompted to change their place of employment by such projects as well as the attraction of international researchers was much higher than it was in Capacities or Cooperation projects.

Table 7: Societal Outreach of Projects by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
with policy makers	8%	10%	**30%**	**25%**	21%
private non-profit research	5%	11%	15%	12%	12%
civil society organisations	4%	9%	12%	10%	10%
healthcare institutions	8%	10%	6%	10%	9%

Source: own analysis

Table 8: Attraction of Excellent Researchers by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
PhD students (avg.) hired for the project/ kept after the project	**2.4/0.4**	**1.2/0.7**	0.4 / 0.2	0.7 / 0.3	0.9
Post-docs (avg.) hired for the project/ kept after the project	**3.2/0.6**	**1.4/0.6**	0.6 / 0.3	0.7 / 0.4	1.0
share of projects attracting researchers...	**Ideas**	**People**	**Capacities**	**Cooperation**	**avg.**
...from leading economies	**51%**	**30%**	22%	19%	24%
...from emerging economies	**28%**	**18%**	10%	13%	14%

Source: own analysis

The fifth FP7 objective, fostering trans-national research collaboration, could *a priori* be expected to fall into the domain of the Cooperation and Capacities programmes, considering the large number and heterogeneity of partners that their projects typically involved. Interestingly, however, both the Ideas and People programmes made a substantial contribution to this objective as well. For example, Ideas projects' contributed to the strengthening of links with the EU and, in particular, global partners more commonly, than Capacities and Cooperation projects. The latter, in turn, more commonly produced improved linkages between science and industry and created collaborative infrastructures.

These findings suggest that the FP7 objective of trans-national collaboration can be achieved in more than one way and not exclusively through the specific network approaches under the Capacities and Cooperation programmes that is based on the inclusion of large and heterogeneous groups of actors. Thus, no simple 'division of tasks' could be found and the multi-dimensional character of the objective was clearly revealed.

Table 9: Networking Effect of Projects by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
contribution to strengthening links to EU partners	**85%**	68%	71%	76%	76%
contribution to strengthening links to global partners	**74%**	**54%**	29%	30%	30%
contribution to establishing joint research infrastructures	22%	14%	**31%**	20%	21%
contribution to strengthening links with industry	27%	23%	**41%**	**38%**	35%

Source: own analysis

With regard to *Research Question 4,* on the commonalities shared by the four sub-programmes, the survey finds that in many ways all four sub-programmes shared certain outcomes, which in a way corresponds to the commonalities identified with a view to their general orientation. Across the four sub-programmes, participants referred to contributions to new lines of research (inter-disciplinarity), an improvement of linkages between universities (critical mass), improved collaboration between institutional sectors (bring ideas to market) as well as contributions to knowledge transfer from science to society. These outcomes can all be considered highly desirable.

On the downside, however, participants in the Capacities and Cooperation programmes, which were formally meant to bring ideas to the market, did not indicate more patent applications than those under the Ideas programme. Also, nearly every fourth participant in either of them sees a need to include more SME. The need to include more non-profit organisations, moreover, is not yet considered as relevant, despite there so far limited involvement. These results seem to suggest that even projects under the Capacities and Cooperation programme continue to face challenges in reaching objectives related to technology transfer and the integration of industry into research networks.

Table 10: Commonalities of the Sub-Programmes

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
new line of research	55%	57%	46%	51%	52%
links with universities	64%	59%	42%	38%	45%
collaboration between institutional sectors	51%	49%	46%	52%	51%
science-society transfer	34%	37%	38%	43%	40%
filing of patent applications	15%	7%	10%	15%	13%
If you were to restart, would you include more SME	-	-	25%	27%	-
If you were to restart, would you include more PNP	-	-	14%	16%	-

Source: own analysis

With regard to *Research Question 5*, the extent to which projects conducted under specific sub-programmes succeeded or failed to meet participants' expectations, satisfaction rates were found substantially higher in the Ideas and, on most accounts, the People than in the other two sub-programmes. To the contrary, assessments regarding the Capacities projects remained notably below average on next to all accounts.

With a view to the abovementioned differentiation of contributions, we thus find that satisfaction rates are highest in non-cooperative programmes with a clearly defined focus on fundamental research and/or researchers' mobility and a less obvious contribution to the socioeconomically more complex areas of the Framework Programmes target system such as networking, creating critical mass, societal outreach, and to support transfers from science to market. On average, apparently, it proved challenging to leverage research activities for the achievement of objectives in domains beyond science.

Table 11: Satisfaction with Projects by Sub-Programme

	Ideas	**People**	**Capacities**	**Cooperation**	**avg.**
benefits greatly exceeded costs	**89%**	**72%**	**59%**	67%	68%
satisfication with					
... direct outputs	**98%**	**83%**	**66%**	72%	75%
...long-term outcome	**98%**	**77%**	**64%**	67%	71%
...project coordination	**74%**	63%	67%	68%	67%

Source: own analysis

With regard to *Research Question 6*, regarding the reasons for participants' satisfaction, regression analyses were conducted to corroborate that a project's attribution to a distinct sub-programme plays a role, irrespective of its overall orientation. In detail, the following factors were taken into account:

- whether the general objective of the research project was fundamental research or applied research or a combination of both,
- which specific objectives were addressed by the projects and have motivated the participants to apply for FP7 rather than alternative types of funding.

Furthermore, a number of structural factors were controlled for, that, on a technical level, could be expected to influence project performance, including:

- the number of project participants as stated in the survey,
- inter-sectoral heterogeneity (share of companies) in the consortium, and
- the degree to which the project was a continuation of an earlier effort under the 6th Framework Programme (Likert).

Finally, outputs and results were taken into account as they will, with great likelihood, impact on participant satisfaction as well, e.g. with a view to

- the number of types of notable outputs achieved (patents, publications, ...),
- whether or not innovations have resulted from the project,
- the degree to which a transfer from science to market was achieved (Likert),
- the degree to which a transfer from science to society was achieved (Likert).

The regressions were performed as ordered probit models for three different dependent variables on four or five point Likert Scales: perceived benefit-cost ratio, satisfaction with direct output and satisfaction with long-term outcomes. Below, Table 12 presents the results of these regression analyses.

In summary, all three regression models corroborate earlier results that projects conducted under the Ideas and People sub-programmes achieved a significantly higher degree of satisfaction than those performed under the Cooperation sub-programme. By contrast, those performed under the Capacities programme tend to lead to lower satisfaction. Interestingly, the significance of this finding is in no manner weakened when their general orientation and the specific objectives in which they are known to differ is controlled for. Evidently, participant satisfaction is determined by characteristics closely associated with a project's attribution certain sub-programmes yet not to a relevant extent covered by any of the control variables. Given that the sum of all control variables comprehensively covers much of the sub-programmes profiles (cf. above analy-

sis), it stands to reason to attribute this remaining, notable effect to differences in their strategic set-up.

With a view to the control variables, all regressions suggest that while a threshold number of partners is necessary, too large numbers will eventually become an obstacle (inverse U-shape). As to be expected, moreover, a broader range of scientific outputs increases participants' satisfaction while the involvement of firms and even positive innovation outcomes tend to lower it. While the successful transfer of results from science to society increases satisfaction, this is not the case for the successful transfer of results to the market. Empirically, therefore, this provides evidence that the transfer of results from FP7 research to the market may be the most critical cross-domain transfer challenge.

Table 12: Determinants of participant satisfaction

dV =	perceived cost-benefit ratio	satisfaction with direct output	satisfaction with long-term outcome
dummy Capacities	**-.421 ****	**-.248 ***	**-.207 (°)**
dummy People	-.145	**.490 *****	**.447 ****
dummy Ideas	**.938 *****	**1.205 *****	**1.193 *****
fundamental research, 'blue sky'	.238	**.390 (°)**	**.692 ****
applied research	-.028	-.000	.319
basic research with applied perspective	-.133	-.154	**-.540** *
aim to reach critical mass	.093	.134	.098
aim to further interdisciplinarity	.004	.036	-.055
aim to bring ideas to the market	.033	.027	-.046
aim to connect science and society	-.123	-.015	-.053
aim to link with excellent int. partners	-.056	.004	.049
aim to enhance int. visibility of research	**.178 ***	-.007	**.240 ****
nr_partners	.016	**.034 ***	**.029 ***
nr_partners (squared)	**-.000 °**	**-.001 ****	**-.001 ***
share companies	**-.006 *****	-.004	-.001
building on FP6 projects	.009	.026	-.029
output (pub, pat, awards)	**.078 ****	**.052 ***	**.135 *****
innovations (product/process)	**-.110 °**	**-.094**	**-.097 (°)**
transfer from science to market	-.058	.075	.064
transfer from science to society	**.151 *****	**.325 *****	**.296 *****
-2 Log-Likelihood	1946.81 ***	1692.03 ***	1784.55 ***
Pseudo R^2 (McFadden)	.065	.105	.107

level of significance: *** = 0.001; ** = 0.01; * = 0.05; ° = 0.10; (°) = 0.15

Source: own analysis

6 Summary

With a view to the abovementioned findings we can thus identify the following characteristics in the way the FP7 sub-programmes worked together both internally and with a view to alternative support opportunities:

Firstly, the different directions of thematically open support under the Ideas and People versus thematically driven support under the Capacities and Cooperation programme were clearly perceived by the participants, as was the more applied orientation of the latter and the by and large fundamental orientation of the former.

Secondly, a delineation from national programmes was perceived unanimously in terms of interdisciplinary ambitions and the aim to link science and society. While the Ideas programme was perceived as distinct next to uniquely due to its interdisciplinarity, participants in other programmes also emphasised critical mass and market orientation.

Thirdly, a factual 'division of tasks' between the four sub-programmes has emerged in line with their orientation, with fundamental research left to Ideas and People and applied research and outreach performed Capacities and Cooperation. The latter, however, serve various key FP7 objectives at the same time and display in part contradictory profiles.

Fourthly, all projects share some outcomes in certain dimensions, while they displayed clear differences in others. Across the board, all were perceived as contributing to new lines of research and as bridging institutional sectors. On the downside, they share that there is limited tangible evidence of transfers from science to market as well as societal outreach, irrespective of the respective sub-programmes' relative focus on these objectives.

Fifthly, projects under the Ideas and, to a certain extent, also the People programme, i.e. those following a thematically open approach to tendering, achieved a much higher degree of satisfaction than those, e.g. under the Cooperation programme, that were thematically driven. Moreover, projects supported under the Capacities programme, fared worse than those under the Cooperation programme.

Finally, the regression analysis of participants' satisfaction confirms the fact that the specific sub-programme under which work was performed, remains an important predictor of the participants' assessment of their FP7 experience even if relevant, known, differences of these sub-programmes are controlled for. Apparently, the sub-programmes' context as such plays an important determining role – that merits further strategic consideration.

7 Discussion

Overall, this study confirmed that an implicit division of tasks was established within FP7, one that follows naturally from its sub-programmes general objectives and ambitions.

With the European Research Council (Ideas) and the Marie Curie Actions (People), two distinctly European approaches have been introduced to research policy that contributed substantially to the key objectives that they were designed to address, the promotion of excellent fundamental research and the encouragement of mobility. At the same time, both made substantial contributions to trans-national networking across Europe and beyond. Finally, both were clearly delineated from national alternatives, and their participants significantly more satisfied with their FP7 experience than those in other projects.

That being so, however, the Cooperation and Capacity sub-programme were not only set up to address new and ambitious tasks of promoting outreach and improving competitiveness. At the same time they still had to - and did - address long-standing strategic ambitions of thematic, mission-driven research – brought forward from earlier FPs and expanded in FP7. Finally, they had to maintain a profile that remained delineated from national alternatives. Evidently, this catalogue of targets comprises more than one single role in the overall system and evokes multiple conceptual and strategic tensions within one formally coherent programme. Among those, a most critical one is that between thematic, mission-driven research, on the one hand, and transfer and outreach-oriented efforts, on the other. Arguably, the below average degree of participant satisfaction could result from those.

While a full separation of both ambitions would counteract justified ambitions of integrating research with innovation and value chains, projects under the Cooperation programme could so far not even be subsumed under a clear primary objective. Even if this was clearer at the project level, the sub-programme thus lacked strategic focus. In the Capacities programme, moreover, a large array of different types of actions added further complexity. Science in Society and Research Infrastructures actions, for instance, had little in common to start with. Also, some actions under Capacities were prone to support oversized networks that this paper's analysis could confirm have a negative impact on participant satisfaction.

Conceptually, the study's empirical findings thus underline that there was indeed a degree of tension between the 7th Framework Programme's overall objectives, which, at the time, was less than satisfactorily accommodated by both its sub-division into four sub-programmes and these sub-programmes individual set-up.

8 Policy Conclusions

As the policy and objective system analysed in this paper has already been replaced by that of Horizon 2020, this conclusion will provide both an assessment of changes adopted and an indication which further amendments could appear useful in the years to come.

Firstly, the tasks of fundamental knowledge generation, addressing societal challenges and supporting growth and competitiveness should be separated in both public communication and the concrete primary targets that participants are required to deliver on. With 'Excellent Science', 'Societal Challenges' and 'Industrial Leadership' H2020 now already defines its key sub-programmes in that manner and should stay true to that approach in the process of defining specific Calls and Terms of Reference.

Secondly, the most positive results found for the Ideas and People programmes can be read as supporting vigorous investments and limited, if any, need for change in the H2020 fields of 'Excellent Science'. Furthermore, positive findings for the thematically-driven research aspect of the Cooperation programme support the new approach of defining a separate support line for 'Societal Challenges' with research as a primary, and transfer and outreach as secondary objectives – that should be further developed.

Thirdly, while the definition of a new, separate sub-programme for 'Industrial Leadership' appears welcome, substantial challenges remain with regards to designing a research policy that directly contributes to the creation of "growth and jobs". Even in science-industry research consortia, a conceptual tension between knowledge generation and diffusion remains. Hence, clear primary targets related to the "growth and jobs" objective have to be developed and further continuous emphasis must be placed on broad-based diffusion.

As such, fourthly, the discontinuation of the Capacities umbrella in H2020 is to be welcomed. The new distribution of its constitutive parts, however, appears less than fully convincing. The integration of the programme for research infrastructures under 'Excellent Science' stands in some contrast to our evidence regarding its role under FP7. Arguably, its desirable contribution to a European Research Area is a so notably different one than that of e.g. ERC projects, that they should be pursued under different headings.

At the same time, objectives like 'Science in Society' that were found reconcilable with all FP7 sub-programmes and, as the only cross-domain ambition, conducive to participant satisfaction, have been relegated to a stand-alone programme. Instead, issues addressed by this programme appear of relevance to all research funded under Horizon 2020 and could be cross-cutting objectives. As our above findings underline, a

specific programme alone will not notably increase the societal outreach of even its host sub-programme.

Finally, limited attention seems to have once more been paid to the geographic concentration effects that all research policy inevitably has, especially in areas where an express focus is put on excellence and critical mass. Thus, there is a danger of H2020 projects remaining detached from relevant areas of the Union's economy and science system should they remain disconnected to other domains of European policy.

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