Building on past experience via ex-post evaluation is an increasingly important element in the design of research programmes and policies, notably at the European level. Being aware of the strength and weaknesses of past Framework Programmes, knowing their impacts and realising in which fields potential impacts could not be achieved, is a precondition for the improvement of any new programme.

Based on the evidence of ex-post evaluations, this chapter looks back at past Framework Programmes and shows what lessons were helpful for the design of the 7th Framework Programme. The chapter starts with some methodological considerations linked to the evaluation of Framework Programmes (Section 1). Turning to the outcomes and impacts of Framework Programmes, the accumulated evidence convincingly shows that the Framework Programme has had a clear positive impact not only on participants’ immediate competitive position, but also on their capabilities, behaviour, and ability to compete. It has improved Europe’s scientific, technological, and innovative performance (Section 2). And it has strengthened Europe’s human capital (Section 3) and integrated European research infrastructures (Section 4), and enhanced the coordination of Member State research policies and actions (Section 5). It has also generated wider economic, social, and environmental benefits (Section 6).

1. Evaluating the framework programme is not easy

1.1. Evaluating research projects is complex

Identifying the outputs and economic, social, and environmental impacts of individual research projects is complex. The first reason is the difficulty of attribution, which concerns the key question at the heart of every impact study: to what

---

1 The Union, in response to its desire to regulate better, calls for transparency and accountability, as well as budget constraints, wants to know what impacts past policies and programmes have generated, and how it can increase those of future ones. The importance attached to learning lessons from the past and building on experience is reflected in the Commission’s impact assessment guidelines.

2 Over the years, an extensive and highly diverse body of Framework Programme ex-post evaluation literature has emerged. It consists of studies carried out for the European Commission focussing on the pan-European Framework Programme experience, and studies carried out for the Member States concentrating mainly on the programme’s national impact. The spotlight of Commission studies was sometimes on the Framework Programme as a whole, sometimes on just one or a few Specific Programmes. Past Framework Programme evaluations were sometimes of an ad hoc and one-off nature, and sometimes carried out repeatedly within the context of the formal Framework Programme ex-post evaluation system.
extent are measurable effects really the result of – that is causally attributable to – the project under review?\footnote{Joanneum Research Forschungsges.m.b.H \textit{et al.}, \textit{Evaluation of Austrian Participation in the 4th EU Framework Programme for Research, Technological Development and Demonstration}, 2001, p. 27.} Usually it is not just the individual research project financed which has produced the solution to a particular problem or a certain impact. Project participants may have received funding from other sources as well. In the case of the Framework Programme, for instance, account has to be taken not only of purely national direct and indirect research funding, but also of other funding schemes supporting international collaboration such as bilateral agreements, COST, and EUREKA. \footnote{PREST \textit{et al.}, \textit{Socio-Economic Impacts}, pp. 85–86; Joanneum Research Forschungsges.m.b.H \textit{et al.}, \textit{Austrian Participation}, pp. 27–28.} Fig. 4.1 shows the evolution of European cooperative research funding schemes, which have grown from 6 per cent of total government expenditure on R&D in 1985 to 15.5 per cent in 2003\footnote{Estimates based on general budget data drawn from financial reports from different institutions.}

In addition, impacts may have resulted not only from intended effects directly related to programme goals but also from indirect and unintended effects going beyond programme goals. Next, factors other than research itself may have contributed to an impact\footnote{PREST \textit{et al.}, \textit{Assessing the Socio-Economic Impacts of the Framework Programme}, June 2002, pp. 159–161; Erik Arnold, \textit{What the Evaluation Record Tells Us about Framework Programme Performance}, May 2005, pp. 8–9.}. Finally, attribution is hindered by the usually long period

---

Fig. 4.1. The Framework Programme accounts for a major share of European Cooperative Research-Funding (Cooperative Research as a share of total government expenditure on R&D)

Source: DG Research

Note: Government Expenditure on R&D (GOVERD). Data are for EU-15 and EFTA-countries
of time between the funding and carrying out of research on the one hand, and the
results of that research becoming visible on the other hand.

The second reason for the complexity involved in identifying the outputs and
impacts of individual research projects is the need to assess additionality or what
it is that would have happened anyway even without public support. Three important
kinds of additionality are input additionality (did public support increase research
and innovation inputs? Or did it just replace and crowd out inputs that would
have been made anyway?); behavioural additionality (did researchers change their
behaviour (importance attached to research and research collaboration, project
management) as a result of receiving public support and participating in the
project?); and output additionality (would the same outputs have been obtained
without the policy action?).

1.2. The Framework Programme has evolved in terms of rationale, content,
and budget

In addition to the methodological problems discussed in the previous section,
puzzling together a consistent picture of past Framework Programmes and their
outputs and impacts is hampered by the programme’s main characteristics having
evolved rather substantially over time. The Framework Programme constitutes a
moving target, and this first of all in terms of its rationale.

The start of the Framework Programmes constituted a radical break with what
came before. Until the late 1970s, European research policy was of an ad hoc nature.
Because it was tied to particular sectors (agriculture, coal, nuclear energy, steel,
etc.), it was also fragmented. Research policy was mainly a national affair, even
though the Founding Treaties already provided the Community with a responsibility
in the field. The 1st Framework Programme (1984–1987), and the inclusion of
a separate chapter on RTD in the Single European Act (1986), heralded the shift
towards a legally solidly grounded integrated European research policy focussing
on the competitiveness of European industry and the quality of life of European
citizens.

This apparent unity of purpose has not precluded a certain evolution of the
programme’s rationale, however, accommodated by the fact that as some observers
have noted the overall Framework Programme objective is extremely permissive. The
reason for this evolution is that each Framework Programme was prepared
against a different background. The rationale for the 1st Framework Programme was

---

6 Joanneum Research Forschungsges.m.b.H et al., Austrian Participation, pp. 30–31.
7 PREST et al., Socio-Economic Impacts, pp. 105–115; Joanneum Research Forschungsges.m.b.H et al.,
Austrian Participation, pp. 28–29.
8 EC, Euratom, ECSC Treaties.
9 Arnold, Evaluation Record, May 2005, pp. 3–4.
the perceived technology gap. The 2nd Framework Programme (1987–1991) was intended to strengthen the research base of European industry in response to fierce Japanese competition. Developing information and communication technologies was high on the political agenda. The 3rd Framework Programme (1990–1994) was developed against the background of efforts to integrate the European market. The conceptualisation of the 4th Framework Programme (1994–1998) took place during the period of the Maastricht Treaty (1992) and the White Paper on Growth, Competitiveness and Employment (1993). The 5th Framework Programme (1998–2002) put increased emphasis on socio-economic values. And the 6th Framework Programme (2002–2006) was designed to help build the European Research Area (Table 4.1). Together with its rationale, the Framework Programme’s content has also evolved. The number and content of Specific Programmes has changed from one Framework Programme to the next. The number of thematic priorities has multiplied. And new instruments have been introduced.

Another indicator of substantial change has been the growth of the Framework Programme budget, which reached about €19 billion (at 2004 prices) for the four-year period 2002–2006 under the 6th Framework Programme, and may reach about €48 billion (at 2004 prices) for the seven-year period 2007–2013 under the 7th Framework Programme (Fig. 4.2). In 2006, research accounted for 4 per cent of

| Periods          | Main objective                   | Main priorities                | New actions                                      |
|------------------|----------------------------------|--------------------------------|-------------------------------------------------|
| Before (1975–1983) | Ad hoc approach                  | Energy oriented                | –                                               |
| FP1 (1984–1987)  | Coordination of Community RTD    | Energy and ICT oriented        | Environment, international cooperation, human capital and mobility |
| FP2 (1987–1991)  | Information society              | ICT oriented                   | Biotechnologies, marine resources, dissemination |
| FP3 (1990–1994)  | Industrial competitiveness       | Multiple priorities            | –                                               |
| FP4 (1994–1998)  | Industrial competitiveness       | Multiple priorities            | Transport and social sciences                    |
| FP5 (1998–2002)  | Innovation and social needs      | Multiple priorities            | Nanotechnologies                                 |
| FP6 (2002–2006)  | Instrument for ERA               | Multiple priorities            | New instruments                                  |

Source: DG Research

10 Stefano Breschi and Lucia Cusmano, *Unveiling the Texture of a European Research Area: Emergence of Oligarchic Networks Under EU Framework Programmes*, CESPRI Working Paper No. 130, July 2002, p. 5.
11 European Commission, *Five-Year Assessment of the European Union Research Framework Programmes 1999-2003*, 15 December 2004, p. 4.
Building on Experience

Fig. 4.2. The growing Framework Programme budget (evolution of the FP budget (€ million, 2004 Prices))

Source: DG Research

Note: *: Provisional

the EU budget (Fig. 4.3) The Framework Programme also accounts for about 6 per cent of EU-15 non-military governmental RTD expenditure. This share increases to almost 25 per cent when public support for research is more narrowly defined.

1.3. Framework Programme data

Painting an adequate picture of the Framework Programme and its evolution over time has been hampered by a relative lack of data. Naturally the first purpose of databases holding information on Framework Programme applicants and participants has always been to facilitate proper Framework Programme contract and financial management, not the production of detailed statistics on Framework Programme application and participation patterns. Under the first few Framework

---

12 European Commission, General Budget of the European Union for the Financial Year 2006 – The Figures, Luxembourg, 2006, pp. 13–15 (Sum of commitment appropriations for “Research” and for “Research Framework Programme” under “Enterprise”, “Energy and transport”, “Information society and media” and “Direct research”).

13 Court of Auditors, Special Report No 1/2004 on the Management of Indirect RTD Actions under the Fifth Framework Programme (FP5) for Research and Technological Development (1998 to 2002), Together with the Commission’s Replies (Pursuant to Article 248(4) Second Subparagraph EC) (2004/C 99/01), 23 April 2004, Paragraph 5.

14 Court of Auditors, Special Report No 1/2004, Paragraph 5: “However, if institutional funding is deducted, the budget for FP5 indirect RTD actions amounts to approximately a quarter of total funding for publicly financed research projects in the European Union”.

Programmes, different and not always compatible databases were in use managed by different Commission services in charge of a particular Framework Programme component, making it difficult to arrive at one integrated dataset for a single Framework Programme. As instruments and rules of participation evolved from one Framework Programme to the next, the labels attached in the databases to Framework Programme participants also changed, which makes it difficult to analyse, for instance, the evolution of the participant type structure (e.g. evolution of industrial participation). Some data on project outputs have been collected in the past via end-of-project reports, but these have tended to be incomplete, and this is not helped by the frequent perception that reporting such outputs represents a significant administrative burden on Framework Programme participants.

1.4. The Framework Programme monitoring and evaluation system

The European Commission has been involved in research programme evaluation since the late 1970s. Yet it was only in the early 1980s, when evaluation became a legislative requirement, that the institutionalisation of Commission research evaluation practices picked up pace.\(^{15}\)

The ex-post evaluation system The Framework Programme ex-post evaluation system was introduced in the mid-nineties.\(^{16}\) Its two main components are yearly monitoring exercises and five-yearly in-depth assessments (the so-called “Five-Year Assessments”) carried out at overall and usually also specific programme

---

15 Ken Guy et al., Strategic Options for the Evaluation of the R&D Programmes of the European Union, Final Report Prepared for STOA, Brighton, 1999.

16 European Commission, Independent External Monitoring and Evaluation of Community Activities in the Area of Research and Technological Development, Communication from the Commission to the Council and the European Parliament, COM(96) 220 final, 22 May 1996.
level. The annual monitoring exercise is intended to be rather light and enable a quick response to issues arising from ongoing programme implementation. The objective of the Five-Year Assessments, on the other hand, is to provide input for policy formulation and decision-making on the basis of feedback obtained from programme implementation.

The current Framework Programme ex-post evaluation system has obvious strengths, for example its independence and legitimacy. However, the literature has also identified some important weaknesses which go beyond the issues plaguing all research evaluations (time lag, attribution, additionality, difficulties of measuring qualitative effects, etc.). According to some evaluation experts, the main problem affecting the current system relates to FP design: “The intervention logic that connects the high-level and operational goals of the FP is poorly articulated, making an overall evaluation of the FP difficult. The Framework needs more systematic planning, clearer objectives and a stronger link to an evidence base. This would ease evaluation and, arguably, improve FP performance.” This problem is of course not specific to EU programmes. The same difficulties apply when it comes to establishing quantifiable ex-ante objectives for programme evaluation at the national level.

Other (potential) problems have been identified mainly with regard to the available evidence base and the use of expert panels. A strong and timely evidence base constitutes the main tool for Five-year Assessment expert panels on which to base their assessment and recommendations. Yet a number of studies have highlighted weaknesses in the evidence base available. Sometimes thematic ex-post evaluations have not (yet) been completed, or they focus on different issues, cover different periods, or have been carried out according to different methodologies. That means that panels must work with rather fragmented evidence, or with what is still possible to do in the very short run. Especially in recent years substantial efforts have been made to address this issue.

In Framework Programme ex-post evaluation, use is often made of external expert panels. As mentioned above, they contribute to independence and legitimacy. However, some observers have considered them to be time- and

---

17 The careful timing of the Five-Year Assessments allows for the combination of an ex-post evaluation of the previous Framework Programme with a mid-term appraisal of the ongoing one to formulate recommendations for the next Framework Programme. To read more about the Framework Programme ex-post evaluation system, see, for instance, Luc Durieux and Gilbert Fayl, The Scheme Used for Evaluating the European Research and Technological Development Programmes, In: OECD (Eds.), Policy Evaluation in Innovation and Technology – Towards Best Practices, Paris, 1997, and Ken Guy and Wolfgang Polt, Strategic Options for the Evaluation of the R&D Programmes of the European Union, Plattform – Technologie – Evaluierung, No. 8, April 1999.

18 Erik Arnold, What The Evaluation Record Tells Us About Framework Programme Performance, Technopolis, January 2005, p. ii.

19 See Guy and Polt, Strategic Options, April 1999; European Commission, Five-Year Assessment of the European Community RTD Framework Programmes – Report of the Independent Expert Panel Chaired by Viscount E. Davignon and the Commission’s Comments on the Panel’s Recommendations, Luxembourg, 1997, and subsequent Five-Year Assessments; Arnold, Evaluation Record, January 2005.
resource-intensive. Though strict rules apply, others have claimed that it is difficult to avoid completely conflicts of interest. Some analysts have suggested that panel members may be pressurised into promoting unrelated agendas and specific interests. And with regard to the 2000 Five-Year Assessment, one scholar noted that “many of the recommendations drew not so much on an evaluation of past FP activities, but on the collective opinions and assessments of the panel member concerning the general structure, and organisation of RTD in Europe.” It should however be borne in mind that these problems are not unique to the Framework Programme, but exist in many other industrialised countries’ R&D programmes as well.

The above observations on Framework Programme evaluation are all well known and well documented. Indeed, most of the remarks come from the Framework Programme evaluation process itself. But this is also one of the greatest strengths of the system, because transparent and constructive criticism is one of the main vehicles for promoting programme improvement. And indeed many important improvements to the Framework Programme in the past have emanated from comments made at the evaluation stage.

**Topics, sources, and methodologies** Above we have argued that, except for the recent introduction of impact assessment, the Commission’s research evaluation system has remained relatively stable over the past decade. Greater change has characterised the evaluation studies carried out. New topics are being explored, studies are based on new kinds of sources, and use is made of innovative methodologies.

In past Framework Programme ex-post evaluations, substantial attention used to be paid to analysing participant characteristics (e.g. type of institutional actor, country of origin, region of origin, etc.) and R&D inputs. At the same time, much emphasis was put on counting project outputs in order to arrive at total and average (per project) numbers of publications, patents, and so on. This has not disappeared. But attempts are now made to profile programme participants in more innovative ways. This includes analysing their scientific (e.g. numbers of publications, numbers of citations, citation impact scores) and technological (e.g. numbers of patents) quality, the nature of their participation (one-time vs. repeat participation), the nature of their networking behaviour (stable vs. changing partnerships), and so on. From merely counting project outputs, the emphasis has also shifted to assessing

---

20 Gustavo Fahrenkrog et al. (Eds.), *RTD-Evaluation Toolbox Assessing the Socio-Economic Impact of RTD-Policies*, JRC-IPTS and Joanneum Research, Strata Project HPV 1 CT 1999 – 00005, August 2002.

21 Luke Georghiou, *Assessing The Framework Programmes – A Meta-Evaluation*, In: *Evaluation*, Vol. 1, No. 2, 1995 (Referred to in Arnold, *Evaluation Record*, January 2005). Panel members cannot have been FP contractors, or members of or experts to any FP Programme Committee during the preceding five years. The organisation for which the panel member works can, however, continue to participate in the FP. So does the panel member after the conclusion of his/her mandate.

22 PREST et al., *Socio-Economic Impacts*, p. 180.
Framework Programme aggregate impacts on Europe’s scientific and technological performance, and on research capacity, or on the European economy and society.

The study of such more challenging topics can be embarked upon because of the mining of new data sources. Framework Programme ex-post evaluations used to be based mainly on surveys (interviews or written questionnaires) and end-of-project reports. However, attempts are now made, for instance, to create cleaned and consolidated participant databases at the individual scientist level rather than just the institutional level, and to link them with bibliometric and patent databases. The use of bibliometric and patent data almost by definition also entails the use of new methodological approaches and techniques. Within this context, mention should be made of the use of econometric models to estimate the impact of the Framework Programme on the European economy, as was done in the impact assessment on the Commission’s proposal for the Seventh Framework Programme.

The way forward Against this background, several steps are envisaged to improve the Framework Programme’s evaluation system. A clearer formulation of the intervention logic in the 7th Framework Programme proposal with clear and measurable objectives and the monitoring of their progress will facilitate the ex-post evaluation of the 7th Framework Programme. A comprehensive effort will be made under the next Framework Programme to ensure that the ex-post evaluation will be based on a wide range of completed, focussed and methodologically standardised ex-post evaluation studies.

Continued efforts will also be made to explore new topics, sources, and methodologies. There is, for instance, a great need to assess better whether project outputs/impacts were the result just of a research project being carried out, or of a research project being carried out at European level. Important questions also remain regarding the optimal mix of partners in a project, or the optimal size of networks. Also, what constitutes a project of critical mass? Does it relate to the number of partners? To the level of funding? How does critical mass interrelate with flexibility, with cohesion, with excellence? Are repeated Framework Programme participation and the stability of networks across Programme calls and even across different Framework Programmes good or bad, and when do they become excessive? To answer these questions, further efforts will have to be made to consolidate and link databases. New methodologies will also need to be explored, especially those being able to shed a light on questions of causality. For instance, does participation in the Framework Programme increase the quality of an individual scientist or institution,

http://ec.europa.eu/research/future/index_en.cfm

To read more, see also European Commission, Building the Europe of Knowledge, Proposal for a Decision of the European Parliament and of the Council Concerning the Seventh Framework Programme of the European Community for Research, Technological Development and Demonstration Activities (2007 to 2013) – Proposal for a Council Decision Concerning the Seventh Framework Programme of the European Atomic Energy Community (Euratom) for Nuclear Research and Training Activities (2007 to 2011), COM(2005) 119 final, 6 April 2005.
or does it attract already excellent scientists and institutions? As much as possible, methodological development in the field will be supported by including relevant research topics in the Framework Programme’s work programmes. It will also be supported through Commission networking. Networking is first of all required in-house, so that methodologies may be standardised. But external networking is also needed so as to achieve complementarity between European Commission and national level Framework Programme evaluations. Those networks also allow sharing and comparing hard evidence of the impact of research policies at regional, national and EU levels and will help identify what is done best at each level, and how to design the S&T governance model in the most efficient and effective way.

2. COLLABORATIVE RESEARCH AND ITS IMPACTS

Collaborative research constitutes by far the largest component of the Framework Programme, accounting for 70 per cent of the budget of the 6th Framework Programme. Collaborative research projects are implemented by transnational consortia composed of firms, universities, and research institutes. Under successive Framework Programmes, collaborative research projects have been organised under broad thematic priorities (e.g. Energy, ICT, etc.) covering a wide range of S&T disciplines. Growth in the collaborative research budget has been accompanied by increases in the number of collaborative research projects and participations. Between the 2nd and 5th Framework Programmes, the number of projects increased by about 140 per cent from 2,779 to 6,712, while the number of participations grew by about 240 per cent from 13,000 to 44,000.

2.1. The size of collaborative research projects

The added value of European funded collaborative research projects is among other things to be found in the fact that they allow for pooling financial resources and knowledge across national frontiers. This allows research projects to attain the appropriate size or “critical mass” needed to achieve scientific breakthroughs. In other words, it helps break down the wasteful fragmentation of research efforts across Europe. It is therefore interesting to analyse how the scale of Framework

25 Within this context, DG Research set up the European RTD Evaluation Network in 1997 to enhance cooperation between the national RTD evaluation units/agencies or agencies concerned with evaluation and the relevant Commission Services. To read more about the RTD Evaluation Network, see http://www.cordis.lu/fp5/monitoring/rtd_evalnet.htm

26 A participation is counted for each participant involved in an FP project. The same participant may be involved in several projects and therefore have several participations.

27 See for example European Commission, Five-Year Assessment, 1997, p. 23: “The [European] scientific community’s added value lies in it being a networked pool of talent that can compete internationally at a level beyond the capability of an individual Member State. Hence a European critical mass can be established in areas where no one Member State can separately mount a major effort”; Arnold, Evaluation Record, May 2005, p. i.
Programme research projects has evolved over time in terms of number of participations and funding. The average number of participations per project increased from 4.7 in the 2nd Framework Programme to 6.5 in the 5th Framework Programme, while the average Commission funding per project increased from €1.2 million to €1.4 million. At the same time, average EU funding per participation decreased from €256,000 to €196,000. The 6th Framework Programme appears to have initiated a trend towards decisively larger projects with more participations per project, and with higher funding per project and per participation (Table 4.2).

So the trend appears to be towards larger projects. But a better understanding has to be gained of what “critical mass” means, and of how it can be achieved. For example, does it refer to the number of participants in and the size of the funding allocated to a collaborative research project? If that is the case, what do we know about the ideal number of participants and the ideal size of funding? Is the relation between project scale and project achievement a simple linear one, or is there a minimum efficient project scale above which there is a disproportionately higher level of achievement? Is it possible to make general statements about it, or is it

| Table 4.2. Towards critical mass – the changing features of shared-cost research actions across Framework Programmes |
|--------------------------------------------------|
| Indicators                                      | FP2-EU-12 | FP3-EU-15 | FP4-EU-15 | FP5-EU-15 | FP5-EU-25 | FP6-EU-25 |
|                                                 | Definitive data | Definitive data | Partial data | Definitive data | Definitive data | Interim data (first calls) |
| Nº of projects                                 | 2779      | 3292      | 2949      | 6709      | 6712      | 1188       |
| Nº of participations (000)                     | 13        | 18        | 21        | 41        | 44        | 16         |
| Average nº of participations per project       | 4.7       | 5.6       | 7.0       | 6.2       | 6.5       | 13.5       |
| Average nº of different Member States per project | 3.0       | 3.5       | 4.2       | 3.7       | 4.0       | 6.5         |
| Average EU funding per project (€000)           | 1202      | 1218      | 1160      | 1405      | 1405      | 4322       |
| Average EU funding per participation (€000)     | 256       | 218       | 165       | 200       | 196       | 320        |

Source: DG Research
Note: FP4 Data Partial (01.01.1994-31.12.1996); FP6 Data Partial (to 11.03.2005); Average EU funding per participation under FP6 calculated by summing the EC contributions of all projects and dividing by the number of participations

---

Evidence Ltd et al., *The Role of Selectivity and the Characteristics of Excellence*, Report to the Higher Education Funding Council for England: A Consultancy Study within the Fundamental Review of Research Policy and Funding, October 2000.
CHAPTER 4

thematic priority or even topic specific? These are tricky concepts to analyse and quantify, but more research on such questions would be very valuable.

2.2. The characteristics of collaborative research participants

Who participates in the Framework Programme and receives Framework Programme funding? What kind of institutions are they? Where, that is what country or region, do they come from? How often do they participate? The answers to these questions provide important insights into the nature of the research collaboration induced by the Framework Programme.

Participation pattern by type of institution

Available data indicate that over time the pattern of participation in collaborative research projects by type of institution has become more balanced. Whereas business enterprises initially accounted for the largest share of funding and participations, that is no longer true. Higher education institutes and research centres now also account for sizeable participation and funding shares (Figs 4.4 and 4.5).

Several factors could explain the growth of the collaborative research participation and funding shares held by higher education institutes and research centres. The wider trend in OECD countries is to put renewed emphasis on funding basic research. In line with this, the 6th Framework Programme included a more basic research-oriented activity called New and Emerging Science and Technology (NEST), as well as a Networks of Excellence instrument less attractive to business enterprises. It has been argued that work programmes have shifted away from the strong applications focus of the 5th Framework Programme, and have become more academic in tone. Higher education institutes and research centres may be

---

29 In this respect, see also DTI – Office of Science and Technology, Targeted Review of Added Value Provided by International R&D Programmes, May 2004, p. 8: “The literature deals poorly with the question of ‘critical mass,’ providing no ready-reckoner to check whether more or better capacity is necessary.”

30 It is not possible to trace in a definitive manner across Framework Programmes the evolution of the collaborative research participation structure by type of institution. In the first section of this chapter, we discussed how painting an adequate picture of the Framework Programme and its evolution over time has been hampered by a relative lack of data. One reason is that instruments and rules of participation have changed across Framework Programmes. Therefore, definitions of especially industrial types of participants have also changed. This makes it more difficult to analyse the evolution of the participant type structure. The result is that a certain margin of error is associated with the statistics reported below. See European Commission, Second Report on S&T Indicators, 1997 – Report, Luxembourg, 1997, pp. 520–522, for a discussion on the drop between FP2 and FP3 and the seeming stabilisation between FP3 and FP4 of the industrial share of participations, and of the drop between FP3 and FP4 of the industrial share of funding. In European Commission, Five-Year Assessment 1999–2003, 15 December 2004, p. 6, the assessment panel, commenting on FP6, states having encountered “significant evidence of industrial discontent and reports from different regions of industry dropping out in unusually high numbers from the Sixth Framework Programme”, but does not find supporting statistics. Nevertheless it calls for the next FP to have a stronger industrial focus.

32 Arnold, Evaluation Record, May 2005, p. 13.

33 Arnold, Evaluation Record, May 2005, p. 13.
Fig. 4.4. How is FP funding shared between the main research actors? (% of FP funding received by type of participant (shared-cost actions only))

Source: DG Research

Note: *: FP6 data partial (to 11.03.2005)

Fig. 4.5. How is participation spread across the main research Actors? (% of FP participations by type of participant (shared-cost actions only))

Source: DG Research

Note: *: FP6 data partial (to 11.03.2005)
less sensitive to the perceived increase over time in the cost of applying to and participating in the Framework Programme.\footnote{European Commission, \textit{Five-Year Assessment}, 1997, p. 15; European Commission, \textit{Five-Year Assessment of the European Union Research and Technological Development Programmes}, 1995–99, Luxembourg, 2001, pp. 18, 20, and 25; European Commission, \textit{Five-Year Assessment Report Related to the Specific Programme: Quality of Life and Management of Living Resources Covering the Period 1995–1999}, p. 25; European Commission, \textit{Report – Evaluation of the Effectiveness of the New Instruments of Framework Programme VI}, Report of a High-level Expert Panel Chaired by Professor Ramon Marimon, 21 June 2004; European Commission, \textit{Five-Year Assessment 1999–2003}, 15 December 2004, pp. 9–12; European Commission, \textit{Five-Year Assessment: 1999–2003 – Research and Technology Development in Information Society Technologies – Interim Panel Report}, June 2004, p. ii.}

Some observers question the appropriateness of the Framework Programme’s mix of participants in terms of type of institution. The supposedly too low participation of SMEs in the Framework Programme, for instance, is a constant in the Framework Programme ex-post evaluation literature.\footnote{Arnold, \textit{Evaluation Record}, May 2005, pp. 27–28.} It has led to the establishment of SME participation targets of 5–15 per cent in the 4th Framework Programme (depending on the thematic area), and of 10 per cent in the 5th Framework Programme. In the 6th Framework Programme, at least 15 per cent of the budget of the first and second Specific Programmes was foreseen for research-performing SMEs. The concern about SME participation relates of course to the important role SMEs play in the European economy. There are between 8 and 12 million SMEs in the EU-15, and a further 2.5 million in the new Member States. They account for over 99 per cent of all enterprises, and for two-thirds of all employment in the enterprise sector. Some 30 per cent of SMEs – thus some 10 million enterprises in the EU-15 – regularly develop, apply, or acquire technology. Less than 3 per cent is involved in leading-edge research, however.\footnote{EURAB, \textit{EURAB Report On: “SMEs and ERA” – Report and Recommendations}, EURAB 04.028-Final, pp. 4–6.}

Judging the appropriate level of SME or broader business enterprise participation in FP-funded collaborative research is difficult. Theory does not offer much insight beyond the one that it is quite natural for SMEs to be more irregular participants in the Framework Programme than large firms. They often lack a permanent R&D activity and staff. Given their scale, the relative cost of participation is higher. And there is no learning effect from regular participation. This argues against uncritically stimulating SMEs to participate.\footnote{Arnold, \textit{Evaluation Record}, May 2005, pp. 27–28.}

On the other hand, there are no appropriate national or international points of comparison as the thematic coverage and instruments of these schemes differ from those of the Framework Programme.

\textit{Participation pattern by country of origin} Framework Programme funding is awarded not on the basis of the nationalities of the applicants, but on the basis of their scientific excellence and the European added value of the research proposal.
Framework Programme funding is important to the Member States, however, especially the smaller ones, so that national stakeholders take an understandable interest in the amounts they receive.

The Framework Programme evaluation literature does not dwell much on the countries of origin of Framework Programme participants. It just observes that national Framework Programme participation shares are broadly in line with Member States’ sizes and RTD capabilities (e.g. number of researchers)\(^\text{38}\) This is confirmed by an empirical check. Fig. 4.6 displays for each EU-15 Member State (the highest ranking being 15 and the lowest 1) its ranking for three variables: the number of shared-cost action participations in the 5th Framework Programme, the shared-cost action funding received under the 5th Framework Programme, and the share of European GDP in 2000. It is clear that a Member State’s Framework Programme participation is more or less in line with its share of European GDP. In other words, Member States accounting for large shares of European GDP participate most often in the Framework Programme and obtain most Framework Programme funding while the reverse is true for Member States accounting for small shares of European GDP. An important exception is Greece, which participates in the Framework Programme to a larger extent and obtains more funding.

\[\text{Fig. 4.6. Comparing Member States’ FP participation with their share of European GDP (Member State rankings in terms of the number of FP5 shared-cost action participations, the amount of FP5 shared-cost action funding received, and the share of European GDP (2000))}\]

\(^{38}\) Arnold, Evaluation Record, May 2005, p. 16; European Commission, Five-Year Assessment 1999–2003, 15 December 2004, p. 4.
from the Framework Programme than one would expect on the basis of its share of European GDP. The reverse is true for countries like Belgium, Austria and Finland.

Similar results are obtained when the comparison is made not with the share of European GDP but with the number of researchers (Fig. 4.7).39

Almost completely opposite results are obtained when we rank Member States in terms of their intensity of Framework Programme participation, in other words in terms of how many Framework Programme participations and how much funding are obtained per unit of GDP, or per researcher (Figs 4.8 and 4.9). Then it becomes clear that smaller Member States participate more intensely in the Framework Programme than larger ones.

Fig. 4.10 shows that the relative importance of established Member States in terms of number of participations has not changed very much across Framework Programmes. New Member States, however, have usually been able to rapidly increase their number of participations across Framework Programmes (See e.g. Sweden, Austria and Finland in Fig. 4.10).

In addition to intra-European collaboration, the Framework Programme supports international collaboration beyond Europe’s borders. The scale of this international collaboration has grown substantially across Framework Programmes. The number

---

39 See also European Commission, Second Report on S&T Indicators 1997, p. 548 (text) and 550 (graph): “The Member States’ total participations in the last two Framework Programmes (1990–6) seem to correlate quite well with their human resources active in R&D, except in the cases of the three new Member States and those of Germany and Greece.”
of non-European countries participating in the Framework Programme has increased from 30 in the 2nd Framework Programme to 140 in the 5th Framework Programme.

*Participation pattern by region of origin* The pattern of Framework Programme participation can be traced not just at national level, but also in Europe’s regions. Some scholars argue that the regional level is the one at which the mechanisms of innovation and resulting economic benefits can be best understood.
A close look at the map of Europe reveals the great diversity in research capacity and innovation performance among its regions. R&D “hot spots” generating above average high-tech employment rates exist alongside pockets of poverty and entrepreneurial deprivation. R&D inputs – the presence of universities, higher S&T education enrolment, patterns of overall and particularly business R&D investment and expenditure, and so on – matter, but regional innovation performance also hinges strongly on the functioning of the region as an innovation system. Less favoured European regions are of special concern to policy-makers as they display a regional innovation paradox. This refers to the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation compared to more advanced regions.

---

40 Andrés Rodríguez-Pose, *The Dynamics of Regional Growth in Europe: Social and Political Factors*, Oxford, 1998.
41 Several typologies have been developed to demonstrate and better understand the diversity found. The report *Enlarging the European Research Area: Identifying Priorities for Regional Policy Focusing on Research and Technological Development in the New Member States and Candidate Countries* (FP6 contract n° COP6-CT-2004-00001) mentions the following typologies of regional innovation systems: Braczyk & Heidenreich (1998); Carrincazesaux & Lung (2003); Clarysse & Muldur (1997; 2001); Cooke (1998); Dunnewijk, Hollander & Wintjes (2004); ECOTEC (2002); Muller *et al.* (2001); Tödtling & Tripl (2004).
42 Christine Oughton *et al.*, *The Regional Innovation Paradox: Innovation Policy and Industrial Policy*, In: *Journal of Technology Transfer*, Vol. 27, No. 1, 2002, pp. 97–110.
A pilot study based on 15 years of Framework Programme data (1987–2002) has analysed in more detail the regional distribution of Framework Programme participation and funding. There have been a number of interesting findings, in particular for Europe’s less favoured regions. Successive FP programmes have created networks of research in less favoured regions which are at the base of the diffusion of knowledge spillovers and which undoubtedly have eased the diffusion of knowledge from the centre to the periphery. In terms of study findings, the study confirms firstly and not surprisingly that, in absolute terms, participations and funding are concentrated in the “usual suspects”: London and the South-East in the United Kingdom; Île de France and Rhône-Alpes in France; the Stuttgart-Karlsruhe-Lower Bavaria axis in Germany; the Randstad in the Netherlands; the greater Brussels area in Belgium; and the North of Italy. Secondly, within peripheral countries, European research activity is often, though not always, concentrated in those areas with the highest levels of GDP per capita and the greatest concentration of researchers and research activity (e.g. Helsinki, Lisbon, Madrid, Athens). Thirdly and most interestingly, a significant number of peripheral regions obtain a share of European research funds which is larger than one would expect on the basis of their overall R&D effort, the size of their economy, or their relative wealth (e.g. Scotland in the United Kingdom; Catalonia and Murcia in Spain; Steiermark in Austria). Put differently, the European Framework Programme offers less favoured regions an important alternative source of research funding. Given the fact that they often face a more limited choice of funding possibilities than more advanced regions, this study indicates that the Framework Programme plays an encouraging role in reducing the research investment gap in less favoured regions. From the viewpoint of the more advanced – in terms of research endowment and innovation performance – regions it can be said that successive Framework Programmes have supported excellent research without being detrimental to cohesion (Fig. 4.11).

The degree of concentration of collaborative research participation In the previous two sections, we have looked at the distribution of Framework Programme participations and funding across countries and regions. This section considers how participation is dispersed at the level of individual organisations. Looking across Framework Programmes, it appears that some institutions have been very effective in competing for Framework Programme funds. Geuna found on the basis of 1st, 2nd, and 3rd Framework Programme data that the distribution of Framework Programme university participations is skewed. Many institutions are present in the system only one or a few times, but a small number of universities achieve a high number of participations. Breschi and Cusmano identified

---

43 Regional Analysis of Framework Programme Participants from 1987 (FP2) until 2002 (FP5) (FP6 contract n° EVA6-CT-2005-000002).
44 See also European Commission, Second Report On S&T Indicators, pp. 552–557.
45 Aldo Geuna, University Participation in Community Programmes: How Does the Selection Process Work? (Prepared for the Conference “New Research Findings: The Economics of Scientific and Technological Research in Europe”, University of Urbino, 24–25 February, 1995), February 1995, p. 25.
Fig. 4.11. A regional map of FP funding marryng scientific excellence and social cohesion

Source: DG Research.

Data: DG Research, data treatment by London School of Economics

on the basis of 3rd and 4th Framework Programme data a large “oligarchic core”, whose centrality and connectivity strengthened over programmes. The Five-Year Assessment 1999–2003 discovered a relatively small core of organisations participating multiple times and across several Framework Programmes and estimated that these organisations accounted for about 20 per cent of all participants. A recent

46 Breschi and Cusmano, Unveiling the Texture, p. 2.
47 European Commission, Five-Year Assessment 1999–2003, 15 December 2004, p. 7.
summary of a series of Framework Programme ex-post evaluations comes to the same conclusion: many organisations’ participation in Framework Programme is short-lived, but there is a core of frequent participants. Finally, a recent network analysis of partial data on the 6th Framework Programme found skewed distributions of connectedness, with a central core of highly linked organisations and a periphery of less well connected entities.

A certain degree of concentration of participation in a selective funding scheme based primarily on scientific excellence is inevitable, and a certain degree of continuity of participation is indeed to be welcomed. The literature identifies a number of factors that may promote a certain degree of concentration of participation in (internationally collaborative) research programmes. Large institutions are more likely to apply multiple times to research programmes as they have more staff, and to internationally collaborative research programmes as they are more likely to have prior experience with international research collaboration. Large, well-known institutions are better placed than small, lesser-known ones to put together research consortia. More than small institutions, large organisations have the institutional capacity to handle complex application and project management procedures, and to do so multiple times. Research project proposals submitted by consortia involving a large, well-known institution with a well-established research reputation are more likely to get selected. A lock-in effect then ensues. This results first of all from the fact that successful applicants can familiarise themselves even more with complex application and project management procedures, which remain stable to a certain extent over time. This facilitates later applications. Successful participation, on the basis of which scientific and technological outputs can be produced, further consolidates the participant’s scientific reputation and reinforces the information signalling effect to both potential consortia participants and proposal evaluators on the occasion of a next application. In the literature, this phenomenon is referred to as the “Matthew effect” and cumulative advantage.

It is not possible to judge now whether the degree of concentration of Framework Programme participation is appropriate. A study would be required of the evolution

---

48 Arnold, Evaluation Record, May 2005, pp. 13–15.
49 Caroline S. Wagner et al., ERAnets – Evaluation of NETworks of Collaboration among Participants in IST Research and Their Evolution to Collaborations in the European Research Area (ERA) – Final Report, March 2005, pp. 17–18.
50 “Selection effect”.
51 “Information signalling effect”.
52 “Selection effect”.
53 “Information signalling effect”.
54 For the need for prior international research collaboration/FP experience, see Arnold, Evaluation Record, May 2005, pp. 13–15. For information signalling, see Geuna, University Participation. For how complex FP application and project management procedures act as barriers to FP participation, see above. For the Matthew effect and cumulative advantage, see Robert K. Merton, The Matthew Effect in Science, In: Science, Vol. 159, No. 3810, 1968, pp. 56–63, and Robert K. Merton, The Matthew Effect in Science, II – Cumulative Advantage and the Symbolism of Intellectual Property, In: ISIS, 79, 1988, 79, pp. 606–623.
of the degree of concentration of participation over time. A comparison would have to be made with the degree of concentration of participation in Member State, intergovernmental, and foreign (collaborative) research schemes. And an assessment would have to be made of the relationship between programme participant and network characteristics on the one hand, and project outputs and impacts on the other hand.

In the meantime, the Commission is aware of the importance of not discouraging small innovative institutions from participating regularly in the Framework Programme. The Commission’s repeated efforts on the one hand to streamline and simplify the Framework Programme bureaucracy, and on the other hand to provide measures to encourage applicants with particular needs, such as SMEs, are aimed at ensuring that this does not happen.

2.3. The characteristics of collaborative research networks

Collaborative research networks described Framework Programme collaborative research projects are implemented via cross-border, cross-sector, interdisciplinary Framework Programme networks. These networks embody the unique European added value of the Framework Programme, which is to bring together different types of high-quality participants from different countries and with complementary expertise in productive partnerships, thus overcoming the sectoral and national fragmentation of the European research system. Over the past two decades, the number of links established between participants in FP-supported collaborative research projects has increased substantially to reach 160,000 under the 5th Framework Programme (Fig. 4.12).

Collaborative research project participants do not just establish collaborative links within their own sectors (businesses just collaborating with businesses, universities just with universities, etc.). FP-funded collaborative research networks succeed in bringing together and creating links between different types of institutions. Over time, the typical configuration of a Framework Programme project has evolved, as expected given the aforementioned changing overall Framework Programme participant structure. At the heart of these networks, however, still lies science–industry collaboration. This is a feature greatly appreciated by Framework Programme shared-cost action participants. It is also a key component of innovation systems.

The average number of different Member States per project has increased from Framework Programme to Framework Programme. Starting from an average of 3 different Member States per project in the 2nd Framework Programme, interim data for the 6th Framework Programme show an average of 6.5 (Table 4.2).

55 For the number of collaborative links created under FP3 and FP4, see also European Commission, Second Report On S&T Indicators, pp. 559–560.
56 European Commission, Second Report on S&T Indicators 1997, pp. 520–541.
57 European Commission, Five-Year Assessment 1995–99, 2001, p. 17.
58 See for example recent OECD reports on Benchmarking Industry-Science Relationships (2002), Turning Science Into Business – Patenting and Licensing At Public Research Organisations (2003), and Governance of Public Research (2003).
Over time, the configuration of intra-European transnational collaboration has also changed (Figs 4.13–4.15). The number of privileged collaboration partners has increased across Framework Programmes. No less than eight Member States are now situated at the core (Austria, Belgium, Greece, Ireland, Netherlands, Portugal, Spain, and Sweden). The groups of “intermediate” and “peripheral” countries have each become more integrated. Countries in these two groups increasingly collaborate amongst themselves thus reducing dependency on the core and diversifying collaboration patterns. Under the 5th Framework Programme, this was reflected in the emergence of two distinct sub-networks in the group of “intermediate” countries – Southern European (Greece, Italy, Spain, and Portugal) and Northern European (Netherlands, Denmark, Sweden, and Finland). Finally, a strong cohesion effect is evident. In the 6th Framework Programme, formerly “peripheral” countries – Austria, Ireland, and Luxemburg – joined the two inner circles of collaboration. In summary these three trends highlight a shift from projects dominated by just a few core countries and relying on geographical proximity to projects with a more balanced national representation and detaching themselves from traditional ties. This illustrates the integrating effect of European collaborative research.

**Box 4.1. Methodology for presenting the global configuration of Community collaborations**

Figs 4.13–4.15 show the changes across Framework Programmes in the positioning of the Member States in Community collaboration networks. For each Framework Programme, a cluster analysis was performed on the correlation matrix of all Member State collaborative links. The results show the degree to which different countries have collaborated with each other (indicated by the percentages) and the relative importance of countries as preferred partner
(indicated by the different zones). They do not provide any indication of the importance of each country in terms of the absolute number of participations in the Framework Programme or the absolute number of links created with other countries through collaborative research projects.

The percentages next to the arrows show the “collaborative links” of a particular country with the countries situated in the light grey zone. In the 5th Framework Programme, for instance, Italy had 50.45 per cent of its collaborations with Germany, France, Belgium, and the United Kingdom (and thus 49.55 per cent with the other countries). The percentages inside the light grey zone show the proportion of collaborative links that exist between the countries of that zone.

In the 6th Framework Programme, for instance, all eight Member States in the light grey zone had 34.56 per cent of their collaborations with each other (and thus 65.44 per cent of their collaborations with other countries).

The central group – (countries situated in the light grey zone): The countries situated in the light grey circle are, first of all, very densely collaborating with each other. At the same time, these countries are also involved in collaborative links with the countries situated in the dark grey and black zones. This is indicated by the percentages in the figures.

The intermediate group – (countries situated in the dark grey zone): These countries are linked to the central group to an extent shown by the percentage figures. It emerges from the cluster-analysis that these intermediate countries also form one or more highly connected sub-networks, encased in checked or dotted zones. Countries that are part of these sub-networks have dense collaborative links with each other (within the dotted and checked cluster, respectively).

The peripheral group – (countries in the black zone): These countries are linked to the central group to an extent shown by the percentage figures and are not members of a particularly densely connected sub-network.

Modern mainstream innovation theory recognises the importance of networks bringing together different types of actors (e.g. science and industry) in regional, national, and supranational systems of innovation. However, an important trade-off exists. Some authors question the value of uncritically promoting transnational collaboration at a time when, they would argue, competitive advantage is mainly determined by advances made by excellent single-country research teams.\footnote{See Giovanni Dosi \textit{et al.}, \textit{Evaluating and Comparing the Innovation Performance of the United States and the European Union}, Expert Report Prepared for the TrendChart Policy Workshop 2005, p. 3: “We suggest that effective European catching up would require much less emphasis on various types of “networking”, “interactions with the local environment”, “attention to user need” — current obsessions of European and national policy makers — and, conversely, much more on policy measures aimed to both strengthen “frontier” research and, at the opposite end, strengthen European corporate actors.”} Even if we accept the value of networking, important questions remain to be addressed. One question concerns the optimal size of networks, as some have suggested
that the large networks promoted under the 6th Framework Programme may be less effective than smaller ones. Another question concerns the optimal mix of participant types and of domestic/international partners. A first step towards answering these kinds of questions should consist of analysing in a more in-depth manner the configuration and performance of networks by Framework Programme, Specific Programme, thematic priority, and call. In tracing and assessing networks, innovative (bibliometric, patent) methodological techniques should be used.

The degree of stability of collaborative research networks FP-funded collaborative research networks are relatively stable across calls, and even across Framework

---

Arnold, *Evaluation Record*, May 2005, p. 17: “Two earlier evaluations suggest that larger networks such as those promoted by FP6 may be less effective than smaller networks. The FP4 Impact Biomed2 assessment states that scientific quality in the programme was negatively related to the number of partners in a project, and that the quality of the larger network projects was problematic. The FP5 Impact Growth study also found that larger networks (averaging 16 partners) generated limited impacts, compared with smaller ones.”
Programmes. The Five-Year Assessment 1995–1999 found evidence to suggest that many of the links formed between academic and industrial researchers persisted beyond initial projects. An analysis by Breschi and Cusmano showed that the centrality and connectivity of the “oligarchic core” of organisations at the heart of the Framework Programme has increased over time. The Five-Year Assessment panel 1999–2003 took the view that the Framework Programmes have played an important part in the formation and reinforcement of inter-organisational networks. A recent summary of Framework Programme ex-post evaluations concluded that the Framework Programme does not generate wholly new R&D networks, but causes network extension. In other words, the basic networks remain stable but they are able to absorb new participants.

---

61 European Commission, *Five-Year Assessment 1995–99*, 2001, p. 18.
62 Breschi and Cusmano, *Unveiling the Texture*, p. 2.
63 European Commission, *Five-Year Assessment of the European Union Research Framework Programmes 1999–2003. Executive Summary*, p. 2.
64 Arnold, *Evaluation Record*, May 2005, pp. 13–15.
Is network stability beneficial? Certainly one of the aims of Framework Programme support is to tackle the fragmentation of the EU research system by encouraging the formation of transnational consortia. If the networks thus created are durable, then, one could argue, a real contribution has been made to the long-term restructuring of research in Europe. Continuity over successive Framework Programmes can allow complex research fields to advance within a stable cooperative structure. However, there are also some important caveats. It may be that, once established, certain networks would have continued without further Framework Programme funds. In such instances, there would be no “behavioural additionality” from repeated Framework Programme support (although there may still be input or output additionality). At the same time, a potential danger of too much stability is that it may make it correspondingly difficult for new or more peripheral institutions to enter the game. This in turn may have negative

---

65 Wagner et al., ERAnets, p. 25.
implications for the innovativeness of research undertaken while raising issues in relation to competition. Finding the right balance between stability and dynamism is therefore important and merits ongoing analysis.

From financial to knowledge returns – the multiplier effect of collaborative research via networks  A Member State’s net returns from the Framework Programme are traditionally calculated by subtracting its contribution to the Framework Programme budget from the combined value of its Framework Programme participations. However, such a restricted financial accounting approach does not capture all the “knowledge returns” flowing from Framework Programme participation. Participating in a Framework Programme collaborative research consortium offers access to an EU-wide knowledge exchange network. In other words, a single project participant benefits from and thus accesses the funding of all project participants combined.

The question is how to calculate these knowledge returns. This is an issue which so far has barely been explored and deserves further investigation. The preliminary, relatively straightforward approach we propose here is to estimate a country’s knowledge returns by subtracting its contribution to the Framework Programme budget, not from the combined value of its Framework Programme participations, but from the combined value of the Framework Programme contracts in which it participates. For example, if a country contributes €1 to the Framework Programme budget, the combined value of its Framework Programme participations is €2, and the combined value of the Framework Programme contracts in which it participates is €10, then that country’s net financial return is €1 while its net knowledge return is €9, and thus the multiplier effect is of a factor 9.

Calculations carried out by DG Research show that for each Euro invested in the 5th Framework Programme, countries’ net knowledge return averaged €19.8 for the EU-25 (Fig. 4.16). Participation in the Framework Programme was thus a win–win situation for all parties involved: all countries enjoyed positive net knowledge returns under the 5th Framework Programme. However, the size of these returns tended to be inversely related to a country’s number of Framework Programme participations. Countries with a smaller number of Framework Programme participations (e.g. smaller EU Member States, and the then Acceding Countries) enjoyed higher net knowledge returns than countries with a larger number of Framework Programme participations (e.g. the bigger Member States). This probably happened because a smaller number of Framework Programme participations translates into a pattern of widely dispersed single participations per project, while a larger number of Framework Programme participations translates into a pattern where regularly two or three participations from the same country can be found in the same project, which partially dampens the net knowledge return.

2.4. Themes, quality, and riskiness of collaborative research

The collaborative research component of the Framework Programme is organised around a number of thematic priorities which have grown in number under
successive Framework Programmes (Fig. 4.17). The focus of the first two Framework Programmes, for instance, was clearly on energy and ICT, which together accounted for 75 per cent of funding under the 1st Framework Programme, and 65 per cent under the 2nd Framework Programme. On the other hand, the 6th Framework Programme was organised around seven thematic priorities. And the 7th Framework Programme will centre around ten thematic priorities.

The coverage of the Framework Programme is comprehensive, and does not appear to leave out any important thematic priority. Though in general the Framework Programme ex-post evaluation literature says surprisingly little on thematic coverage, the 1999–2003 Five-Year Assessment Panel could not identify any major thematic gaps in the parts of the Framework Programmes examined.

---

66 Life sciences, Genomics and Biotechnology for Health; Information Society Technologies; Nanotechnologies and nano-sciences, knowledge-based multifunctional materials, new production processes and devices; Aeronautics and Space; Food Quality and Safety; Sustainable Development, Global Change and Ecosystems; Citizens and Governance in a knowledge-based society.

67 Health; Food, Agriculture and Biotechnology; Information and Communication Technologies; Nanosciences, Nanotechnologies, Materials and new Production Technologies; Energy; Environment (including Climate Change); Transport (including Aeronautics); Socio-economic Sciences and the Humanities; Security; and Space.

68 European Commission, *Five-Year Assessment 1999–2003*, 15 December 2004, p. 5.
The Framework Programme thematic priorities also correspond more or less to those of major US and Japanese research support programmes.

Within this context, it is legitimate to ask whether the Framework Programme’s increasingly comprehensive coverage may have led to a degree of fragmentation in the sense that Framework Programme resources may be spread too thinly across too many priorities. This is always an important consideration because, to make a real difference, the level of support in a particular S&T area should be sufficient to achieve critical mass and a minimum efficient scale of research. However, there are no indications as yet in the Framework Programme evaluation literature or elsewhere that this is a major cause for concern.

A rigid predefined thematic priority structure can make it more difficult to accommodate important scientific advances and new needs which emerge during the life-time of the programme. For this reason, there have been a number of calls to introduce greater flexibility in the Framework Programme. The Davignon Five-Year Assessment, for instance, noted on the basis of the 3rd and 4th Framework

---

69 European Commission, *Towards a European Research Area – Science, Technology and Innovation – Key Figures 2002*, Luxembourg, 2002, p. 22.

70 See the US National Science Foundation Internet webpage for a listing of programme areas: Biology; Computer and information sciences; Crosscutting programs; Education; Engineering; Geosciences; International; Math, physical sciences; Polar research; Science statistics; Social, behavioural sciences. See Council for Science and Technology Policy Japan, *Japan’s Science and Technology Basic Policy Report*, 27 December 2005, p. 17, for Japan’s priorities under its Second S&T Basic Plan: life sciences; ICT; environmental sciences; nanotechnology and materials; energy; manufacturing technology; infrastructure; frontier (outer space and oceans).
Programme experience that adjustments to meet new needs, or to reflect new scientific advances, required a tortuous and time-consuming legal process. In the recent ICT Five-Year Assessment, the Panel was of the opinion that, in a fast-moving area such as ICT research, the programme should be willing and able to respond rapidly – if justified – to changes in the economic, technological, or even policy context. It cannot be denied, however, that such flexibility is gradually being built into the programme. The 6th Framework Programme, for instance, has been able to fund research on, for example, SARS and avian flu. Under the EU-supported SEPSDA (Sino-European Project on SARS Diagnostics and Antivirals), scientists from across Europe and China have spent the past years screening over 8,000 existing drugs to find prime candidates for combating SARS, and identified a number of promising anti-SARS compounds. The European Commission recently also announced that it would be making a further €20 million available for research into avian and pandemic influenza. Relating to animal health, the relevant call for proposals would cover issues such as developing vaccines for avian species, improved diagnosis and early warning systems, and technology transfer to third countries. Relating to human health, it would cover issues such as clinical research on pandemic influenza vaccines, better understanding of the influenza virus, and strengthening support to surveillance.

In terms of quality, FP-supported collaborative research has generally been found to be of a high standard. Industrial participants have reported that Framework Programme projects are of relatively high scientific and technological complexity, while university participants have identified major benefits in the form of knowledge enhancement. A first important factor underlying the high quality of FP-funded research is the well-functioning Framework Programme proposal assessment and project monitoring system. For instance, it has been suggested that the strong correlation between the number of participations by country in the 4th Framework Programme and the number of researchers in that country provides some evidence that the proposal selection system is working as it should. Another crucial factor is that Framework Programme participants themselves are generally of high quality. A recent study on the networks resulting from funding under the 6th Framework Programme in the field of ICT concluded that networks under this Framework Programme attract knowledge leaders from corporate and academic centres of excellence, evidenced by the rate at which relevant patent holders and institutions

---

71 European Commission, *Five-Year Assessment*, 1997, p. 14.
72 European Commission, *Interim Panel Report*, p. 28.
73 EU-Chinese Co-operation Pinpoints Potential Treatments for SARS, In: *European Research Headlines*, 29 July 2005.
74 News Alert – Commission Releases New Funds for Avian Flu Research, 17 January 2006.
75 Arnold, *Evaluation Record*, May 2005, pp. I, 6, 12 and 29.
76 European Commission, *Five-Year Assessment 1999–2003*, 15 December 2004, p. 7.
77 European Commission, *Five-Year Assessment 1999–2003*, 15 December 2004, pp. 9–10; Arnold, *Evaluation Record*, May 2005, p. 12.
78 Arnold, *Evaluation Record*, May 2005, p. 16.
A recent bibliometric study on participants in the 5th Framework Programme in the fields of the life sciences and nanotechnology convincingly demonstrated that the level of Framework Programme participants is generally above world level and that they reach citation impact scores higher than what could be expected on the basis of the journals in which they publish or the fields in which they are active. A substantial number of Nobel Prize laureates in medicine, chemistry, and physics are involved in research projects and networks under the 6th Framework Programme, many of them oriented towards medical purposes.

Although Framework Programme collaborative research is of high quality, it has been observed that it can often be too mainstream and insufficiently risky and “at the frontier”. The Five-Year Assessment 1995–99 found that the Framework Programme should retain its overarching emphasis on excellence, but make extra efforts to ensure that “risky” projects are not excluded. Efforts were made to address this in the NEST programme under the 6th Framework Programme, and while this was welcomed by the subsequent Five-Year Assessment panel, they felt it was still a too narrow approach. The panel therefore recommended that an ambition to fund more risky projects should be embedded in the Framework Programme objectives, instruments and implementation as well as in the assessment of achievements and impacts. Under the 7th Framework Programme, risky frontier research will be supported through the planned European Research Council.

2.5. The additionality of collaborative research

Before assessing the various impacts generated by FP-funded collaborative research, it is important to establish whether or not Framework Programme collaborative research funding schemes have generated effects that are additional to what would have happened anyway in the absence of such funding schemes. In other words, in the absence of the Framework Programme collaborative research component, would projects have been carried out at all or would they have been carried out differently?

The consensus appears to be that Framework Programme collaborative research funding schemes are characterised by a high degree of additionality. Without Framework Programme funding, projects would in general not have been carried

---

79 Wagner et al., ERAnets, March 2005, pp. vii–viii.
80 Bibliometric Analysis for Participants Under the 5th European Framework Programme for Research and Technical Development (Contract Number EVA6-CT-2005-00001) – Final Report.
81 Nobel Excellence in EU Research Projects, In: European Research Headlines, 9 December 2005: Medicine: Erwin Neher (1991 Nobel laureate), Christianne Nüsslein-Volhard (1995), Rolf M. Zinkernagel (1996), Stanley B. Prusiner (1997) and Tim Hunt (2001); Chemistry: Harmut Michel (1988 Nobel laureate), John E. Walker (1997), Kurt Wüthrich (2002) and Aaron Ciechanover (2004); Physics: Theodor W. Hänsch (2005).
82 European Commission, Five-Year Assessment 1995–99, 2001, p. 21.
83 European Commission, Five-Year Assessment 1999–2003, 15 December 2004, p. 5.
out or they would have been carried out differently, often entailing substantial losses in terms of efficiency and effectiveness. Typical is the conclusion of a UK study on the EU Framework Programmes, which reported a broad agreement that Framework provides considerable added value. It expands the funds available to national researchers over and above that which is available to them through national research funds alone. It provides UK participants with access to foreign researchers and research outputs in a way that national funds cannot. By pooling financial resources, it boosts investment in important research topics, and by pooling competencies it increases the likelihood of a breakthrough in a given area. Complex issues are resolved more quickly and more thoroughly as a result of larger projects and portfolios and multiple projects across successive Frameworks.

Supportive evidence is wide-ranging and convincing. Almost 95 per cent of respondents to a survey of Norwegian participants in the 5th Framework Programme answered that EU-funding was very important for getting the project started, 90 per cent that it was important for the size of the project, and over 80 per cent that it was important for how fast the project could be carried through. Among Irish participants in the 4th Framework Programme responding to a survey, 82 per cent would not have proceeded with their project without Framework Programme funding. Of the 18 per cent who would have continued, over 70 per cent would have done so with reduced objectives and reduced funds, while close to 40 per cent would have done so over a longer timescale, and with fewer partners. An Austrian study found very high additionality of the EU Framework Programmes. Of those questioned, 70 per cent said they would not have continued their research project had it been rejected. Of the remaining 30 per cent who would have continued the project without EU subsidy, only 14 per cent said that they would have done so without any adjustment. Typical adjustments entailed a modified goal orientation, a reduced number of project partners, and a different project volume. Of Finnish participants in the 5th Framework Programme, 70 per cent would not have carried out the project without EU funding, 40 per cent would have carried it out on a smaller scale, and 35 per cent would have carried it out more slowly.

2.6. The impact of collaborative research

Evaluations of past Framework Programmes have shown that impacts are important and wide-ranging. The evidence is considerable that the Framework Programme

---

84 DTI – Office of Science and Technology, The Impact of the EU Framework Programmes in the UK, July 2004, p. 3.
85 DTI – Office of Science and Technology, EU Framework Programmes, p. 10.
86 NIFU et al., Evaluation of Norway’s Participation in the EU’s 5th Framework Programme, 2004, p. 100.
87 Forfás, The 4th Framework Programme in Ireland – An Evaluation of the Operation and Impacts in Ireland of the EU’s Fourth Framework Programme for Research and Development, 2001, p. 43.
88 Joanneum Research Forschungsges.m.b.H et al., Austrian Participation, p. 83.
89 Marjo Uotila et al., Finnish Participation in the EU Fifth Framework Programme and Beyond, 2004, p. 28.
helps to improve participants’ research capabilities, and modifies their behaviour, in addition to generating significant scientific and technological outputs, and contributing to competitiveness and innovation by boosting productivity and encouraging the development of new products and processes.

**Impact on capabilities, behaviour, and ability to compete**

FP-funded collaborative research projects strengthen participants’ research capabilities by enhancing their knowledge base, and improving the skills of staff. Behaviour is also permanently changed resulting in a better ability to compete. For example, participants able to achieve short-term networking goals are more likely to carry out research through networks in the future. An analysis of the Third Community Innovation Survey (CIS-3) shows that Framework Programme participating enterprises are more likely to engage in innovation cooperation with other partners in the innovation system, such as other firms and universities (Fig. 4.18).

![Graph showing % of FP companies with cooperation arrangements compared to non-FP companies.](image)

**Fig. 4.18.** FP participants are more likely to collaborate

*Source:* DG Research, Eurostat

*Data:* Eurostat

*Note:* Results here are for firms in the manufacturing sector

---

90 Databank Consulting et al., *IST Impact Study – Microelectronics & Microsystems, Health, Mobile Communications* – Draft Final Report D.6, 4 August 2004, p. 24; Arnold, *Evaluation Record*, May 2005, p. 20–21; European Commission, *Five-Year Assessment 1999-2003*, 15 December 2004, p. 7.

91 Databank Consulting et al., *IST Impact Study*, p. 24; Arnold, *Evaluation Record*, May 2005, pp. 20–21, 25.
Impact on scientific performance  The extension of the knowledge base is to some extent codified and made explicit through scientific publications. Framework Programme projects generate many publications and thereby contribute directly to Europe’s total output in terms of scientific publications, an important indicator of scientific performance.

The publication of peer-reviewed scientific work is an important goal for Framework Programme participants, especially those from universities and research institutes, now accounting for most Framework Programme participations and funding. For instance, 94 per cent of British public sector researchers participating in the 4th and 5th Framework Programmes rated refereed publications in journals and books as important outputs. A similar survey in Austria found that around 80 per cent of respondents considered publications an important or very important goal of participation. And a study in Ireland showed that Framework Programme participants from the public sector ranked publications as one of the ten most important goals.

Framework Programme participants generally achieve their publication goals, and thus generate large numbers of scientific publications. For instance, 92 per cent of Finnish university participants in the 4th Framework Programme (and 91 per cent of such participants in the 5th Framework Programme) had achieved their publication goals. And 85 per cent of 3rd/4th Framework Programme public sector participants declared that they had achieved their publication goals. In a study of Irish participants in the 4th Framework Programme, 83 per cent of university/research institute respondents listed publications in refereed journals as important outputs. Over 80 per cent of Austrian university participants in the 4th Framework Programme responding to a survey (and over 70 per cent of such research institute participants) had already reached their publication goals or expected to do so within the next three years. A recent IST impact study obtained for publications a score for goal achievement of over 3 (important goal achieved as expected). In the majority (79 per cent) of projects under the 4th and 5th Framework Programmes with British participation surveyed, at least one peer-reviewed publication was produced, while in around 10 per cent of those projects more than 20 such outputs were produced. An analysis of impact variables resulting from research projects in the fisheries and aquaculture domain of the FAIR programme under the 4th
Framework Programme identified 711 publications in 219 peer-reviewed journals by the participants of 82 projects, an average of 8.7 peer-reviewed publications per project. Participants in the BRITE-EURAM II programme under the 3rd Framework Programme reported 3,621 publications for 454 projects, an average of 8 publications per project. Participants in the transport programme under the 4th Framework Programme reported 3,766 publications for 269 shared-cost projects, an average of 14 publications per project.

The scientific publications resulting from FP-funded collaborative research projects are often intra-European international co-publications, which points once more to the integrating effect of these projects. Direct evidence for this comes from a recently completed bibliometric study on participants in the 5th Framework Programme in the life sciences and nanotechnology, which found that for those Framework Programme participants the growth in intra-European international co-publications was much larger than that in international co-publications with US authors or in the overall number of scientific publications. This may explain the fact that also at the aggregate level the share of intra-European international co-publications in Europe’s international co-publications has increased, while that of international co-publications with the United States has decreased.

The scientific publications resulting from Framework Programme collaborative research are generally of high quality. It is well known that the citation impact score of international co-publications is generally higher than that of purely national publications. Direct evidence, however, also comes from the aforementioned recently completed bibliometric study on participants in the 5th Framework Programme, which found that the citation impact scores of those Framework Programme participants were higher than could be expected on the basis of the journals in which they published, and that they scored above world level when allocated to specific fields.

Impact on technological and innovative performance

Framework Programme participation enhances the development and use of new tools and techniques; the

---

101 Gesche Pluem, Analysis of Impact Variables Resulting from Research Projects in the Fisheries and Aquaculture Domain of the European Commission’s Fair Programme (1994-1998), 2003, pp. 12, 14.
102 European Commission, Five Year Assessment Report Related to the Specific Programme Competitive and Sustainable Growth Covering the Period 1995–1999, June 2000, p. 25.
103 European Commission, Competitive and Sustainable Growth, June 2000, p. 28.
104 Bibliometric Analysis.
105 Laurence Esterle and Ghislaine Filliatreau (Eds.), Indicateurs de Sciences et de Technologies Édition 2004, Rapport de l’Observatoire des Sciences et des Technologies, Paris, 2004, pp. 284–285.
106 Wolfgang Glänzel, National Characteristics in International Scientific Co-Authorship Relations, In: Scientometrics, Vol. 51, No. 1, 2001, pp. 69–115; Isabell Gómez et al., Collaboration Patterns of Spanish Scientific Publications in Different Research Areas and Disciplines, In: M.E.D. Koenig and A. Bookstein (Eds.), Proceedings of the Biennial Conference of the International Society for Scientometrics and Informetrics, Medford, NJ, 1995, pp. 187–196; Wolfgang Glänzel et al., A Bibliometric Analysis of International Scientific Cooperation of the European Union (1985–1995), In: Scientometrics, Vol. 45, No. 2, 1999, pp. 185–202.
107 Bibliometric Analysis.
design and testing of models and simulations; the production of prototypes, demonstrators, and pilots; and other forms of technological development. One finds confirmation of a strong impact on the innovative performance of European firms in analyses of the Community Innovation Survey (Fig. 4.19). The results show that firms participating in the Framework Programme, irrespective of their size, tend to be more innovative than those that do not participate. Although no causal links can be “proven” by these results, they nevertheless provide a strong indication that public funding for research strengthens innovation performance.

FP-funded collaborative research projects also generate a large number of patents, once more exerting a positive influence on an important S&T indicator. A 2002 assessment of nearly 1900 non-nuclear energy research and demonstration projects under the 4th Framework Programme found that they had resulted in about 400

![Fig. 4.19](image)

**Fig. 4.19.** FP participants are more likely to produce product/process innovations

*Source:* DG Research, Eurostat

*Data:* Eurostat

*Note:* Results here are for firms in the manufacturing sector

---

108 Databank Consulting *et al.*, *IST Impact Study*, p. 24.

109 In the CIS-3 survey, organisations are defined as “innovative” when they had either introduced a product or process innovation in the course of the past three years, or had engaged in innovation but had not (yet) completed or abandoned it. They were asked whether they had received EU funding in general and FP funding more specifically. This made it possible to look for a relation between the receipt of FP funding and other variables such as the degree of innovativeness, the likelihood to apply for a patent, the likelihood to hold a patent, and the likelihood to cooperate with other partners in the innovation process.

110 Even when causality is assumed, it is not clear in which direction causality is operating: does the FP attract more innovative participants or do companies become more innovative as a result of FP participation? See also Chapter 2 of European Commission, *European Competitiveness Report 2004*, Luxembourg, 2004.
Corroborating evidence is again found in the Community Innovation Survey which shows that Framework Programme participating enterprises are more likely to apply for patents than non-participants (Fig. 4.20). In Germany, for example, FP-funded firms submit three times as many patent applications as non-participating firms. Again, no causal links can be “proven” by these results. Nevertheless they provide a strong indication that public funding for research strengthens innovation performance.

The micro-economic benefits of collaborative research The Framework Programme not only strengthens participants’ mid- to long-term ability to compete, but also directly enhances their competitive position. A wide range of ex-post evaluation studies show that as a result of Framework Programme participation firms are able to realise increased turnover and profitability, enhanced productivity, improved market share, access to new markets, reorientation of the commercial strategy, enhanced competitive position, enhanced reputation and image, and reduced commercial risk.

![Fig. 4.20. FP participants are more likely to patent](image)

**Source:** DG Research, Eurostat  
**Data:** Eurostat  
**Note:** Results here are for firms in the manufacturing sector

---

111 European Commission, *Clean, Safe and Efficient Energy for Europe - Impact Assessment of Non-Nuclear Energy Projects Implemented Under the Fourth Framework Programme - Synthesis Report*, Luxembourg, 2003, p. 13.

112 Databank Consulting et al., *IST Impact Study*, p. 36; Arnold, *Evaluation Record*, May 2005, pp. 24–25.
One of the important effects of Framework Programme collaborative research projects is the enhancement of skills of participating research staff, which helps to strengthen research capabilities. Some Framework Programme actions also explicitly target the training, mobility, and career development of researchers, notably the “Marie Curie” actions. These commenced under the 3rd Framework Programme and now account for about 10 per cent of the 6th Framework Programme’s budget. The purpose of the Framework Programme human resources schemes is to enable researchers to participate in top transnational teams and high-level projects, and benefit from training and knowledge sharing. This should ultimately lead to better R&D, while also having a positive impact on the attractiveness of the EU as a place to pursue a scientific career for European and third country researchers.

The Framework Programme human resources schemes are very much in demand. In the period 1994–2002, almost 12 000 researchers undertook international research training funded by the Marie Curie fellowships under the 4th and 5th Framework Programmes. The 6th Framework Programme is characterised by high numbers of applications as well. Widely appreciated and prestigious, it is useful to take a closer look at the characteristics of and impacts achieved through the Marie Curie fellowships. Most fellows (79 percent) applied to the scheme to gain international experience, and a substantial share of them (28 percent) would not have gone abroad without a fellowship (which has a bearing on the question of additionality). In addition, the scheme enabled many fellows (50 per cent of post-graduate and about one-third of post-doctoral researchers) to gain their first international experience. Fellows mostly came from Spain (16 per cent), Italy (14 per cent), and Germany and France (13 per cent each). They mostly went to the United Kingdom (28 per cent), France (17 per cent), Germany (12 per cent), the Netherlands (9 per cent), and Spain and Italy (6 per cent each). This turned some countries (e.g. the United Kingdom, Denmark, Netherlands, Norway) into clear “host” countries (hosting more fellows than sending) and other ones (e.g. Slovak Republic, Iceland, Hungary) into clear “home” countries (sending more fellows than hosting), with the reminder reaching a rough balance. Most fellowships by far took place in an academic setting, though the 5th Framework Programme included a special fellowship programme for industry in which 8 per cent of respondents to a survey participated. About one-fifth of fellows were engaged in university–industry collaboration during their fellowship.

113 Daphne van de Sande et al., Impact Assessment of the Marie Curie Fellowships Under the 4th and 5th Framework Programmes of Research and Technological Development of the EU (1994–2002), IMPAFEL 2 – Contract nr. IHP-D2-2003-01, June 2005, p. iv.
114 European Commission, Implementation Report 2004 on “A Mobility Strategy for the European Research Area” and “Researchers in the ERA: One Profession, Multiple Careers”, Commission Staff Working Document, SEC(2005) 474, 6 April 2005, p. 33.
115 The remainder of this section is based on van de Sande et al., Marie Curie Fellowships.
Marie Curie fellows identified as most important impacts for themselves having gained international research experience, having had dedicated time to carry out research, and having developed research skills. Marie Curie fellowships generated a number of tangible research outputs. Scientific publications were produced, their number depending on the duration of the fellowship and the experience of the fellow. The longer they stayed, the more likely they were to publish. Of those on fellowships of up to 6 months (for 94 per cent at postgraduate level), 57 per cent produced at least one publication. Among fellows on fellowships of between 6 and 12 months (for 65 per cent at postgraduate level), the percentage rose to 77 per cent. And among fellows on fellowships of at least 12 months (for 92 per cent at postdoctoral level), it rose to 90 per cent. Looking only at postdoctoral fellows, the average publication rate was 3.1 publications per year for a fellowship at a university, 2.6 for one at a research centre, and 1.2 for one in industry. Of respondents who had already concluded their fellowship, 7 per cent reported that their research project had resulted in one or more patents (one-third owned by the fellow and two-thirds owned by the host organisation). Supervisors were of the opinion that in 43 per cent of cases, the work of the fellow had led to the creation of new technologies.

After their fellowship, a majority of fellows eventually returned to their home country, though planning a new mobility experience within five years. They generally returned to positions of more responsibility under more stable contracts. They took with them the networks established and reinforced through their fellowship. The scheme strengthened existing connections for 34 per cent of postgraduate researchers, 40 per cent of postdoctoral researchers, and 73 per cent of senior researchers. Over 70 per cent of fellows reported that their stay abroad generated new contacts influential for subsequent career progression, and 86 per cent maintained contacts with their Marie Curie host institution after the fellowship.

4. THE IMPACT OF THE FRAMEWORK PROGRAMME ON RESEARCH INFRASTRUCTURES

If Europe’s research teams are to remain at the forefront of all fields of science and technology, then they will have to be supported by state-of-the-art infrastructures. The successive Framework Programmes have been active in this sense, promoting the development of a fabric of research infrastructures of the highest quality and performance in Europe, and their optimum use. The term “research infrastructures” refers to facilities and resources that provide essential services to the research community in both academic and/or industrial domains. Research infrastructures may be “single-sited” (single resource at a single location), “distributed” (a network of distributed resources, including infrastructures based on Grid-type architectures), or “virtual” (the service being provided electronically). Examples of research infrastructures include large-scale research installations, collections, special habitats, libraries, databases, integrated arrays of small research installations, high-capacity/high-speed communications networks (e.g. Géant), networks of computing
facilities (e.g. Grids), and infrastructural centres of competence, which provide a service for the wider research community based on an assembly of techniques and know-how.

To develop a strategic approach for research infrastructures at European level, comprehensive and up-to-date information about the current pattern of existing infrastructures is essential. To this end, the Commission organised a *Survey of European Research Infrastructures* between December 2004 and January 2005. Existing research infrastructures of clear European dimension, as well as a certain number of infrastructures under construction, were invited to participate. The first round of the survey resulted in feedback from 585 existing research infrastructures and 157 under construction, that is, in total 742 research infrastructures were reported.

The technical review panel for the access to research infrastructures action under the 5th Framework Programme concluded that it succeeded in providing researchers with access to unique or outstanding infrastructures in a broad range of disciplines, and thus contributed to the production of high quality research. It also noted that the Framework Programme helped to develop interdisciplinary approaches between several areas as well as cooperation between European researchers, while giving a European dimension to several national facilities and, in several cases, organising more efficiently their networking. Through infrastructure RTD projects, it also contributed to improving the technical performance of several categories of infrastructures and thus to enhancing European scientific competitiveness in several fields.

A questionnaire to participants who received 5th Framework Programme funding for transnational access to infrastructures, carried out as part of this technical review, found that 88 per cent of respondents would have been unable to carry out their project at this research infrastructure without EU support. Of these, 71 per cent indicated that they would have been unable to pay for travel and subsistence, while 41 per cent could not have afforded the user fees.

5. THE FRAMEWORK PROGRAMME AND INTERGOVERNMENTAL COOPERATION AT THE PROGRAMME LEVEL

Although the vast bulk of public R&D spending in Europe is still carried out at national or regional level, these substantial resources remain fragmented and poorly coordinated. As was noted in the Communication on the European Research Area, “the European research effort as it stands today is no more than the simple addition of the efforts of the 15 [now 25] Member States and the Union. This fragmentation, isolation and compartmentalisation of national research efforts and systems and

---

116 European Commission, *Enhancing Access to Research Infrastructures – Improving the Human Research Potential and the Socio-Economic Knowledge Base (1998–2002)*, Technical Review of IHP-ARI Contracts – Panel’s Technical Review Report, January 2003.
the disparity of regulatory and administrative systems only serve to compound the impact of lower global investment in knowledge”\[117\]

Before the 6th Framework Programme, successive Framework Programmes focussed on fostering cooperation between research actors at “project” level by bringing together universities, research agencies, and companies. They were not used as vehicles for promoting the better coordination of national R&D programmes. This changed under the 6th Framework Programme when following the ERA initiative the first steps were taken to move cooperation forward to the next level by coordinating at programme level. The main tools proposed under the 6th Framework Programme for promoting the coordination of national and regional research at programme level were the ERA-NET scheme and the application of Article 169 of the EC Treaty.

In early 2002, EU research ministers recognised the importance of the mutual opening of national research programmes. CREST followed this impulse by launching five pilot actions for the mutual opening of national programmes in March 2002\[118\]. During the course of 2003, CREST came to the conclusion that the exchange of good practices between national programme managers was very useful, but that there was a need for a framework for further discussion. The ERA-NET scheme was considered to be the most suitable mechanism for pursuing the first stages of coordination.

The ERA-NET scheme was a highly innovative component of the 6th Framework Programme\[119\]. Its objective was to contribute to the creation of the European Research Area by facilitating practical initiatives to coordinate regional, national and European research programmes in specific fields, and to pool fragmented human and financial resources in order to improve both the efficiency and the effectiveness of Europe’s research efforts. It provided support for creating close, long-term links between national research programmes with shared goals. The scheme’s participants were programme funders and managers working in national and regional ministries and funding agencies rather than universities or enterprises. Ultimately ERA-NETs were expected to lead to collaboration of major significance, including the strategic planning and design of joint research programmes, the reciprocal opening of national research programmes to researchers from other member countries, and the launch of fully transnational programmes jointly funded by more than one country. Interest in the scheme was large, which is evidenced by the fact that by 2006, 229 proposals involving 2003 participants had been submitted. ERA-NETs were active in a wide range of fields\[120\].

\[117\] European Commission, *Towards a European Research Area*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, COM(2000) 6 final, 18 January 2000.

\[118\] CREST stands for: Scientific and Technical Research Committee.

\[119\] This paragraph is based on the series of publications (four so far): European Commission, *ERA-NET – Networking of National Research Programmes in the European Research Area – Project Synopses.*

\[120\] For instance, Aeronautics; Agriculture; Astronomy; Biodiversity; Cancer clinical practice; Computational biology, Systems engineering, Informatics, mathematics; Coordination of national and regional activities; Energy; environmental science, environmental technology and Policy development; Ethical,
Another coordination mechanism supported through the 6th Framework Programme was Article 169 of the EC Treaty, which enables the participation of the Community in Member States’ joint national R&D programmes. The use of this mechanism was approved by the Council and the European Parliament for the first time in 2003 and this for the European & Developing Countries Clinical Trials Partnership (EDCTP). The European Commission is supporting this long-term partnership between Europe and Developing Countries by providing €200 million for the development of new medicines and vaccines against HIV/AIDS, malaria and tuberculosis. The EDCTP brings together 14 EU Member States, Norway and Switzerland, Developing Countries, and other donors and industry. The main objective is to combat poverty-related diseases through more and better-structured R&D that meets the needs of the African populations in need.\(^\text{121}\)

6. ASSESSING THE WIDER IMPACTS OF THE FRAMEWORK PROGRAMME

The above sections have dealt mainly with impacts that are produced within a relatively short period of time, and that are “manageable” from a data collection point of view because they are situated at the project level. Much more complex, however, is the assessment of the Framework Programme’s wider impacts. It is well known that the effects of R&D can be spread out over very many years, and it is therefore important that research projects and programmes are not judged narrowly in terms of there immediate outputs. Moreover, the benefits of research are not confined to the R&D actors themselves, or to the beneficiaries of public funding (such as Framework Programme participants), but spill over across many actors, sectors of society, and the economy.

6.1. Wider economic impacts of community research policy

Measuring the economic impact of research is extremely difficult. Among the complicating factors are the long lead time between R&D activity and the eventual economic exploitation of the results, and the problem of unambiguously attributing effects on a firm’s turnover to specific research projects. Even if one manages to

---

\(^\text{121}\) See www.edctp.org
estimate such effects, this will not provide the whole picture because there may be various indirect effects, as well as spillover effects on other actors.  

Nevertheless, efforts have been made to try and evaluate the wider economic impacts of the Framework Programme. One approach that has been usefully employed in the past is mathematical modelling. For example, a recent UK study estimated the impact of the Framework Programme on the United Kingdom’s total factor productivity using a model developed at the OECD. It was found that application of the formula generated an estimated annual contribution to UK industrial output of over £3 billion, a manifold return on UK Framework activity in economic terms.

The European Commission’s Joint Research Centre at Ispra subsequently extended the analysis to all Member States for which data were available. The results seem to indicate significant effects on total factor productivity (Fig. 4.21). For example, for Finland, first estimates suggest that 0.9 per cent of the value added of industry per annum is attributable to funding from the Framework Programme, while many Member States record even higher contributions. It is estimated that on average €1 of Framework Programme funding leads to an (long-term) increase in industry added value of between €7 and €14, depending on the assumptions and

Fig. 4.21. FP5 returns to industry expressed as impact on total factor productivity (%)
Source: JRC, ISPRA

122 For instance, calculating net economic effects at the macro-level on the basis of private, gross effects measured at the participant level would require taking full account of indirect effects (intended and unintended) and carry-over effects to arrive at private net effects, and taking full account of spillovers (effects on non-participants) and crowding-out effects to arrive at net economic effects – see Joanneum Research Forschungsges.m.b.H et al., Austrian Participation, pp. 26–27.
123 DTI - Office of Science and Technology, Targeted Review, p. 8. This study uses the model developed at the OECD by Guillec and van Pottelsberghe, which is presented in Dominique Guillec and Bruno van Pottelsberghe de la Potterie, R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries, STI Working Papers 2001/3, 14 June 2001.
parameters used. This increase will be spread over a number of years, because there is always a time lag before R&D spending has its economic effects. Of course, it is also important to stress that econometrics is not an exact science, and that such results must be treated with a large degree of caution. Other evidence on the positive macro-economic impact of the Framework Programme comes from the projections regarding the macro-economic impact of the 7th Framework Programme carried out via the Némésis model and discussed in a later chapter in this book (Chapter 6), as well as from BRITE-EURAM impact studies on a selection of projects. In the latter, it was found that nearly 1 600 new jobs were created and another 1 000 safeguarded.

### 6.2. Wider social and environmental impacts of community research policy

It is not possible to present – like in the case of macro-economic impacts – in an aggregate way the many social and environmental societal challenges to the meeting of which FP-funded research projects have contributed directly. Only an extensive enumeration of case studies would be able to provide a proper insight into the vast range of areas in which valuable contributions have been made. It is important to note, however, that ever since the 5th Framework Programme the Framework Programme has been more explicitly positioned as having to contribute to the solution of such societal problems. In other words, ever since the 5th Framework Programme, research has become more mission oriented than curiosity driven.

Some examples of the contribution made by the Framework Programme to societal and environmental goals include the following:

- Developing the sophisticated analytical tools needed to predict and optimise the net environmental, economic, and social impacts of new policy measures. For example, 3E – a powerful computer model of interdependent economic, environmental, and energy variables – enabled EU negotiators at Kyoto to calculate the cost implication of different policy scenarios on the spot;
- Producing forecasting systems to give early warning of flooding, improving water treatment technologies, and planning tools to protect coastal zones against erosion and pollution;
- Creating many of the new technologies on which sustainable development will depend – for instance, new sensor systems to monitor levels of pollutants in the rivers that supply our drinking water;
- Strengthening the environmental research infrastructures which underpin European work in priority areas like climate change, encouraging coordinated transnational use of complex data sets, and state-of-the-art facilities.

The inclusion of socio-economic research in the Framework Programme has surely made it easier for European researchers to help meet the many social and environmental challenges Europe is facing. Through the Targeted Socio-economic

---

124 European Commission, Brite-Euram – Making a Lasting Impression on Europe, Luxembourg, 2002.
Research (TSER) Programme under the 4th Framework Programme, the Key Action “Improving the Socio-economic Knowledge Base” under the 5th Framework Programme, and the Thematic Area “Citizens and Governance in a Knowledge-based society” under the 6th Framework Programme, efforts have been made to improve the understanding of the major structural changes taking place in European society, to identify ways of managing these changes, and to involve European citizens more actively in shaping their own future. Issues related to the emergence of a knowledge-based society and new forms of relationships between citizens on the one hand and between citizens and institutions on the other are being addressed. The activities carried out in these programmes mobilise the wealth and diversity of European research in the economic, political, and social sciences, and the humanities.

Wider social and environmental benefits have also been generated by the fact that policy-makers are increasingly well-informed and policies are increasingly evidence-based. This is the result of three different trends. First, there is the aforementioned inclusion of socio-economic research in the Framework Programme. Second, there is the inclusion in the Framework Programme of the so-called “scientific support” for policies. Third, there is the increasing willingness to base the development of new policies on the results of FP-funded research projects. Research serves more and more as the knowledge-base referred to in key policy documents. The key internal provider of such scientific support for EC policies is the Joint Research Centre (JRC). Its role as a Community reference for EU policy in scientific and technological questions is epitomised by the increasing volume of legislation which is based on the work of (and which mentions) the JRC.

Thus European BSE (Bovine Spongiform Encephalopathy) research, to which the Community contributed €90 million in the period 1996–2003, provided the basis for close to 300 scientific opinions in support of almost 40 pieces of Community legislation in the fields of consumer protection, public health, and risk management. This research was proactive and explorative in nature, and thus enabled a rapid response to increased consumer food threats. In fact, the announcement in March 1996 of the links between BSE and the new variant Creutzfeld-Jacob Disease was the result of Community-funded collaborative research. Even more recently, with the outbreak of the SARS epidemics, Community action proved extremely adaptive and prompt. Some 70 projects under the Environment and Sustainable Development Programme of the 5th Framework Programme were explicitly referred to in various

125 See notably European Commission, The Overall Socio-Economic Dimension of Community Research in the European Framework Programme, Luxembourg, 2003.

126 In 2003, the JRC provided scientific and technical support to over 80 pieces of EU legislation. More widely, it should be noted that the JRC implements its mission through Direct Actions under the nuclear and non-nuclear Framework Programmes (FP). Thematically, the focal points are spelled out in the Specific Programmes (nuclear and non-nuclear parts) and are further defined in the Multi-Annual and Annual Work Programmes. To a lesser degree the JRC also uses Indirect Actions under the FPs, additional work for customer DGs, Enlargement Actions and Third Party Work to implement its mission. See also: http://www.jrc.ec.europa.eu
EU policy documents. This provides an indication of the actual exploitation of research results for policy support. A case in point is also the European Climate Change Programme (ECCP), which explicitly recognised the role of research in the energy and environmental fields. The preparatory work that led to the adoption of the Directive establishing a scheme for greenhouse gas emission allowance trading was supported by the results of the PRIMES and POLES models developed under previous Framework Programmes.

A number of societal issues (ethics, gender issues, environmental issues) have also been put on the agenda via the Framework Programme proposal evaluation process. Since the 5th Framework Programme, each project’s environmental targets and objectives must be detailed in the project proposal. This plays an important role in the evaluation and selection of projects to be funded. Nonetheless, the detail provided on these targets and objectives is seldom sufficient to allow for subsequent systematic monitoring and evaluation at the programme level. Therefore, it is difficult to quantitatively assess the environmental effects of these projects (e.g. in the form of reduced emissions, or decreased health risks, etc.) at an aggregate level. Even so it is widely recognised that most RTD projects funded by the Framework Programme generate either directly or indirectly positive environmental impacts.

6.3. The Framework Programme and the EU’s international standing

As discussed in the beginning of this chapter, many industrialised countries outside Europe participate in the Framework Programmes. Some – including the United States, Canada, Israel, and Australia – have already signed S&T agreements with the EU. For these countries cooperation with Europe is attractive. A study commissioned by the Australian Government Department of Education, Science and Training (DEST) on Australian science and technology cooperation with Europe, for instance, concluded that Australian researchers want to work with Europe because it is seen as a site of leading-edge collaboration, and that there is a large potential for expanded collaboration.

International S&T cooperation with developing countries via the Specific International Scientific Cooperation Activities (INCO) programme of the Framework Programme established in 1983 starts from the concept of sustainable development and the idea that poverty and social marginalisation can be overcome successfully by investing in human and institutional resources. The INCO programme is

---

127 Among those, a few (ca. 15) relate to Written Questions from MEPs or/and to Annual Reports of JRC, while the majority point to actual policy documents (13 different policy documents often citing several research projects). For more details see Ricci Report, 2004.
128 As mentioned in European Commission, Green Paper on Greenhouse Gas Emissions Trading within the European Union, Presented by the Commission, COM(2000) 87 final, 8 March 2000 and European Commission, Proposal for a Directive of the European Parliament and of the Council Establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and Amending Council Directive 96/61/EC, Presented by the Commission, COM(2001) 581 final, 23 October 2001.
based on dialogue and promotes the development of long-term durable research partnerships, with four main regions: Latin America, Asia, and Africa; the Mediterranean countries; the Western Balkans; and the Newly Independent States.\textsuperscript{129} Though difficult to quantify, the impact of the Framework Programme in these regions is fourfold. First, research projects contribute directly to meeting local challenges. Positive impacts concern, for instance, scientific job creation, substitution of imported goods, improved food quality, and environmental protection from rapid industrialisation and urbanisation. Impacts of Asian and African INCO-funded projects in the fields of agriculture, food, and health concern improvements in farmer incomes, gender equality, public health, education, employment, protection against erosion, conservation of natural resources, and training and professional improvement. Second, Framework Programme projects also strengthen the local capabilities to meet local challenges.\textsuperscript{130} Third, Framework Programme projects inform local policy development.\textsuperscript{131} And fourth, Framework Programme projects promote regional collaboration.

**CONCLUSION**

Assessing the impacts of research programmes is complex, and even more difficult in the case of the Framework Programme. Nevertheless, a number of definite things can be said about past Framework Programmes. Across Framework Programmes, the collaborative research component has been characterised more by growth in the number of projects and participations than by growth in the average size of the project, raising the issue of the optimal size of projects and critical mass. The degree of industrial participation has become smaller, while that of universities and research institutes has increased. The by-country ranking in terms of participations and funding is more or less in line with that in terms of GDP or number of researchers, although smaller countries prove to be more “efficient” in obtaining funding than larger ones. The by-country ranking in terms of Framework Programme participations has not changed very much across Framework Programmes. The same finding is valid for the regional distribution of participations and funding: the regions with the highest income levels and/or the highest research activity are the front runners. However, a large number of peripheral regions are allocated a larger share of European research funds than could be expected on the basis of their R&D effort, economic importance, and so on. Regarding individual participants, it was shown that a relatively small number of organisations participate in a relatively large number of projects across calls and across Framework Programmes, collecting most

\textsuperscript{129} See also the INCO portal: http://cordis.europa.eu/inco/home_en.html

\textsuperscript{130} For example, under FP5, 344 research projects mobilised 461 teams from 19 Non-EU partners from the Mediterranean Basin together with their European peers. The projects addressed the key challenges in this extremely water-scarce region.

\textsuperscript{131} See INCO impact study and high impact projects analysis carried out in support of the five-Year Assessment.
participations and most funding. Collaborative research projects establish an ever-increasing number of cross-sectoral and cross-border collaborative links. Networks remain remarkably stable after the end of projects and have a multiplier effect on a country’s returns from the Framework Programme. Collaborative research has been characterised by an ever-increasing number of thematic priorities, avoiding major gaps in terms of coverage, though this does not seem to have caused fragmentation. Framework Programme collaborative research is generally considered to be of high quality, though not sufficiently risky and at the frontier. Community-funded collaborative research is characterised by a very high degree of additionality. In the absence of Framework Programme funding, projects would not have been carried out at all or would have been carried out in a very different manner with reduced objectives and a smaller number of partners. Framework Programme collaborative research has clear impacts on capabilities, behaviour, and competitiveness, and on scientific and innovative performance. The Framework Programme also contributes to human resources development and has a structuring effect through its coordination of national research programmes.

We have seen in this chapter that learning from past experiences and identifying the strengths and weaknesses of previous Framework Programmes draws upon the evidence of ex-post evaluations. And such evaluations rely to a large extent on good and robust data. In the past few years, the Commission has undertaken important efforts to improve the completeness and consistency of cross-Framework-Programme-participation data. These ongoing efforts need to be continued and consolidated. Special attention should also be paid to developing innovative, including qualitative, approaches for assessing project outcomes.132

When conceiving its new Framework Programme, the Commission did not only look backwards to the experiences gained with previous Framework Programmes. It also started an open broad-ranging dialogue with the key actors who would be affected or involved. This will be the subject of the following chapter.

---

132 In this context, it needs to be noted that the Commission is supported by the Member States. For instance, in early 2006, a group of 20 Member States – on the initiative of the German Ministry for Science and Research – submitted a joint paper to the Commission outlining ideas of how the reporting system on the Framework Programme implementation could be improved. See letter from the German Ministry for Science and Research to DG Research, together with a joint paper on “Future Supply of FP Data and Statistics to Member States and Associated Countries.” 05.01.2006. Internal document.