The Use of Foresight: Institutional Constraints and Conditions

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ABSTRACT

The idea of foresight as a new tool for S&T policies rests on the need to face the challenges of high tech developments, to respond to increasing global competition and to develop inter-organisational strategies. However, the impact of technological and global changes varies per country and per innovation sector, as do possibilities to develop inter-organisational strategies. In this article we analyse how the use of foresight studies depends on institutional characteristics of innovation sectors. We distinguish two independent factors to explain why foresight has more impact in certain countries and in certain sectors than in others. The first factor is the dependency between the actors involved in the foresight activity. The second is the strategic uncertainty due to the technological and global developments. The argument is supported by a secondary analysis of national foresight studies and of environmental technology foresight in the Netherlands, and a first analysis of foresight in medical technology.

Keywords:
Foresight, innovation policy, systems of innovation, institutional theory, comparative studies.

Acknowledgement

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1. Introduction

Reviews of foresight often cover a limited set of government-initiated exercises, specifically labelled as (technology) foresight. Of these, some exercises are exemplary, like the Japanese and German Delphi studies, the UK Technology Foresight, the Australian, and Dutch foresight processes. In addition to these, tables of foresight processes typically list an unsorted set of critical technologies studies and priority setting processes. In their seminal study of what with hindsight was defined as (quasi-) foresight processes, Martin and Irvine [1] define foresight mainly through its objectives and design requirements. Following Coates [2], foresight is described as “a process by which one comes to a fuller understanding of the forces shaping the long term future which should be taken into account in policy formulation, planning and decision making.” Subsequently, in an attempt to provide a typology of research foresight, they show the variety of methods and processes through which the fuller understanding can be obtained, rather than characterising different types of foresight. Apparently, there is no single such thing as foresight.

But what practice do we adopt if we use foresight as a tool for innovation policy? What phenomenon do we look at, when we study foresight? From studies on science and technology development we know that expectations are important in technology strategies and that these expectations have their own dynamics. Innovation patterns evolve from the sharing of expectations within technological communities and the translation of expectations in innovation strategies. [3, 4, 5] We also observe that public and private organisations try to cope with ‘external’ uncertainties from new technological developments, global economic competition and environmental changes, and ‘internal’ uncertainties about R&D investments, technology strategies, collaborations and regulations [6]. The exemplary foresight exercises are typically exercises initiated by governments that try to cope with the perception of an high tech backlog, a crisis in the definition of their responsibilities and the need to invest selectively the limited budgets. In a way they are products of the eighties. More recent foresight exercises, like the Austrian Delphi, have a broader focus and include environmental considerations and societal effects of technology. Foresight processes instrumentalise dynamics of expectations to cope with uncertainties and develop innovation strategies.

The variety of foresight approaches raises the question in what circumstances what kind of foresight is useful and even whether foresight is always a useful tool for innovation policy. In this article, we argue that the use of foresight depends on how a foresight process affects the strategic certainty of organisations and their strategic position within innovation systems. Foresight is an innovation practice, but one with specific consequences for the relations within systems of innovation.

To understand the impact of foresight processes in different systems of innovations, in this article we review national and sector foresight processes and compare their impact relatively to the configuration of actors involved in the process. In the next section we will conceptualise foresight processes in terms of co-ordination and
interaction processes within national innovation systems. Subsequently we are able to identify the main dimensions - dependency and uncertainty - that may explain differences in impact, and we derive a hypothesis about the relation between these dimensions and the use of foresight.

Next, we review national foresight processes in Germany, the Netherlands and the UK as well as foresight in the environmental and medical sector in the Netherlands. These reviews are based on several studies and results have been published earlier, except from those on foresight in medical innovation. Since the aim of this article is not to review these foresight studies as such, we concentrate on those aspects relevant to the comparison. The case of foresight of technological innovation in the Dutch medical RTD sector is presented in some more detail. We conclude by assessing our hypothesis and discussing the consequences for our understanding of foresight and for the design of foresight processes.

2. Systems of Innovation

National systems of innovation (NSI) analyses have several roots. [7] For our purposes two premises of the analyses are particularly interesting. The first is the idea that today’s economy is a knowledge-based one. In such an economy, the traditional assumptions of neo-classical economics have to be put aside. Science-based innovation has become a major source of improvement of productivity, has fostered the de-materialisation of production and, through the emergence of ICT and the service sector, knowledge has become a main production factor. While knowledge must be subject to increasing codification, the greater capacity for innovation and learning this allows means that a greater momentum is given to the development of less controllable, tacit knowledge. A basic question for all (public and private) organisations is what sort of knowledge they need to retain to maintain their innovative capacities. What can be out-sourced, what secured elsewhere, what shared with others? Firms have to become increasingly sophisticated in their knowledge management practices, in terms of both processing new information and gate-keeping incoming information, selecting out that which might make a useful contribution to their innovation needs. They must try to increase the efficiency and effectiveness of their information gathering. As the knowledge they have is important, so is their capacity for learning. [8, 9, 10]

As a result of these developments, the distribution and use of knowledge occurs not through some knowledge market tending towards equilibrium, but through new institutional structures - virtual universities, science parks, R&D consortia, public and private collaborative links and so on. National systems of innovation accounts draw our attention to the way in which knowledge is generated, codified, managed and shared within and between innovation networks. Such networks can be seen to be differentiated in terms of their levels of structural complexity and reflexivity.

This takes us to the second premise. Differences in innovation capacity are a function of the institutional arrangement. Differences in institutional structures, the role
of intermediary organisations, the character of the industrial (production) structure, and the investment in human capital formation and training, are all important: as Lundvall observes, systems differ in what they do (specialisation) and how they do it (institutions). [8] The concept of institutions is not unambiguous within studies on national systems of innovation.[11] Without going into the literature of neo-institutionalism in depth [see 12, 13] it is clear that it is worthwhile to distinguish between “organisations” like firms, universities, government (ministries) that can have a technology strategy, and the “institutional arrangements” of organisations.

Technological developments, along with trends like globalisation and the environmental crisis, have confronted all kind of organisations with the limits of ‘business as usual’ and an increased uncertainty about viable strategies. For instance, in genetic diagnostics and medical information technologies several uncertainties and strategic objectives get linked. For some actors these new developments are opportunities to create new markets and improve competitiveness. At the same time they threaten existing markets, especially if genetic diagnostics indeed will result in possibilities for early warning and cure of hereditary diseases - although that is yet still “just” an expectation. Other actors stress possibilities to improve health care and are indifferent to economic dimensions. The expected impact of the new medical technologies also creates uncertainty about benefits on the societal level and may end in ambiguous pressures on governments to promote the new technologies in order to extend the positive for individual health care, and to regulate the technologies in order to eliminate the negative. Organisations in the medical innovation system develop their own strategies with respect to genetic diagnostics, depending on their specific position in the innovation system and the kind of uncertainties they have to cope with.

The outcome of any of these technology strategies does not depend mainly on organisational characteristics, but on the combined effect of all technology strategies and thus is related to the institutional arrangement. The institutional arrangement is defined by the relations between the organisations, such as resource relations, principal-agent relations, market relations, trust relations etc. The institutional arrangement also determines the strategic options of organisations, the available information and knowledge and the relation between strategies and outcomes. [14] Firms that try to exploit opportunities of new medical technologies, have to compete with other firms and need to develop competitive and promising trajectories by positioning themselves strategically in terms of R&D projects, patents, and products. In innovative, government regulated sectors like the current health system, firms also have to be aware of changing perceptions, preferences and needs within the government and the public. Likewise, governments have to adjust regulations to new technological possibilities. E.g. they have to allow the health care system to provide new therapies against acceptable costs, but can only do so successfully in interaction with - among others - hospitals, firms, patient organisations and medical researchers.
2.1 Co-ordination of innovation and foresight

How does this relate to foresight? Foresight may be described both as a production of information, in order to reduce uncertainties about technological development, and as an interaction process between actors to co-ordinate their research, development and innovation activities. But the resulting information and co-ordination are not like any other. The specific nature of foresight lies in its focus on expectations and its inherent uncertainty because of the unpredictability of the future. The paradox then is that if foresight is successful, organisations reduce uncertainty and improve their ability to develop technology strategies by relying on necessarily uncertain intelligence, rather than on e.g. the certainty of past performance or present markets.

In order to understand this paradox, we have to look more closely at how expectations may co-ordinate innovation processes. In general, co-ordination is a result of interactions between the actors in the innovation process who aggregate and circulate information, knowledge and artefacts and couple their own local innovation practices to existing and emerging technological regimes. [15, 16, 17] A well-known example of such co-ordination is how Moore’s Law works. In 1965 Gordon Moore, former chairman of Intel Corporation, observed in a speech that up till then each new chip contained twice as much storage capacity and was presented 18-24 months after its predecessor. This observation has become known as Moore’s Law and more and more so as throughout the next decades the trend continued as if it was a scientific law. In the eighties Moore’s Law became a focal point in the innovation race in microelectronics: the law-like innovation dynamic was reproduced by the locked in strategies of electronic firms. Their adoption of Moore’s Law as a forecast implied specific innovation targets both in time and technical specification. [18] It also predicted a short time for returns on investment for those who were first, and hardly any returns for those who lost. Each generation of chips required higher investments and the higher the investments the higher the risks. Governments entered the game to provide (temporary) losers with resources to play a next round. [19] The innovation regime around Moore’s Law placed the firms in a game with characteristics of the well known prisoner’s dilemma: as other firms might innovate and develop the next chip, each firm had to try to do it as well or loose its position. As all firms invested in innovation they all had to face the costs while they hardly had a chance to win. Moreover, the use of Moore’s Law to target innovation policies made Moore’s Law a self-fulfilling expectancy.

In its economic, technological and social consequences, the innovation in chips is probably historically unique. The pattern of mutual positioning based on shared expectations of technological dynamics is not. Van Lente has described similar patterns in his study on Promising Technology [3]. Van Lente and Rip even argue that co-ordination of scientific and technological development through expectations has become a feature of the contemporary research system. [20] The dynamic of expectations and the resulting co-ordination rest on the aggregation and circulation of information, knowledge and artefacts through journals, workshops, conferences, bilateral exchanges, and individual
expectations. If aggregation and circulation continue, convergence of individual
expectations in a shared ‘foresight’ will be the result. In the end this may result in a
reversal: where first expectations arose as a result of local knowledge and interactions,
now the local knowledge practices and interactions become structured by the
expectations. The expectations gain the potency to act upon the local level and become
constraining resources.

It is in this sensitive interaction between local practices of innovation and global
levels of expectations that foresight enters if it tries to co-ordinate innovation. Foresight
as information and most of all as an interactive process may result in co-ordination of
innovation through (1) creating new innovation regimes, if the expectations result in new
institutional arrangements with strong, shared expectations; (2) structuring mutual
positioning of actors and structuring their relationship; and (3) affecting the strategies of
actors by informing them about possible technological developments. The three effects
are connected, but to understand the use of foresight it is useful to distinguish them. This
is especially the case because, as we argue in this article, not all effects are to be expected
to the same extent within every institutional arrangement and around every technological
development.

2.2 Hypotheses

From the analysis of national systems of innovation, two dimensions appear as important
to understand possibilities for developing viable technology strategies. The first
dimension is the strategic uncertainty of organisations, induced by technological
developments. Especially if existing innovation patterns are challenged, this uncertainty is
high. If strategic uncertainty is high, we might expect a high interest in foresight as well
as adoption of the results. Consequently, if the uncertainty is low we expect little need for
foresight and little use, if there happens to be a foresight.

The second dimension is the dependency of organisations on other organisations
for resources (information, knowledge, funding, supplies, etc.) to cope with the new
technologies and thus, for the success of their technology strategy. If this dependency is
high, we might expect foresight processes to be effective. It is in the interest of
organisations to make use of the process and the outcomes. If the dependency is low,
our hypothesis is that the processes will have little effect.

These hypotheses can be summarised in a 2x2 matrix. In the next section, we will
assess through comparative analyses how the level of uncertainty and dependency affects
the use of foresight.
3. Foresight processes: a comparative analysis

3.1 National foresight exercises

Looking at the development of foresight in several countries, we observe that (1) the relation between government and sciences has been institutionalised differently in countries and (2) these differences constrain the development of foresight. National foresight processes are a policy instrument, a strategic tool of governments to cope with a set of uncertainties (globalisation, technological progress, budget deficiencies, development of a knowledge society etc.). These uncertainties are not simply uncertainties as such. They are uncertainties with respect to relations between the government and other constituencies.

One of these is the relation with the public science system. The institutional arrangement of the government and the science system can be characterised as a principal-agent relation. [21, 22, 23] Such principal-agent relations are generally characterised by an asymmetry in information on the agent’s performances and, without institutional framing of the interaction, by instability and uncertainty about optimal strategies. In public research systems we have since WW II seen a progressive framing of the relationship, from research councils, research agencies to evaluation and programming activities. Scientists often tend to consider autonomy of science and the discretion of decision making to the lowest organisational level as something natural to basic science, and governments have for quite long subscribed this idea. The resulting institutionalisation is only one of various possible stable combinations of strategies and is based on specific assumptions (of the actors involved) about the expertise of scientists to judge each other and about the use of long term basic research. Other assumptions of actors involved might result in another institutionalisation of the science policy relations and in other stable combinations of strategies. [24]

Foresight can be considered as a next step in the development of the contractual relation between government and science and as an investment in the possibility of decision making. Van der Meulen [24] has shown for Germany, the UK and the Netherlands that these foresight processes have been shaped by the existing institutional arrangements. In these three countries in the early nineties the institutional context for foresight differed substantially, especially the relationship between government and

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<td>Low Uncertainty</td>
<td>Foresight is unlikely, but if it occurs it will be effective</td>
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science. In Germany the research system is characterised by a strong autonomy for the basic science organisations, like the Max Planck Gesellschaft, the Deutsche Forschungsgemeinschaft and the universities. The well-known Delphi study, commissioned by the Federal Ministry for Research and Technology, the BMFT, had little effect on the scientific organisations. The scientific organisations neither used the outcomes explicitly to improve their strategies nor where they stimulated to do so.

In the Netherlands, organisations in the research system are not autonomous. Because of overlapping tasks, organisations have to compromise and build consensus to innovate the system. Policy implementation is always a process of “mediating through” (as a third option next to top down and bottom up). The government’s policy is aiming at linking public research efforts to social and economic development. As part of that policy, in 1992 the Ministry for Education and Sciences installed a Foresight Steering Committee. The committee initiated a large number of committees in cooperation with ministries, the Royal Academy of Arts and Sciences and other advisory bodies as well as with universities. Its final report was published in May 1996 and included fourteen research priorities. The government adopted the priorities within its own Science Budget, the Netherlands Research Council used them to review proposals for research programs, and some universities opportunistically started to implement certain priorities to improve their research profile. Indeed, the foresight process parallels the ongoing consensus building in the research system and implementation of results is in general nothing but effectuating ongoing strategy processes.

The UK Technology Foresight exercise was announced in the White Paper Realising our Potential, which announced a new time for the UK science system. The Foresight exercise was sponsored by the newly established Office of Science and Technology. Within a relatively short period fifteen sector panels made a foresight study of their sector. The results were translated by a steering group into a list of priorities, which are used by the government and research councils to determine strategic plans, to allocate resources and to select new initiatives for the LINK funding scheme. One of the aims of the foresight program was to increase science-industry interactions. ‘Users’ have been heavily involved in the process. The overall effect of the Technology Foresight has been double-sided. The Technology Foresight strengthened the interactions between scientists and users, and as such, made ongoing practices somewhat less vulnerable to government intervention. Nevertheless the government remains strong and the results of the foresight process provide it with necessary information to allocate resources selectively.

These three short discussions of the national foresight exercises underscore the differences in approaches and successes. In Germany the relationship between government and science is stable; funding is (still) prosperous and provided by the government without clear objectives, apart from scientific excellence. As a consequence the dependency is, despite the level of funding, relatively low, and so is the uncertainty. In the Netherlands dependency between organisations is high. The strategic uncertainty
is somewhat higher than in Germany, but not much higher. Allocation of funds is hardly affected by the priorities, as most of the funds are allocated according to historically developed formulae. Dependency and uncertainty in the UK are high since the government has implemented competitive funding schemes.

3.2 Sector foresight studies

In the previous section we have analysed foresight as part of the institutional, bilateral arrangements between government and science. In addition to these national, large-scale foresight studies, one can find foresight studies focusing on certain areas of technological development or specific sectors. In the context of this article, these sector foresight exercises merit a coverage similar to the national programmes, as similar dynamics can be seen to take place between and within organisations. Although the scale is smaller, the configuration of the actors involved in the foresight process might be more complex.

Environmental policy and environmental research, technology and development (RTD) are a case in point. In the Netherlands, environmental policy is formulated by the government in collaboration with the actors responsible for adopting and implementing environmental targets and instruments. Since the early nineties, environmental technology foresight has been used repeatedly to identify sustainable technologies that could help to meet the ambitious environmental targets set in the early nineties. [26] The first foresight process organised by the government was rather limited. The report remained within the bureaucracy and its conclusions had little impact. Subsequent processes were initiated by other actors, but did not have a real impact either. The actors involved in the process were relatively independent and outcomes of the foresight processes could not be enforced upon one another. Nevertheless, in an analysis of the effects, one of us has shown how gradually within the foresight processes the environmental targets were translated into convergent R&D strategies and policies of funding agencies, universities, research institutes, government and industry. [27] The foresight processes provided the opportunity for the necessary aggregation of actors and their interests, within an overall regime focused on sustainability as a shared aim and shared uncertainty.

Within actor configurations with different and even diverging interests, foresight is in principle even more attractive, but its use can be more problematic. The medical innovation system in the Netherlands is a case in point. Within the health sector, the constituencies have different interests in medical research, technology and development (RTD). Although there is a general focus on health care, constituencies may be involved for economic, ethical, managerial, and professional reasons as well. Figure 1 represents the complex configuration of the main actors involved in medical RTD in the Netherlands. The RTD sector involves industry, universities, research institutes, and hospitals, each with their own objectives and set of possible strategies to realise these. Within the government we find several ministries involved because of health policy, economic policy and research policy, respectively. Each of these policies implies specific
objectives and expectations of medical RTD. Another constituency, quite specific for medical RTD, is consisting of the patient interest groups. Depending on the number of patients, the level of organisation, and their identity, these interest groups may have crucial positions and link up with research, industry and policy in various ways.

In addition, we find a high number of intermediate bodies that try to regulate and mediate the relationships between the different constituencies. These intermediate bodies have gained established positions, up to a point that they have developed more or less in a separate constituency themselves: relations between them are tight and often facilitated through co-membership in boards or mutual auditor positions at board meetings. Some of the intermediate bodies are focused on the medical research system, other more on the health system, but through their activities they link the several constituencies.
MINISTRIES
VWS  Health, Welfare and Sports
EZ    Economic Affairs (which covers technology)
OCenW Education, Culture and Sciences

ADVISORY
RGO    Advisory Council for Health Research
Gezondheidsraad Health Council for the Netherlands
RIVM  National Institute of Public Health and the Environment
STG   Foundation for Future Scenarios of Health Care
Rathenau Institute for Technology Assessment

INTERMEDIATE
NWO    Netherlands Research Council
STW    Foundation for Technical Sciences
MW     NWO section for Medical Research
KNAW   Royal Netherlands Academy of Arts and Sciences
ZON    Care Research Netherlands

OTHER
KNMG   Royal Dutch Society for the Advancement of Medicine
We present this configuration in some detail because its complexity allows for quite different phenomena with regard to the use of foresight to be observed in two, equally radical, domains of technological development. The medical sector is and will in the future be affected by two main technological innovations: medical information technologies and genetic diagnostics and engineering. Both developments introduce new possibilities to identify diseases and new research strategies for understanding the causes and the courses of diseases, and are expected to introduce new therapies. Yet in the Netherlands until recently neither medical foresight nor general technology foresight had addressed genetic diagnostics and engineering in much detail, and where they did, there was little impact. Developments in medical information technology, on the contrary, are subject of many (quasi) foresight activities.

To explain these differences, one should look at the actual dependencies and, especially, the uncertainty these medical innovations create. In the Netherlands, most of the policy with regard to genetic diagnostics focuses on regulation. Most technology foresight studies in other countries define genetic diagnostics as a strategic, economic opportunity. In the Netherlands, its development has been regulated since the first introduction of genetic tests in 1985. Development and use of genetic tests up till now was restricted to a few centres in the academic hospitals, which have defined strict rules on their application. As a result, there is hardly an economic market for genetic diagnostics. Definitely, technological progress, the development of more and more tests, puts pressure on the rules. However as yet this is hardly perceived. The point is that the strict regulation not only constructs a restricted space for the development and application of the tests, it also produces certainty about viable strategies for those involved. Nelis shows how the regulation has resulted in a stable regime that provides the actors involved hardly any strategic space to innovate, except within the established patterns. [17] Only recently, the Rathenau Institute, the Dutch institute for technology assessment and a relative outsider in the configuration of medical RTD, has initiated a foresight study on the societal consequences of prospective medicine.

Within the complex configuration a niche has been constructed in which a few actors, rather independently of others, develop the new technologies. Within recent foresight processes, like the Medicine foresight initiated by the Foresight Steering Committee and the medical foresight study by the Netherlands Research Council, the development in genetic tests was hardly an issue. As far as it was addressed, it was considered just as an option for prevention and early diagnostics of diseases.

Innovation patterns, the institutional arrangement and the foresight culture are different with respect to medical information technology. Uncertainty in medical information technology is high, and a number of organisations are involved in the foresight activities:
• Within its policy to stimulate information and communication technologies in services, the Ministry of Economic Affairs has initiated studies on e.g. the use of chip card technology in medical care, as well as stimulated research on IT for imaging technologies;

• Several health care organisations have experimental projects on Electronic Patient Files, often framed and publicly funded as projects to improve technological learning;

• The Scientific Council for Government policy and the Rathenau Institute both have initiated studies on societal and policy consequences of medical information technology;

• The Medical Research Council and the Health Research Council consider research on the use of medical information technology as a priority in health care research.

Strictly speaking, not all of these are explicit foresight processes. Nevertheless, they explore the opportunities and consequences of the developments of medical information technology and shape expectations, relationships and innovation strategies of the actors involved. Like the role and impact of national foresight exercises, their role and impact can be considered in terms of the dependency between the actors involved and the strategic uncertainty of these actors. Because of the systemic character of information technologies and the need to align information technologies to ascertain continuity of patients’ profiles if the patient moves between different health care institutes, the dependency is relatively high. As the technology itself is still evolving and experiments abound, it is difficult to trace an overall impact of the foresight processes. The close involvement of numerous actors and the eagerness to learn from experiments and exchange visions suggest foresight to be an effective tool.

4. Conclusions

Through comparative analysis, we have analysed the relation between the use of foresight and institutional arrangements. The findings allow us to test the hypotheses we formulated about the effect of strategic uncertainty and of dependency on the need and use of foresight. In general the comparative results corroborate our hypothesis. Dependency and uncertainty were high in the UK science system in the early nineties and are so in the configuration around medical information technology in the Netherlands. In both cases we observed a high interest and need for foresight and large effects of the foresight activities. Actor configurations in the German science system, and to a lesser extent, in the genetic diagnostics regime in the Netherlands are characterised by low dependency and low uncertainty. In accordance with our hypothesis we found that foresight was not developed and the few attempts had no effect.

As often, effects of high/low combinations are more difficult to foresee. The Dutch science system in general is characterised by a high dependency between organisations, but the uncertainty is relatively low. Here, one can find foresight processes but in a specific way and closely linked to consensus making and with a relatively short
time horizon. If a foresight is organised its impact are high. In configurations of high uncertainty and low dependency we did expect a need of foresight, but there are hardly any procedures or policies to implement the outcomes. In the Dutch configuration around environmental policy, several foresight studies were required to aggregate the interests of the actors and align their strategies. The 2x2 matrix summarises the findings and specifies the hypothesis with regard to occurrence and use of foresight.

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<td>Low Uncertainty</td>
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<td>Foresight not likely and ineffective</td>
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<td></td>
<td>• Netherlands foresight process</td>
<td>• German science system</td>
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Our hypotheses were based on an analysis of co-ordination processes in (national) systems of innovation. We stipulated that co-ordination processes within more complex sector configurations merit a similar analysis. We conceptualised foresight in terms of these co-ordination processes, emphasising expectations that actors have within innovation systems. We suggested that foresight may affect existing innovation systems by creating new innovation regimes, by structuring the mutual positioning of actors or the ‘dynamics of expectations’ [3, 5] or just by providing actors with new strategic information.

The different levels of these effects imply that our understanding of foresight processes requires two related understandings: (1) an understanding of how foresight acts upon the different constituencies and organisations in a system of innovation. That is, how it affects the institutional arrangements of organisations. And (2) it requires an understanding of how foresight as an instrument is linked to strategies of organisations. Foresight itself can be seen as a strategic action with specific possible outcomes.

The broad-brush comparison of the foresight processes does not allow us to analyse in detail the effect of the actor configuration on the occurrence of each of these effects. But inductive reasoning from the results strongly suggest that the creation of new regimes is only likely to occur when uncertainty and dependency are high. Mutual positioning supposes relationships between actors, and thus foresight is likely to effect
this process if dependency is high. Last but least, provision of strategic information as a main impact is to be expected when uncertainty is high.

The comparison has an uncertainty itself, in the sense that we have compared national cases with sector cases. Certainly, at both levels one can find dependency relationships and strategic uncertainty, the two main dimensions we used to analyse our cases. In general, there is tendency in innovation studies to use the concept of (national) innovation systems also for other levels, esp. regional, sector and European levels. Therefore, it would be useful to analyse in subsequent research the nature of these dimensions at both levels in depth and assess whether the two levels can be normalised in comparative innovation studies.

One question, often prominent within analyses of foresight, is left aside in this article: how to design foresight processes? We will not conjure a blueprint out of our analysis, but our analytical perspective does have an important consequence for the design of foresight processes. Instead of just perceiving the development of a foresight process as a methodological problem that requires skills of forecasting, managing interaction processes and some quantitative methods, we would claim that it (also) requires institutional design. There is no blueprint for a good foresight process, but the appropriateness of certain methods depends on the institutional context.

**References**

11. Within studies on (national) systems of innovation, the concept is used for “organisations” like firms, universities, ‘the government’, for all “contractual arrangements”, including organisations, the market, the law, or even more loosely for all norms, values and rules, including standard approaches to technological innovation, to policy making and shared expectations. For an overview, see Edquist, Ch. and B. Johnson, 1997, Institutions and Organizations in Systems of Innovation, In: Edquist, Ch. (ed.), 1997, Systems of Innovation: Technologies, Institutions and Organizations, Pinter: London and Washington: 36-63


15. The implicit perspective on co-ordination deviates from the general view on co-ordination as an (ideal typical) optimal organisation of interactions either through markets, hierarchies, or networks. Instead we perceive co-ordination as a result of the interplay between local and global levels of interactions. Co-ordination then might structure non-equilibrium interactions that typically occur around (radical) innovation processes. See: [16]


