Thematic research prioritization in the EU and the Netherlands: an assessment on the basis of content analysis

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Abstract

With the upsurge of the knowledge economy, a balanced and professional setting of science and technology research priorities is becoming increasingly important. Priority setting in general - and in the European Union Framework Programmes (FP) in particular - has often been criticized by many academics, who tend to describe them as ‘Loch Ness monsters of bureaucracy’: new granting rules and funding terminologies tend to appear almost every five years; the procedures involved in granting awards are often considered as impregnable and unclear; and the decision-making process is sometimes rather different from classical, quality-controlled peer-review systems. In practice, researchers often prefer small-scale transparant national research programmes over the European FPs, provided they are based on quality criteria. This paper aims to provide: (i) a critical overview of mechanisms for establishing priorities in research programmes (or themes); and (ii) an assessment approach to the current practices of setting research priorities in the EU and the Netherlands in particular, by means of counting procedures based on statistical content analysis. Our investigation of the EU and Dutch national theme priority-setting experiences shows that the two mechanisms are largely complementary and, as such, can prove an important stimulus for further excellence, collaboration and connectivity in the complex world of science policy.

Key words: knowledge economy, triple helix, priority setting, content analysis

1. Introduction

Frontier research that shifts the borders of our current knowledge horizon is a sine qua non for any civilized nation. Inspiration for such innovative research may stem from two distinct sources: (1) a curiosity-driven attitude from individual scientists; and (2) the need felt by the research community to respond to urgent societal, industrial or policy challenges. In both cases, the necessity for advanced scientific research as a critical factor for innovative performance in a modern knowledge society is increasingly being recognized, a development that seems in line with the growing demand for applied research leading to useful knowledge for both industry and society. In recent years, this trend of research valorization has led to an intensification of the relation between universities, industry and government, and brought about a wave of commercial research and targeted publicly-funded research. Proper arrangements and networks among these three institutional spheres provide input and sustenance to science-based innovation processes. At the same time, this has given rise to serious concerns about the negative effects that the university's ongoing entanglements with the marketplace and beyond might have on the long-term health and independence of the basic research enterprise. In the present paper, the changing role of scientific knowledge as a critical factor for knowledge-driven societies is further discussed. The interaction between industry and research has received ample attention in the current literature. But the role of governments in knowledge development has been less extensively studied.

In this paper, therefore, research priority setting in the public domain is analysed as a tool for countries or regions to influence and focus their knowledge potential. Priority setting is believed to support excellence, collaboration and connectivity in a country or region. Priority setting, however, exists in different forms and its effectiveness is often hard to measure. Since it is not obvious to what extent government should intervene or how far a university has to reach out, these questions need to be the subject of systematic reflection and theoretical debate. Comparative research may inform policy makers about how other (potentially competing) agents have solved the production growth puzzle of integrating the various ingredients into a specific mix, given local or regional conditions (Nelson and Winter, 1975; Lundvall, 1988).

In our study two forms of priority setting will be discussed in more detail, namely, the benefit-cost method of priority setting, and the system-based method of priority setting, represented by the Framework Programmes (FPs) of the European Union (EU) and the research priority setting exercise of the Netherlands Organisation for Scientific Research (NWO). While a number of different reports have been published on the working of the FPs, there have been only a few studies on Dutch research on priority setting. By means of a so-called content analysis of a selection of research projects that have applied for funding since the early 1990s, we hope to gain proper quantitative insight into the priority settings on thematic and programmatic research in the Netherlands and into the mechanisms that steer them. In this context, we hope to find some further evidence for the effectiveness of priority setting in general in stimulating excellence, collaboration and connectivity, as well as the differences between the benefit-cost method and the system-based method of priority setting in realizing these goals.

2. Changing interactions in the knowledge field

2.1 Prefatory remarks

In general, knowledge creation and diffusion is considered a mission of academic research and education institutions (universities, research laboratories, colleges, high schools, etc.), and, consequently, governments are not a neutral actor in this context. In today's knowledge-based economy, the overall innovation performance of an economy is not only dependent on how specific formal institutions perform. In general, performance for a large part also depends on how these institutions interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions such as values, norms and legal frameworks (OECD, 1994). Hence, the idea may be supported that investment in pure curiosity-driven research is not in itself a guarantee of the proper technology that is required to compete in the world economy: it is a necessary though not sufficient condition. There is also a full spectrum of other societal needs that need to be met (Beesley, 2003). The valorization of academic research is as such becoming increasingly important as a means to connect science and society. The economic benefits for society at large are highlighted by what is known as the triple-helix model (Leydesdorff and Etzkowitz, 1996), where in particular the importance of linkages between industry and science is emphasized. In this section we use the triple-helix model as a theoretical frame of reference for the assessment of knowledge-based development options, while the focus will be especially on the role between science and government. Later, in Section 3, the different forms of priority setting are presented.

2.2 Scientific research

Nowadays, there are three analytically distinct knowledge production systems in the general university or academic setting: curiosity-driven research; targeted publicly-funded research; and commercial research and development. According to the characterization of science by Gibbons et al. (1994), curiosity-driven research falls into Mode 1, or the traditional academic mode of knowledge production, whereas targeted publicly-funded research and commercial research and development are part of Mode 2, i.e. the knowledge that is developed in the context of application. In Mode 1, knowledge production is considered to be carried out in the absence of a particular goal with quality control maintained essentially through peer review. Mode 2, on the other hand, is viewed as a transdisciplinary, heterogeneous and hierarchical method that achieves quality through social accountability and reflexivity, leading to results that are highly contextualized. These modes are in line with the ideas of Snow (1959), who states that the research process essentially has two motives: one is to understand the natural world; the other is to control it. Hence, curiosity-driven research or basic research is motivated by the desire to seek new understanding and knowledge about nature, while use-driven or applied research is motivated by the desire to use that knowledge in a practical way. Mode 3 takes place outside the public domain and has its own justification, although it will need input from Modes 1 and 2.

It is nowadays widely accepted that science is undergoing a major transformation, and the above divisions in academic knowledge processing are highlighted when the changing nature of science is debated. Basically, applied science and science-based technology are now recognized to be of vital importance in the major knowledge-based economies (OECD, 1992). This change is, however, not always widely supported in scientific circles, and, moreover, there is a growing concern that the current interest in applied research will come at the cost of fundamental research, and that commercial thinking will dominate academic thinking. Clearly, the idea of science as instigator of rapid economic growth is not new. In the nineteenth century, both de Toqueville (1848) and Marx (1844) had already highlighted science as the key engine of technological progress and national wealth. It is especially the societal aspect of science that has been gaining ground in current debates. Here, it is not so much the ability to solve problems relevant to society's needs that is referred to, as this particular role of science has already been stipulated by Merton as early as 1942 (Beesley, 2003). Rather, it is the visibility of the practical consequences of science that is now considered important in modern society, keeping the amalgamation of applied and fundamental research alive (Chalip, 1985).

Today, society seems to depend on science more than ever before, but what scientists do remains unclear to most people. At the same time, public opinion is becoming more powerful, as more people are educated and emancipated citizens. As applied research is in general more practical, in the eyes of public opinion it is easily considered more valuable than fundamental science. However, fundamental research is often virtually incomprehensible to the non-professional, often because of the highly technical language used (Sokal and Bricmont, 1998). The question is, of course, how important the distinction between applied and fundamental research really is, and whether the differences between fundamental and applied research are really as significant as some claim. But this is another discussion altogether. Increasingly, however, the need to create public awareness of the value of science in general is being acknowledged. Of course, it would be ideal to map out all expected and realized benefits of research expenditures, but this is virtually impossible. Yet, in most countries in the western world research sponsors have developed professional evaluation and accountability schemes, which offer due insight into the use of public money. As such, the role of government in the modern production process can by no means be ignored.

Together with industry, government forms a network overlay of communications with science that reshape the institutional arrangements among researchers, industries and government, a formation clearly depicted by the triple-helix model of Leydesdorff and Etzkowitz (1996) (see Figure 1).

- Insert Figure 1 -

According to the triple-helix model, the interests of industry and government merge with and alter the performance and organization of university research, thus challenging the collegial role of research. In the literature, this idea is supported in the sense that there is currently a wide belief that the traditional linear models of 'demand pull' and 'technology push' have now been replaced by evolutionary models that describe and analyse these developments in terms of interacting and co-evolving networks of institutions and techno-economic infrastructures (Nelson and Winter, 1982; Dosi et al., 1988; Leydesdorff and Besselaar, 1994). These networks then provide a relatively efficient way to link the work of universities or public research institutes to industrial needs, i.e. make science more broadly applicable. Of course, the quality of the network dynamics strongly matters. In a positive scenario, the network consists of loosely coupled relations that enable openness and integration, and create perspectives for action. In a negative scenario of 'lock-in', however, networks become conservative and inward-oriented – thereby preventing any learning-based action – or they become subject to confusion leading to high transaction costs in inefficient adaption (see, e.g., Acs et al., 2002).

The way in which the different network partners interact is of great importance for successful network participation. The interaction between industry and science has been widely discussed in the literature, but far less information is available about the relation between policy and science. Yet, the relations between academia and government seem to be intensifying (Leydesdorff and Etzkowitz, 2001). There is an important, though not dominant, role for government and an enhanced role for the university in the triple helix. This redefinition of the public/private divide is unavoidable in a knowledge-based economy, because academic knowledge is a public good, whereas entrepreneurship requires conditions for private appropriation. What links the different helixes, however, is the need to sustain a high level of innovation. Interaction between the different functions is thus essential in order to generate and sustain the specific configuration of an innovation system. In the next subsections, these roles of the partners in the triple-helix model will be discussed in more detail.

2.3 Industry

Among economists, there is a wide agreement that productivity (output per unit of input, usually output per worker) is the key to economic growth. Higher productivity is for a large part stimulated by investment in capital formation (including infrastructure), in people (e.g. training and education), and in technical progress (including new technologies and corresponding new ways of organizing industrial activities). Of these variables, in particular the design and use of better technology is considered especially significant for growth. Moreover, according to the widely cited growth-accounting literature, traditional factor inputs like capital and labor cannot account for a significant percentage of national economic growth, because this role is attributed to advances in technical know-how (Boskin and Lau, 1994; Denison, 1974; Solow, 1957; Tassey, 1995). The relation between technological progress and economic performance is further explained by the New Growth Theory, which emphasizes that the rate of economic growth is driven by the total stock of human capital, i.e. the collection of knowledge or innovative ideas held at any one time by people in businesses, universities, and governments (Romer, 1986, 1990). Essentially, this theory contends that new ideas are the root source of growth, because they lead to technological innovation and hence to productivity improvements. Investment in education and scientific research and development (for the purpose of increasing the stock of both human capital and new ideas) is essential for the economic growth process.

There is thus a growing awareness that innovation by companies is not a linear process, running from invention to commercialization and ultimately to market introduction, but a cyclical and interactive process with networks of many different actors. According to Sorenson and Fleming (2004), there are at least three lines of empirical research that support the positive relation between science and industry (and consequently economic growth). First, GDP growth in the United States is linked to higher scientific employment (Sveikauskas, 1981), and to increased private and public expenditures on R&D (e.g. Mansfield, 1972; Adams, 1990). Secondly, high-tech companies that adopt a research orientation seem to outperform those that do not (Henderson and Cockburn, 1994; Gambardella, 1995). Thirdly, higher citation rates are found among patents originating from university labs (Jaffe and Trajtenberg, 1996; Mowery and Ziedonis, 2002). These results support the idea that a new type of knowledge production has emerged that specifically contributes to meeting industrial needs (Mansfield, 1995). Further, governments can contribute to industrial growth by streamlining entrepreneurial support programmes, minimizing red tape, and working towards government flexibility (as opposed to growing bureaucracy). Especially with the upsurge of the idea of the innovative potential of entrepreneurs, the link between not only industry and government, but also between industry and universities seems to have strengthened. Although only a small fraction of university innovations relative to R&D budgets is actually utilized by industry, a transmission belt of firm-formation has been created, often with government assistance, through incubator facilities and entrepreneurship centres (e.g. Klofsten et al., 1999).

According to Leydesdorff and Etzkowitz (1996), it is the increase of these interactions among institutions that further generate within each of them new structures, such as research centres in universities or strategic alliances among companies. Evaluation studies of national network activities have provided ample empirical evidence that formal and informal R&D links between the public and private research sector do indeed foster knowledge diffusion and contribute to innovative activities (e.g. Callon et al., 1992; Faulkner and Senker, 1994). In the learning concept, this relation is further defined and outlined. This is a local development concept in which the emphasis is put on improving individual and collective learning through open and flexible networks (OECD, 2001). The learning is not exclusively between local or regional partners. Regional actors (e.g. policy institutes and companies) learn through both regional and global networks. One of the first regional scientists who addressed the learning region as a paradigm is Florida (1995). Earlier seminal work underlying the learning regions paradigm was done by Aydalot (1986), Camagni (1991), Maillat (1991) and others, while the paradigm was fertilized from different angles in regional studies, like the ones on innovation systems, technology complexes (including knowledge spillover phenomena), post-

Fordism and clusters, and the ones on technology policy, local and regional institutions and community action (see e.g. Benner, 2003; Morgan, 2002; Ratti et al., 1997; Cooke, 1998; Maskell and Malmberg, 1999; Gertler and Wolfe, 2002). Hence, the learning region has an advantage over other approaches in that it explicitly addresses the quality of policy making and of other institutional conditions in the regional economy and society. In the next subsection, we will look at the role of the government in more detail.

2.4 Government

For innovation and economic growth, investments in education and scientific research and development are widely considered to be of vital importance. Governments play a dominant role here. Public expenditures on science and technology are critical success factors for accelerated economic development. For example, in studies by Nijkamp and Poot (2004) and Nijkamp et al. (2001), a convincingly positive causal relationship between economic growth and public expenditures in education and R&D is shown by means of a collection of empirical studies on growth and government-spending policy. Governments themselves are also increasingly becoming aware of the role they can play in the innovation process. Many governments today are deliberately trying to enhance high-tech activity in their regions and often embrace the learning regions paradigm to improve policy making. This has led to policy approaches based on the participation of relevant actors and on holistic perspectives: learning by companies but also by policy making institutes and other organizations. In one form or other, most countries and regions are trying to attain some form of triple-helix in order to drive productivity and economic growth (Etzkowitz and Leydesdorff, 2000).

According to Leydesdorff and Etzkowitz (2001), governments are entering the scene as entrepreneurs directly and/or indirectly, to greater or lesser extent, not only supplying the resources to the other actors or regulating their relations with each other, but also acting as instigators of organizational innovations and structural adjustments that often form the basis of innovation systems. These developments are in line with the ideas of Hirschman (1958), who states that the main task of public policy is to address the balance between directly productive inputs and social overhead capital. Social overhead capital in Hirschman's view has a fairly broad meaning: it is usually public capital which is normally characterized by lumpiness and indivisibility and does not have an immediately productive character (in contrast to labour or capital). It may be either material in nature (roads, railways, (air)ports, pipelines, etc.) or immaterial (knowledge networks, communication, education, culture, etc.). The first of these classes is often referred to as 'infrastructure', and the second as 'suprastructure' (for an extensive overview of social overhead capital, see also Wilson et al., 1966; Nijkamp, 1986; and Lakshmanan, 1989). Traditionally, in regional development theory, the main emphasis has been placed on the physical (or material) components of social overhead capital, i.e. on infrastructure. It is only recently that the assessment of the impact of suprastructure has received more attention.

Public sector involvement in R&D is not new, but the heightened pace of international industrial competition has obliged the governments of most advanced countries to consciously seek to improve the level of economic benefit deriving from public sector research. Rationales derived from economic theory seem to explain little of the pattern of public sector involvement in R&D, because, as with all activities of government, political and institutional factors determine what is done (Stewart, 1995). Choices are made according to a shifting pattern of political, economic and institutional effects. But, overall, the relative priority accorded to fields of activity within the public sector seems to owe more to politics. The transfer of technology from public-sector research bodies and the forging of closer links between science and industry, for example, are prominent concerns in virtually all OECD countries. But the interest in broader societal issues is a more recent concern, which is in line with the science and industry debate, in the sense that it also addresses the changes that are taking place as a result of the rapidly changing knowledge society. In contrast to the more economic effects aimed for when linking science and industry, the societal debate also strongly addresses political and institutional issues.

Innovation requires agencies that are competent and able to assess the possibilities contained in a given situation and aware that such assessment can always become more knowledge-intensive. In the case of knowledge-based developments, one can no longer assume fixed endpoints to development. Here, institutional layers function mainly as a retention mechanism for economic wealth, archival knowledge, and best practices (van Lente and Rip, 1998). The level of functionality for improving communication and collaboration among partners with reference to innovation will further decide whether institutionalization will take place, or instead de-institutionalization and "creative destruction" (Schumpeter, 1943). Communication and collaboration will, however, never be optimized, since they remain disturbed by institutional interests, by market forces, and unexpected innovations. As such, although the triple helix system under study is driven by the increased relevance of technological knowledge and academic knowledge to industrial production and social development, the *study* of the triple helix is driven by policy questions which bring the relation between university and government to the fore (Wouters et al., 1999; Guston, 2000). Research on university-industry relations in the US did not originally take into account the role of the government, but this made the topic difficult to understand elsewhere. Rather, there is a growing need for the knowledge-based construction of new bridging functions in order to help the political system to provide the incentives to structure the local innovation systems, in order to retain the wealth potentially generated from expected innovation (Freeman and Perez, 1988). Understanding the dynamics of these relationships can be considered as the very purpose of innovation studies (Wouters, 1999; Cutcliffe, 2000).

In the following subsection, our focus will be on the relation between academia and governance. According to Leydesdorff and Etzkowitz (2001), the university can act as a vanguard in the public sphere, because it has a clearly defined function in the social system on which it can build recursively and knowledge-intensively. But, when academia fails to explain the complexity of the transformation processes to larger audiences, the public discussion may degenerate. So, whereas innovation was originally viewed primarily as the application of technology, increasingly innovation at the organizational level is regarded as the social precondition for creating technological innovations, especially where it concerns the interactions between industry, government and university. In this connection, insights from the social sciences and humanities are important, since (re)organization at the social level is always a reflexive activity. One way for governments to influence national research is through funding programmes. Research priority setting is increasingly used by national governments and the EU to influence and direct the research agenda towards innovation and development and, ultimately, economic growth. Some see it as a perfect means to bring science closer to society, while others view it rather as an inferior form of research as opposed to more fundamental research, but what is interesting for this research is especially the interaction between university and governance in this regard. Hence, this paper then addresses the questions whether lessons can be learned from thematic priority setting exercises and programmes in the Netherlands and the EU, or whether conditions are fundamentally different across locations. Also, it would be interesting to know if these programmes can be used elsewhere, and at what cost to the original function? First, priority setting will be discussed in more detail and the different forms of priority setting will be presented.

3. Priority setting for public sector research

3.1 Introduction

Research priority setting is increasingly recognized by research managers as a tool for enhancing excellence, collaboration, and connectivity. For some people, too much applied research may, however, also come at the cost of fundamental research, while others even fear negative effects on the long-term health of the basic research enterprise. Also, in the case of national science priorities, the desired benefits of research are not always economic or even necessarily quantifiable, particularly since the effects of research priority setting have not yet been extensively studied. In an OECD report (1991) research priority setting is looked upon as being “essentially a complex political process involving many people who interact with one another”. Also, the report notes that: “It is not a case of science-push or demand-pull, but a changing combination of the two which is impossible to break down precisely”. In this paper we hope to obtain some deeper insight into the working and effects of prioritization. We hereby base ourselves on two basic models of priority setting for public sector research: the benefit-cost method, and the system-based method of priority setting of Stewart (1995).

3.2 Benefit-cost method of priority setting

The benefit-cost method of priority setting is a centralized decision-making process and hierarchy with a strong, often explicit, political component that requires both the political determination to gather the threads together and well-defined consultative processes involving both the public and the private sectors. Although the change is slow the process forces participants to define their objectives and argue for their *preferences. Banality or unacknowledged politicization, however, poses a risk (Stewart, 1995).*

In choosing between a number of possible research projects, a research agency or company seeks to quantify all relevant variables that affect pay-offs from the research. In principle, this should fit into a framework governed by economic objectives. In practice, benefit-cost analysis in setting priorities is undertaken in a much looser and less formal way than is implied by a strict application of the above concept and is done, not at the national level, but by specific research-performing and research-funding organizations operating within overall budgets. Many institutions involved in priority setting use variations of the benefit-cost method, which are less information-intensive, and which compare objectives on the basis of predicted money-benefits alone. Research objectives are rated according to a number of criteria which capture both the general economic and strategic importance of research in the area and the capacity of the organization, for which priorities are being set to contribute to the desired outcome. The criteria are normally weighted in some way to produce an overall score for each research purpose.

According to Stewart (1995), logically, public sector research should concentrate on those problems which are unique to the country concerned, or which lead to the generation of saleable intellectual property, or to indigenous commercialization. Furthermore, setting national priorities must be a centralized exercise, otherwise the necessary trade-offs cannot be made. Therefore, a specific group should make the decisions. These decisions however, are neither obvious nor straightforward. There are usually different stakeholders involved, and, in order to make the policy successful, the preferences of stakeholders for different combinations of benefits need to be known. The relationship between what is done now and the emergence of benefits in the future is, by definition, uncertain. Also, the projects undertaken will be further away from the marketplace than would be the case in industry-related decision making. The method can therefore lead to serious errors of judgment, or may serve simply to vindicate existing power relations within the institution

3.3 System-based method of priority setting

The system-based method of priority setting is a tool that changes outcomes by changing processes. It offers a powerful method for changing outcomes in a non-incremental way, but unless the operation is carefully thought through pre-existing structures may be distorted rather than transformed in socially beneficial ways (Stewart, 1995).

The focus of this second system is not so much on the designation of areas of research, but rather on the way in which such choices are made. Hence, three quasi-normative models are discerned: the user-based model; the institutional model; and the political model. This systemic priority-setting method is further explained in Table 1. According to this typology, the user-based model is a market-like model that brings in some way or other the demand for, and the supply of, research into balance. For example, much health research is funded by charitable trusts. In the case of major drug companies, this may even be research of a highly fundamental kind. The institutional model is directed by the work of scientists, who, in planning their work, are influenced by their personal values and objectives and by the incentives and disincentives offered by their institution. Different institutions perceive organizational and personal roles differently. In the political model, government institutions are in charge of the planning process. Because of the highly political character of government and ever-changing priorities in politics, any set of institutions and activities that are highly dependent on government must expect considerable change and disruption flowing from that arena.

- Insert Table 1 -

Whereas the benefit-cost method of priority setting is demand-driven, the system-based method of priority setting is supply-driven by market-oriented users, scientists, or government institutions. The demand-driven model uses the general economic and strategic importance of research and research objectives as its starting point. It is generally top-down and is of most value in highlighting which areas of research should be dropped or downgraded within an institutional (or national) portfolio of research investments. A proper judgment process is thus of vital importance. The supply-driven models, on the other hand, are led by a strong steering mechanism - be it the market, scientific reward systems, or political priorities - which sets research objectives primarily for its own benefit. This model is more bottom-up and can bring to bear a much greater measure of demand pull than would be possible using institutional and political arrangements (especially for the user-based model). However, users are often not in a position to understand the importance of long-term basic and strategic research, nor can they be expected to take into account the research training, teaching and infrastructural requirements of the research system as a whole. From an institutional perspective, changing research incentives can have a great impact on research priorities. Policy makers should be able to understand in what way existing arrangements are causing priorities to be set. A similar situation applies for the political scene. Here, political priorities have a great influence on research priorities.

So far we have discussed priority setting by defining broad areas that provide a focus for more detailed evaluation of R&D opportunities, but are in themselves too broad to permit specific priority decisions. Priority areas can however be subdivided into *research themes*, which are broad R&D programmes or issue areas. *Research themes* then can be further subdivided into specific *R&D topics or issues*, which are sufficiently specific to allow identification of R&D products that can be evaluated in terms of potential benefits and 'researchers and research teams', which can be evaluated in terms of R&D capability. In the next section, we will discuss theme priority setting in more detail by analysing the systems of both the EU and the Netherlands with the help of the different methods of priority setting. Then we perform a content analysis in order to gain more insight into the actual strengths and weaknesses of priority setting. In this connection, the Dutch research priority setting will be used as a case study.

4. Priority setting in the European Union and the Netherlands

4.1 Introduction

Priority setting is increasingly being employed throughout the world as a means of strategically focusing national resources on areas of key importance. The idea is that research priority setting cannot only change the way research is done but can also promote cooperation between those who do not normally interact and encourage participation of research users. These trans-institutional discourses soon generate a vocabulary of their own. For example, the EU has developed a lingo of "RTD projects" with "objective 1" and "work package 2" within "Framework Five". The discourses generate visions and metaphors that can be utilized to shape new economic, political, and social initiatives (Leydesdorff and Etzkowitz, 2001). Priority setting should therefore ideally be able to address the increasing demand for knowledge, the link between science, industry and government, and the growing importance of strong local, regional and global networks. So far, however, not much research has been published that analyses the actual effectiveness of priority setting, even though the system, as such, is gaining importance. As a result, the effectiveness of the system for national and regional development is undefined, even though various reports have been published that discuss its strengths and weaknesses on the basis of expert interviews. Comparative research of the priority programmes of the EU and the Netherlands (NWO) may hopefully help to inform policy makers about how other (potentially competing) countries and units have addressed the issues of valorization and bringing science closer to society, and vice versa. The focus will therefore be on priority setting in the area of Research and Technology Development (RTD) with a strong societal component.

4.2 Europe and research priority setting

Developments like the growing pace of change and complexity in social and environmental areas, the rapid technological change in established areas such as ICT and biotechnology, the emergence of new technologies such as nanotechnology and novel materials, rapidly escalating costs of research facilities and programmes, global competition for research staff, and the increasingly multidisciplinary nature of research programmes all mean that a strong relation between science, industry and government is increasingly recognized. In Europe, since the March 2000 Lisbon European Council endorsed the objective of creating a European Research Area (ERA), many initiatives have been launched in this direction under the name of the EU Research Framework Programme (FP), the first FP of which was launched in 1984. Besides creating a European internal market for research, where researchers, technology and knowledge can freely circulate, and implement and fund initiatives at a European level, the ERA concept has also been set up to coordinate national and regional research activities effectively on a European level.

Overall, EU priority setting is highly structured and centralized, while it is driven to a large degree by direct funding of identified priorities. As such, the EU FPs are a typical representation of the benefit-cost method of priority setting. The integrated set of priorities include broad thematic areas, such as the ‘user-friendly information society’, horizontal socio-economic priorities, such as the ‘promotion of innovation and encouragement of the participation of small-to-medium enterprises’, and what are called key actions, which address specific applied or fundamental research projects related to the broader themes. With this approach, Europe tends to integrate both the supply of, and the demand for, technology. The primary focus is on the technologies, but they are increasingly linked to social needs, bearing in mind that future technology depends on the pressure of social, ecological, and economic problems. The Fourth Framework Programme (FP4), which ran from 1994 to 1998, introduced socio-economic research for the first time. Four years later, the Fifth Framework Programme (FP5), which ran from 1998 to 2002, intensified social science research support. Research in the Social Sciences and Humanities (SSH) remains as one of the collaborative research themes under FP6 and FP7.

According to an evaluation of the Framework Programme Performance (Arnold, 2005), the Framework broadly funds good quality work, in which universities and research institutes play an important and increasing role. Framework participation is further led by a ‘core’ of major beneficiaries, who sit at the heart of multiple European Research and Technology Development (RTD) networks. As such, the Framework projects, according to the evaluation, primarily produce knowledge and networks. These networks have become larger in FP6, although the experience from FP4 and FP5 is that large networks are less productive than small and medium-sized ones. Further, it appears that the networks consist of a strong ‘core’ of research institutions and companies that remains rather stable across FPs, spanning multiple projects and networks, and a rapidly revolving ‘periphery’ of those who participate only one or twice. Not all stakeholders may therefore be sufficiently represented by the FPs. Moreover, often on account of the burdensome administration, only networking and scale could persuade participants to choose participation in an FP over national programmes.

The evaluation (Arnold, 2005) states that FPs only satisfy low-level process goals to do R&D in various areas of science and technology and contribute to their high-level goals of strengthening the science and technology bases of European industry and contributing to the quality of life of European citizens. Higher-level goals are, however, in general so abstract as to be untestable and hence remain untested. An overall evaluation of the working of the FP is difficult because of issues such as attribution, time scales, appropriate choice of methods, inadequate models of the relationship between R&D and other socio-economic variables, and because of difficulties concerning document access, access to timely and adequately analyzed data, and independence from line management (see Fahrenkrog et al., 2002, and Georghiou et al., 2002). Conclusions about the functioning of the FPs are therefore difficult to make. FP project participants consider that they produce ‘intermediate outputs’, i.e. knowledge and networking outcomes that can subsequently be built upon, rather than results that can be commercialized in the short term. As such, there appears to be widespread agreement that networking, resource sharing, and mobile human capital can indeed all be part of the 'European Added Value', and that FP programmes do not simply duplicate national schemes.

This finding is interesting in the light of another outcome of Arnold's evaluation, namely, 'the need for Member States to improve the way they develop national R&D funding strategies by taking better account of what is happening on the European level'. An evaluation of national FP impact studies of Austria, Denmark, Germany, Ireland, Finland, Sweden and the UK (Arnold, 2005) shows that these studies find that there is a lack of national R&D strategy, and that such a strategy would be needed to make best use of the opportunities represented by the FPs. EU priority setting and national priority setting are here considered to be highly complementary. This is, however, not widely recognized yet nor analysed in great detail. But the growing need for knowledge production and long-term planning makes research priority setting a useful tool when applied properly. A thorough understanding of the working of the tool both on the national and regional (EU) level is therefore essential. On the EU level FPs are evaluated by means of panel reports, FP-wide impact studies, evaluation and impact studies at Specific Programme and research activity level within the FP on thematic issues such as socio-economic aspects, as well as studies which evaluate impacts of the FP at national level. On a national level such evaluation studies of research priority programmes are less widely available, often because of the scientific use of expert peer review, which makes a comparison of the different programmes almost impossible. This paper will attempt to bring the programmes together for further analysis.

4.3 The Netherlands and research priority setting

The Netherlands has made extensive use of foresight exercises to set priorities for research investment. Science and technology foresight exercises are the latest fashion in science policy, and their avowed goal is to help governments and public bodies to formulate science policy priorities. In countries like France and the UK but also the EU as a whole, the approaches tend to have a strong top-down component, but in the Netherlands they are embedded in the intermediary layer of the Dutch research system (van der Meulen and Rip, 1998). The intermediary level of research councils, other funding bodies, advisory and programming bodies, organizations of universities and other research organizations, is the level between the top level of government agencies, and the research performance level (see also OECD, 1991). In the Netherlands, the intermediary layer is densely populated, and there are many network linkages between the institutions, committees, councils, programming bodies, etc., where horizontal co-ordination occurs naturally. Universities carry out about a quarter of the Netherlands' research and receive the majority of their funding from the Ministry of Education, Culture and Science (OCW). Contestable funding is supplied from the same ministry, mainly through the Netherlands Organization for Scientific Research (NWO) and to a far lesser extent through other bodies, such as the Royal Netherlands Academy of Arts and Sciences (KNAW). KNAW allocates predominantly public funds to its own research institutions; NWO allocates funds across the research providers, in particular universities.

NWO has established a variety of priority programmes, proposed and decided in a primarily bottom-up dynamic. The priority setting of NWO is system-based and in line with the political model but with scientists, interest groups, etc. being consulted on what priorities to choose. NWO has set up these priority programmes largely in response to pressures that it should be more active in linking basic science to socio-economic objectives. This question of linking fundamental research to socio-economic objectives is often considered a matter of addressing the intermediary level in a proper way. Without directly having to force scientists and intruding upon their relative autonomy, governments are able to address intermediary bodies, programmes and committees, and are in fact prepared to 'force' the intermediary bodies to change. The NWO policy was not originally geared towards linkages between basic research and socio-economic objectives (van der Meulen and Rip, 1998). The strategic research programmes in the Netherlands, and international programmes, especially the European ones (those of the FPs and to a lesser extent, the programmes of the European Science Foundation) have been an important incentive, and a framework for a new kind of scientific interaction.

The Dutch research system, in line with the Dutch political system in general, can be described a corporatist and consociational democracy, with consultation and representation occurring as two sides of the same coin (Lijphart, 1975; van Waarden, 1992). No actor should have conclusive power and be able to overrule others. This often limits the scope of the Ministry responsible for science policy to exert the power it formally has. As such, scientists have remained powerful and, despite pressures put on them to be relevant and to show excellence, they can often still follow their own objectives. Initiatives for NWO priority programmes are in general left to scientists and checks on relevance are made by a small group of respected persons (including past ministers) (van der Meulen and Rip, 1998). In addition, interaction with societal actors and potential users of research has become quite common. Foresight exercises are often used for this purpose. In these exercises, opinions and views are sought from research users and scientists. The government as a main sponsor of the research system plays a relatively modest role here. The main ways these opinions are collected and aggregated is usually by inviting key persons in scenario workshops and strategic conferences.

Whereas the EU RTD Framework Programmes are subjected to 5-year assessments, which in turn are also analysed by external researchers (see Arnold et al., 2005), the Dutch research priority setting by the NWO does not have such an assessment system that we can use for our comparison (NOW's policy was only evaluated in 1996 and recently in 2008). In order to make a comparison of the priority systems possible, the Dutch approach will require some further analysis. Since the checks on the relevance of the NWO research priority setting take place through internal mechanisms and are often not publicly available, another form of analysis is used. By investigating a large database of social sciences and humanities research projects that have applied for funding through NWO priority programmes from the period 1990-2007, proper insight can be gained into main thematic research orientations. A content analysis then is used to bring to the surface the frequencies of most used keywords in project titles in order to detect the more important structures of their communication content. We are interested to find out to what extent this is a reflection of the theme priorities decided upon by NWO and to what level there is an overlap between priorities of the EU and the Netherlands. Also, we are interested to know whether there is any noticeable difference between the projects that have been accepted for funding and those that have been declined. We believe that this will give us further insight into the systematics of selection procedures and research priorities of NWO. Of course, we are well aware that our approach will provide us with only limited and somewhat subjective information, but in combination with the literature review, the content analysis should give us sufficient information to make a first general comparison between the different forms of priority setting under study here.

5. A content analysis of priority setting

5.1 Introduction to content analysis

Content analysis (also known as textual analysis or corpus linguistics research) is a research tool used to determine the presence of certain words or concepts within texts or sets of texts. Historically, content analysis was a time-consuming process, but already in the 1950s researchers were considering the need for more sophisticated methods of analysis, focusing on concepts rather than simply words, and on semantic relationships rather than just their presence in a text (De Sola Pool, 1959). Since then, a proliferation of corpus software has been introduced. Perhaps because it can be applied to examine any piece of writing or occurrence of recorded communication, content analysis is currently used in a wide array of fields, ranging from marketing and media studies, gender and age issues, sociology and political science, psychology and cognitive science, and many other fields of inquiry. For our purposes, in particular a conceptual analysis is used. This is the most traditional form of content analysis, where a concept is chosen for examination, and the analysis involves quantifying and tallying its presence. In this respect, it is important to note that, while explicit terms are easy to identify, coding for implicit terms and deciding their level of implication is complicated by the need to base judgments on a somewhat subjective system. However, the method does enable the researcher to include large amounts of textual information and systematically identify its properties, e.g. the frequencies of most-used key words. In this particular instance, content analysis can be a strategic vehicle for research priority evaluation or research priority analysis. We will use the software program TextStat.

5.2 A content analysis of Dutch research priority setting

According to the policy document “Science Budget 2004: Focus on excellence and greater value” by the Ministry of Education, Culture and Science (OCW), one of the major challenges for the Netherlands is the fragmentation of the Dutch research policies and research performers. A much-debated issue is the choice of priority areas for the Netherlands and how this should be made. The history of funding mechanisms for the public sector has led to the fragmentation of research efforts across many universities, research institutions and networks. Finding an appropriate balance between creating sufficient focus and critical mass, while also supporting excellence in a number of priority areas, is considered a major political challenge (Boekholt, 2007). By means of content analysis, hopefully, some of these assumptions can be tested. The focus will therefore be on three issues: Do our findings support the observations recently expressed in the "OMC Policy Mix Review Report (Boekholt, 2007)" that Dutch research policy – implemented by one of the key players, viz. NWO – is fragmented and shows a lack of consistency for the longer term? Is NWO research theme setting in any way in line with EU priority setting? And, what can be said about the level of excellence, collaboration and connectivity of the different programmes?

In order to make the interpretation of the findings easier, we will look at the research priority setting of the EU and NWO with regard to the Social Sciences and the Humanities (SSH). On a European level, the Fourth Framework Programme (FP4), which ran from 1994 to 1998, introduced socio-economic research for the first time. In the Netherlands, a similar trend has been visible. It is only recently that a realization has been growing in the Netherlands that a broader view on valorization is more fruitful, and that science also contributes to the preservation of social fabric, culture and democracy. Tables 2 and 3 support this development and show a large overlap between the EU priority setting of the FPs and the priority setting of NWO. For the period 2002-2007, NWO invested a substantial part of its means in the development of nine themes: Shifts in Governance; Cognition and Behaviour; Cultural Heritage; Digitalization and Information Technology; Ethical and Social Aspects of Research and Innovation; Fundamentals of Life Processes; Nano-sciences; Emerging Technologies; and System Earth. Five of these are associated with SSH research: namely, Shifts in Governance; Cognition and Behaviour; Cultural Heritage; Digitalization and Information Technology; and Ethical and Social Aspects of Research and Innovation (see Table 3).

- Insert Table 2 -

- Insert Table 3 –

When looking at the output of our content analysis of the research project titles that have been submitted for NWO funding in the period 1990-2007, there is a large overlap in key words that are frequently used with the themes formulated by NWO in this period (Table 4). It should be noted that the process of content analysis is subjective, in the sense that the researcher must make coding choices (see Carley, 1992). Thus, coding is for single words in the project titles. Further, our content analysis focuses primarily on those single words that have a relatively high frequency in Table 4. Hereby, it should be noted that words that have great similarity, like 'education' and 'learning', will be regarded similar in meaning. However, frequency is in all instances the guiding principle. Our selection of words is in all cases based on the highest frequency of a particular word, and no combination is made of all words of somewhat similar meaning that appear in the output. Further, irrelevant information like ‘and’, the’, and ‘or’ is ignored (see Weber, 1990). They add nothing to the quantification of words like ‘education’ or ‘language’ and are disregarded without affecting the outcome of the coding. Although words like ‘knowledge’, ‘innovation’, ‘development’ or ‘networks’ seem to have a much higher interpretative value, they are so broad in meaning that they will also be screened out here.

We will now present the findings from our content analysis. In Table 4, in bold the following top ten key words are selected that represent the dominant research interests of Dutch researchers that apply for NWO research funding. In general, ‘language’, ‘learning’, ‘law’, ‘economic’, ‘policy’, ‘cultural’, ‘health’, ‘cognitive’, ‘history, and ‘environment’ have according to our coding the highest combination of interpretability and frequency. On the basis of these key words the research focus can be determined with same certainty. With a key word like ‘social’, this is far more difficult, because it can be used in an unlimited amount of combinations and meanings and is, as such, meaningless. As mentioned earlier, the top ten key words also represent a selection of lower scoring key words that have a similar meaning. In our output the following combinations can be made: ‘language’ (linguistics, languages, etc.), ‘learning’ (education, teachers, etc.), ‘law’ (legal, laws, justice, etc.), ‘economic’ (economy, management, etc.), ‘policy’ (governance, political, institutional, etc.), ‘cultural’ (family, culture, society, etc.), ‘health’ (genomics, medical, etc.), ‘cognitive’ (brain, memory, behavior, etc.), ‘history’ (heritage, contemporary, etc.) and ‘environment’ (biomass, energy, etc.). It should be noted here that key words can have different meanings in different contexts and may thus be subdivided under different key words. The software program TextStat does have a function that allows users to see key words in their original context, but the levels of interpretation and generalizability remain very limited.

- Insert Table 4 -

Looking at key words of the projects that applied for funding at NWO per year, some shifts in key words are recognizable over the course of the period 1990-2007 (Table 5). In order to make a comparison of the EU and NWO priority setting, the change in key words will be presented in three time periods: the period 1990-1998, the period 1998-2002, and the period 2002-2006 (see also Table 2 and 3). For the period 1990-1998, the term ‘learning’ scores very high. This seems in line with EU priority setting. ‘Education’ was also an important theme for the EU at that time. Furthermore, the results of the content analysis show that in this period Dutch words score very high, which means that a large number of the projects are still using Dutch as their working language. In the period 1998-2002, the word ‘learning’ still scores high, but other issues concerning ‘health’, ‘economy’ and ‘culture’ are gaining importance. NWO, in line with the EC, appears to be intensifying social science research in the period 1998-2002. Then, in the period 2002-2006 ‘language’ becomes an important key word; ‘learning’ keeps on scoring high; ‘law’ seems to be gaining ground. This may indicate a further diversification of SSH research funding by the NWO in this period. The growing importance of ‘law’ may be explained in terms of the FP priority setting with regard to the priority ‘new forms of relationships between the EU's citizens, and between citizens and institutions'. The upsurge of 'language', however, seems to generally show a more national orientation, although it is also for a large part interlinked with 'education' and 'cognition'. Clearly, the outcomes of our content analysis are only indicative.

- Insert Table 5 -

The focus of our content analysis has so far been on the complete list of research project titles that have applied for NWO funding in the period 1990-2007. However, the list contains both those projects that have been granted funding and those that have not. In order to get an idea of how NWO funding is granted and thus what key topics are hereby considered important, it is further interesting to distinguish between those research projects that were awarded funding by NWO and those that were not. In Table 6, a slight shift towards what seem to be more national-oriented subjects like 'language', 'history', and 'culture' is visible, while 'language', which scores high in Table 4, is in this table among the lower scoring key words. One reason may be that when looking at 'learning' in context in the programme, this key word is often closely related to other categories like 'cognitive' and thus may have a higher frequency unrelated to 'education' when all its occurrences are counted together. On the whole, for all high scoring key words in our analysis the level of 'funding' and 'no funding' is more or less balanced out. Hence, the key words below may be regarded as key research priorities of NWO that deserved extra funding. The national orientation that is reflected by topics like 'language' or 'history', further underlines the national orientation of the priority setting of NWO. Even though the NWO priority setting is primarily bottom-up and supply driven, there does seem to be some national direction that takes into account the future direction and interests of Dutch society as a whole.

- Insert Table 6 -

So what do these results say about Dutch priority setting and its systemic character? A systems approach is believed to lend real cogency to the task of priority setting, because the object of attention is not so much the designation of areas of research but rather the way in which such choices are made (Stewart, 1995). In the case of NWO priority setting the political model is applicable. The decision-making strategies employed within the political model vary from country to country. In smaller countries, like Sweden and Norway, but also the Netherlands, in general a more explicit managerial approach is used to coordinate research budgets, with the 'political' element represented by consultative and interactive processes involving scientists, interest groups and funding agencies (Martin and Irvine, 1989). This supports the finding of our content analysis that the funded priority topics have a national orientation, which are not necessarily recognizable in the themes set by NWO. This outcome also implies that the theme priority setting of the Netherlands is complementary to EU priority setting. The programmes overlap in general theme setting, hereby improving collaboration and connectivity, but due to the Netherlands' specific national orientation with regards to actual project funding more specific national strengths and weaknesses are also addressed. The theme setting of NWO for the period 2002-2007 is, like the EU, rather broad. Content analysis has nevertheless made it possible to obtain a better and more detailed insight into the funding preferences of NWO, even though the interpretation of the output is subjective. On the basis of the above output, we may conclude that, although the frequency of thematic key words has changed slightly, the overall priority topics that have been funded have remained rather constant. As such, NWO research policy seems to show consistency. This is in line with the general idea that political or consultative models encourage the necessary balance, both ex ante and ongoing, between objectives and real research feasibility (Stewart, 1995). Commitment to the decisions that are made by those who will be carrying them out hereby seems to overcome the problem of the substantial drift occurring between the actual activities and priorities of the researchers.

6. Strengths and weaknesses of theme priority setting

In this paper, two forms of research priority setting have been discussed: the benefit-cost model represented by the EU priority-setting programmes, and the systemic model represented by the priority setting programme of the NWO. A literature and content analysis of the EU and NWO programmes show that the two methods are indeed different and appear to have their own strengths and weaknesses. Table 7 gives an overview of the most important strengths and weaknesses of the different programmes in relation to greater excellence, collaboration, and connectivity, assets that are generally ascribed to priority setting. Whereas EU Framework Programmes primarily encourage network development, resource sharing and mobile human capital, i.e. connectivity and collaboration, the Dutch national priority setting system seems especially focused on national knowledge production and less on network promotion inside the research community or between the different stakeholders. However, because of their highly structured and centralized character, EU Framework Programmes are a designation of a specific group that does the deciding. Because categorization of research programmes is difficult, ratings inevitably contain a strong subjective component. Furthermore, the benefit-cost method is often used in a less information-intensive way. Research objectives are rated according to a number of criteria which capture both the general economic and strategic importance of research in a particular area, and the capacity of the organization for which priorities are being set to contribute to the desired outcome. This means that full information is never available, which may lead to serious errors of judgment. This is especially the case if this method is the only one employed.

- Insert Table 7 -

This paper therefore supports the idea of employing a systemic approach on a national level, in order to deal with biases related to mis-specified agendas for priority setting or unchanged actual priorities. The relative influence of the suppliers (i.e. performers) of research can in this way be balanced with that of those who will make use of the results (i.e., in this case, the Member States). From this perspective, the most important and realistic goal of the priority programme of the EU is beyond doubt collaboration and connectivity. Excellence is more difficult to achieve on a European level, because the most important priorities are related to the Lisbon targets of increasing productivity and economic growth. These are, however, priorities that can only be effectively improved when dealt with on a national level. The level of productivity differs per country, and the institutional systems in the different Member States require different approaches to stimulate economic and social development. Therefore, it seems of great importance for the well-functioning of the EU Framework Programmes that they are backed up by national priority-setting programmes. National programmes can concentrate on those problems that are unique to the country concerned. As with the Netherlands case, consultation between the planners and those who do research further adds richness and precision to the information base used in setting priorities. A system-based approach on a national level thus seems highly complementary to the benefit-cost model at the EU level. On the other hand, researchers can greatly benefit from networks on a European level which, for example, facilitate resource sharing, while on the other hand, promoting excellence on a national level is essential for the EU to reach its own goals. The stimulation of national priority-setting programmes on an EU level may therefore be further advisable.

7. Conclusion

The heightened pace of international industrial competition has obliged the governments of most advanced countries to seek consciously to improve the level of economic benefit deriving from public sector research. In the case of the Netherlands, the research system has long been divided into an academic system that has mainly dealt with fundamental, blue sky research, alongside its educational mission, and a semi-public contract research system, that has conducted applied research for the government and industry. For decades, there were hardly any linkages between these two systems or mechanisms to transfer fundamental results to the applied research organization or vice versa. Research priority setting has been introduced in many countries as an applied form of targeting the total science and technology effort towards the solution of defined problems. In this context, a distinction is made between 'public good research (funded by government) and research for which specific groups of beneficiaries are identifiable (suggesting the application of 'user-pays' principles). Although in practice, the boundaries between the different systems are not as clear-cut as suggested in this paper, and often a combination of the two systems is used, certain characteristics can be ascribed to the systems that make them identifiable. Most importantly, the benefit-cost model heavily relies on centralized decision making and hierarchy with a strong, often explicit, political component, whereas the system-based method is based on changing outcomes by changing processes.

In this paper, the practical implications of these different methods of research priority setting have been studied by looking at the programmes on an EU level and on a national level (i.e. the Netherlands). For the EU a benefit-cost method is applied with regard to priority setting. This method requires both a political determination to gather the threads together and well-defined consultative processes involving both the public and private sectors. Since political agreement is exceptional on an EU level and the inclusion of all stakeholders virtually impossible, the priority goals have a high level of abstraction and as a result are largely untestable. Collaboration and connectivity are, however, at a relatively high level, which can be beneficial both to the EU and the individual Member States. On a national level, the research community was for a long time very much inwardly-oriented with hardly any interaction between the different disciplines (or even within the disciplines themselves). Although collaboration and connectivity are increasing on a national level, in general networking seems easier on an international level because 'historically-determined rivalry' seems absent. So, from this perspective, the EU Framework Programmes are highly beneficial to national research development. This is, however, an observation that is not supported by substantive evidence, and thus needs further researching. National priority setting, in turn, can be highly beneficial to the EU as the Member States are better able to tackle national problems and stimulate relevant national research, which not only promotes national development, but eventually also EU development. Therefore, in this respect EU and national priority setting can prove highly complementary.

The analysis further shows that high quality research depends on many factors as well as the human brain factor: the presence of good scientific infrastructure and facilities, the provision of sufficient and well-allocated funding and adequate funding instruments, excellent access to information, favourable social capital, good possibilities for exchange and interaction, attractive career structures, clear and visible leaders, and so on. It is also important to realize that the more such opportunities are created in Europe and the better they are, the more it will succeed in retaining and attracting talented people, resulting in a higher quality of research in science and technology, which is key to a successful European economy and society. In order to achieve this goal, important improvements are still necessary in a number of critical aspects for research, such as the improvement of mobility, improvement of facilities and access, and better career perspectives and funding on both a national and European level. Driving forward the formation of research concentrations at the European level through the provision and the development of the funding of major, expensive infrastructure will improve the exploitation of the scale offered by Europe. And, last but not least, more and better coordinated efforts in terms of communication and dialogue are necessary to promote the visibility and attractiveness of European science both to its stakeholders and society at large. We believe that EU and national priority setting can combine these factors and can thus add value to the modern-day science and research domain, if stimulated and directed in an appropriate manner.

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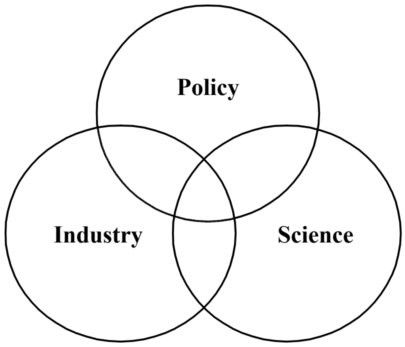

Figure 1 The triple helix model

Table 1 A typology of systemic priority setting

	User-based	**Institutional**	**Political**
Who chooses?	Users (firms, citizens)	Scientists	Organized interests
Level of decision-making	Decentralized	Decentralized	Centralized/ decentralized
Incentives to choosers	User needs	Rewards for research	Group benefits / costs

Source: Stewart, 1995.

Table 2 EU theme priority setting in the period 1994-2013

Framework Programme	**Period**	**Themes**
FP4	1994-1998	Science and technology policy options; education and training; social exclusion
FP5	1998-2002	Societal trends and structural change; employment and changes in work; economic development; social cohesion; welfare and migration; governance and democracy; citizenship and identity; enlargement
FP6	2002-2006	Knowledge-based society and new forms of relationships between its citizens, and between its citizens and institutions
FP7	2007-2013	Economic growth, employment and competitiveness, social cohesion and sustainability, quality of life and interdependence between world regions

Source: European Commission website 2008

Table 3 NWO theme priority setting in the period 2002-2013

NWO strategy	**Themes**
2002-2007	Shifts in Governance; Cognition and Behavior; Cultural Heritage; Digitalization and Information Technology; Ethical and Social Aspects of Research and Innovation; Fundamentals of Life Processes; Nano-sciences; Emerging Technologies; and System Earth
2007-2010	Conflicts and Security; Creative Industry; Cultural Dynamics; Sustainable Earth; Dynamics of Life Courses; Brain and Cognition; New Methods for Production, Storage; Transport and Use of Energy; Knowledge Base for ICT Applications; Responsible Innovation; Dynamics of Complex Systems; Use of Nanosciences and Nanotechnology; New Instruments for Health Care; and Systems Biology

Source: NWO 2008

Table 4 Word frequency in SSH project titles applying for NWO funding 1990-2007

Word* choice	**Frequency****	**Percentage**	**Word choice**	**Frequency**	**Percentage**
Social	334	0.47	Public	115	0.16
Dutch	235	0.32	Human	112	0.15
Development	210	0.29	**Cultural**	108	0.15
European	205	0.28	Innovation	101	0.14
Language	178	0.25	**Health**	100	0.14
Learning	176	0.24	Governance	94	0.13
Law	156	0.21	**Cognitiv**e	94	0.13
Network	146	0.20	Management	88	0.12
Dynamics	135	0.19	Political	87	0.12
Economic	121	0.17	**History**	86	0.12
Knowledge	120	0.17	Brain	82	0.11
Policy	118	0.16	**Environmental**	57	0.08

* The top ten key words are shown in bold print
** The content list contains 72,588 words in total

Table 5 Top five* word frequency in SSH project titles per year

Year	**Top five words***	**#**	**%**	**Year**	**Top five words**	**#**	**%**
1990-96 (124)	Environmental	2	1.61	1997 (508)	Learning (nl)	4	0.79
	Management	2	1.61		Math (nl)	3	0.59
	Conflicts (nl)**	1	0.81		Education (nl)	3	0.59
	Policy	1	0.81		Capital (nl)	2	0.39
	Spatial economics	1	0.81		Organization	2	0.39
1998 (1069)	Learning (nl)	6	0.56	1999 (5694)	Energy	17	0.30
	Services right (nl)	4	0.37		Education (nl)	13	0.23
	Behavior	4	0.37		Learning (nl)	11	0.19
	Medical	3	0.28		Biomass	10	0.18
	Law enforcement (nl)	3	0.28		Cultural (nl)	10	0.18
2000 (4814)	Information	14	0.29	2001 (5979)	Transport	16	0.27
	ICT	14	0.29		Economic	12	0.20
	Political	12	0.25		Health	12	0.20
	Economic	11	0.23		Learning (nl)	11	0.18
	Law	11	0.23		Policy	11	0.18
2002 (8504)	Language	25	0.29	2003 (8214)	Law	26	0.32
	Learning	24	0.28		Language	24	0.29
	Genomics	23	0.27		Cultural	24	0.29
	Cultural	22	0.26		Family	19	0.23
	Evolution	20	0.24		Governance	18	0.22
2004 (12820)	Language	36	0.28	2005 (11064)	Learning	46	0.42
	Policy	34	0.27		Language	41	0.37
	Governance	33	0.26		Law	33	0.35
	Law	29	0.23		Education	27	0.24
	Learning	24	0.19		Citizenship (nl)	24	0.22
2006 (10828)	Learning	40	0.37	2007 (3085)	Democracy	20	0.65
	Law	32	0.30		Brain	13	0.42
	Language	29	0.27		Cognitive	12	0.39
	Brain	22	0.20		Political	8	0.26
	Policy	19	0.18		Culture	7	0.23

* The words in the top 5 are a selection of words with a more explicit meaning. Adjectives etc. have been screened out, as well as words with a more general meaning (like knowledge, innovation, development).
** (nl) = word in Dutch.

Table 6 Overview of key words for funded projects as compared to not funded projects

High scoring words FUNDING	**Frequency***	**Percentage**	**High scoring words NO FUNDING**	**Frequency****	**Percentage**
Language	96	0.31	Learning	126	0.31
History	64	0.20	Law	96	0.23
Cultural	63	0.20	Language	82	0.20
Law	60	0.19	Economic	68	0.17
Economics	53	0.17	Policy	65	0.16
Policy	53	0.17	Health	59	0.14
Learning	50	0.16	Governance	58	0.14
Health	41	0.13	Cognitive	57	0.14
Cognitive	37	0.12	Family	45	0.11
Governance	36	0.11	Cultural	45	0.11

* The content for FUNDING contains 31,414 words in total.
** The content list for NO FUNDING contains 41,170 words in total.

Table 7 Strengths and Weaknesses of EU and NWO priority programmes

	EU Framework Programmes		**Dutch national priority setting (NWO)**	
	Strengths	**Weaknesses**	**Strengths**	**Weaknesses**
Excellence (innovative way research is done)	Knowledge production & R&D development in various parts of science and technology	Intermediate outputs & too large abstraction level which leaves goals untested, which can lead to errors in judgement	Strong national focus and consistency in knowledge production	Large abstraction level of priorities
Collaboration (promotion of research cooperation)	Resource sharing & mobile human capital	Not all stakeholders sufficiently represented	Commitment through consultative and interactive processes on institutional level	No clear internal network promotion
Connectivity (encouragement of participation of research users)	Strong network development	Strong and stable 'core' of research institutions and companies	Foresight exercises promote interaction with societal actors and potential users of research	No clear external network promotion