Understanding technology foresight: the relevance of its S&T policy context [1]

Luis Sanz-Menéndez and Cecilia Cabello

CSIC Institute for Advanced Social Studies, Research Unit on Science and Technology Policy (RUSTEP), c/Alfonso XII, 18, E-28014 Madrid, Spain
E-mail: lsanz@iesam.csic.es E-mail: cabelloc1@wanadoo.es

Clara Eugenia García

Carlos III University of Madrid, Department of Business Administration, c/Madrid 126, E-28903 Getafe, Madrid, Spain

Abstract: Recently Technology Foresight (TF) exercises promoted by governments are spreading all over Europe, however the forms that TF takes within each country is very diverse. First, in order to understand the importance of the policy context, as an example, we will explain the 'fate and fortune' of foresight in Spain in relation to the attempts to bring it into the science and technology (S&T) policy agenda and will analyse the institutional constraints over the development of TF. The second part of this paper is related to the extent in which TF is a useful tool for policy making. We will enlighten the analysis with the use of the theory of decision making, especially by reflecting on the role of the information emerging from TF as legitimation for policy makers, but more importantly on the promising use of TF for coordination within national innovation systems.

Keywords: Technology foresight; science and technology policy; Spain; policy legitimation; information and decision making.

Reference to this paper should be made as follows: Sanz-Menéndez, L., Cabello, C. and García, C.E. (2001) 'Understanding technology foresight: the relevance of its S&T policy context', *Int. J. Technology Management*, Vol. 21, Nos. 7/8, pp.661–679.

Biographical notes: Cecilia Cabello is a grant holder at the CSIC and holds a Master's degree in Science, Society and Technology from the University of Madrid and a BS in Food Science from Michigan State University (USA). Her previous work experience includes research at the European Commission's Institute for Prospective Technological Studies (Seville, Spain).

Clara Eugenia García is Associate Professor at the Department of Business Administration of the University Carlos III of Madrid. Previously she had been doing research and teaching at the CSIC (Spanish National Research Centre), the Autonomus University of Madrid and the University of California at Berkeley.

Luis Sanz-Menéndez holds a PhD in Political Science and Sociology from the University of Madrid. He is a research fellow at the CSIC (Spanish National Research Centre) since 1990 and was an associate professor at the Complutense University of Madrid and visiting scholar at the University of California at Berkeley in 1992–1994.

1 Introduction

A new spectre is haunting Europe: the spectre of foresight. In the last decade foresight [2] has become a fashionable word in documents and conversations of science and technology policy makers all over Europe [3]. After reincarnation of future studies in the modern form of foresight in the mid nineteen-eighties [4,5], the design and implementation of some exemplars (as the German Delphi [6,7], the UK Technology Foresight [8], the Dutch Foresight Program [9], or the French Key Technologies [10]), and some general reviews [11–14], we observe that almost every year new governments promote or commission foresight activities associated to science, technology and innovation (STI) policies and more European countries join the ‘Foresight Club’ (recently Italy [15], Austria [16], Hungary, Sweden, ...), not to mention Australia, New Zealand, etc.

What is fuelling the renewed interest of governments in technology foresight? Scholars have embraced this new fashionable faith with the impetus of the convert, and propagandists have emerged glorifying the virtues of foresight, insisting on the ‘intrinsic’ value of the new tool or approach for STI policies. Some analysts point out that this salience of Foresight is because it has become the solution to problems posed by the new challenges of STI policies (for example international competitiveness and concerns for the technological competitive decline of Europe *vis à vis* Japan and USA), while others interpret the situation in terms of international diffusion or imitation of management practices. Whatever the driving force, many policy makers in Europe have embraced the rhetoric of foresight and some of them have adopted the new tools, either as a form of experimenting or as a way of not being part of the shrinking group of countries that ignore the *promised land* that foresight appears to represent.

Because of this fashion, the dominant approaches are biased by the normative assumptions and prescriptive propositions of foresight, while very little attention is given to addressing the empirical study of real foresight practices in different countries. However we think that the quality of foresight practice could be improved with a better understanding of the cognitive, socio-political and policy conditions in which it emerges. The kind of questions that guide our reflection are to improve our understanding of the growth, development and diffusion of the different forms of foresight taken in European countries [17].

This paper will develop an analytical framework to better understand the empirical problems that foresight as a practice is raising and give arguments to explore the diversity in relationships between governments and foresight. For understanding foresight and its evolution in the different countries we insist on the need to consider its science and technology policy context and arrangements surrounding the emergence or non emergence of foresight. We have to approach foresight in governmental arenas just as one of the possible tools or strategies available for decision makers. When considering the selection of this practice (and its concrete form) this is conditioned by the specific forces and circumstances emerging from local environments. Therefore, we have made the attempt of approaching foresight in its STI policies context, because foresight, its effects and benefits cannot be considered independently of its institutional arrangements in the policy arena.

The main aim of the paper is to explain the variation of fates and fortunes of foresight in governmental environments in Europe. In the following section some general properties of the policy making process are explored to help us to conceptualize the

emergence of foresight as part of the general dynamic of policy making, linking problems and solutions. In the third section of this paper we will report on some developments of the Spanish situation, understanding how the S&T policy arena and the existing institutional arrangements constrained foresight development. This approach will help better understand the dynamics of technology foresight evolution in Europe.

After the exploration of foresight practice, we will come to the issue of the value and effects of foresight. In section four we will try to improve our general understanding of foresight reflecting on the complex role of information in decision making in an organizational context. Information or foresight can be substantive inputs for the decision making process but they also play a central role in the legitimation of decisions and policy makers. Finally we will develop some reflections on the future of foresight and its potential, that is, as a process of actor interactions that could help to improve coordination of innovation systems.

2 Foresight as an embedded practice in policy making

We insist on the importance of the context, and we state that foresight, if it gains relevance, could be understood as a 'local practice' emerged and consolidated (in competition with other local practices or outside practices) in specific policy arenas. Country specificity and policy context are our explanatory variables of the wide differences in foresight practices. In this section we will try to develop some insights from the theory of policy making to understand how and under what circumstances foresight activities become a plausible solution (or is incorporated into a solution) for some of the issues and problems associated to STI policies and, thus, explain why in other circumstances it does not. In the next section we will apply the argument to understand the Spanish case.

The emergence of foresight in some countries could be treated as a case of 'policy innovation', but to understand this we should make clear our model of the policy process. Kingdon [18,19] identifies three 'streams' that develop independently and determine opportunities in the policy process: problems, solutions and politics. The regular development of each stream is relatively independent of the others and the matching between streams is at the core of policy innovation; the effect of this model is the existence of randomness and contingency in the outcomes.

This matching process between problems and solutions depends on two variables: the dynamics of the political system creating the policy window, and the emergence of skilful political entrepreneurs to handle the fitting. The former are fostered by significant political changes, or crisis [20] and they represent the preconditions for merging or matching of the different streams, but connecting them is dependent on the actions of policy entrepreneurs [21]. The policy process is mainly determined by the artful connection of solutions to problems; different actors in diverse institutional arrangements follow different patterns, as is demonstrated by the diversity of missions and understandings of foresight as the comparison of United Kingdom with the Netherlands show us. Meanwhile policy entrepreneurs are the brokers who orchestrate the fitting between problems and solutions [22], such that the policy entrepreneur or 'human agency' is a central element in the explanation because of their ability to introduce manipulation [23].

However the process of issue definition [24] is at the heart of the political battles because it contributes to structuring the problem and also to 'advance some solutions'. We should comprehend how social phenomena become 'policy problems': that is how public attention is focused [25]. Equally relevant is to discern how specific understandings of problems emerge and consolidate, and through what channels they come to policy makers. Argumentation and creation of new understandings of an issue are at the heart of the political process. Policy making is influenced by changing definitions of 'what social conditions are at the heart of political process' (e.g., UK favouring reorientation to client approaches, Netherlands improving aggregation, etc) and, at the same time, by changing definitions of 'what would be the most effective solution to a given public problem'.

This approach gives us the analytical tools to explain policy innovations. Foresight could be taken as one of them, however, it is important to account for some historical factors within an integrated institutional framework. History is relevant to understand that problems, solutions and politics are not entirely independent. Past experiences and policy choices might influence the set of choices available at a later time. The identification of problems and their definition would be dependent on previous policy experiences, and therefore on learning. The space in which policy entrepreneurs operate is redefined with experience, including contact with others' ideas and suggestions; earlier policies, even in other policy domains or taken from international experiences, provide politicians and policy makers with analogies that they use to assess policy options. The availability of appropriate solutions can then be influenced by earlier policies, which direct exploration on new innovations along particular lines.

For searching connections among policies over time and for trying to understand how opportunities for innovation emerge we require an historical approach. Policy innovations, such as foresight, cannot be taken in isolation because they are part of a policy sequence [26] in which the institutional development facilitates some interpretations of problems and makes some prospective policies more plausible than others. In economics, political science and policy analysis, there is broad support for this argument, which brings in the issue of path dependency [27,28], trajectories of development and critical junctures [29] and policy inheritance [30]. In that way, we insist in how actions taken at one time can make a future perception and decision more plausible than another.

The fact that problems, alternatives, policies and politics are linked over time does not mean that we have a determinists model in which the past determines what is possible at a later time. Evolution of societies provides a strong case for speculation about the dynamic processes of institutional and policy changes. Here we take the concept of co-evolution to include, through historical links, the ideas of specialization (between problems and alternatives, and between policy and politics) and mutual dependency, in the context of 'reciprocal evolutionary change in interacting elements' [31]. Our specific set of policies associated to STI have been evolving (and co-evolving) in the last decades [32]. Science and Technology policies have received pressures for adaptation from the emergent problems of 'competitiveness' and 'innovation', centring the focus on firms in a new domain of innovation policy. In fact, such transformations of the policy domain can become a turning point in a sequence, by creating opportunities for political actors to promote new ideas and different visions. Evolution in the policy domain is linked to the shift of boundaries between policies which is the most likely force to foster the internal dynamics of public policies.

Our final consideration in this section relates to institutional development. Often new institutional arrangements and structures emerge during a period in which new policy issues are addressed, and once created they remain in place for years. Institutions structure the rules of participation that constrain policy actors' patterns of behaviour and decision making rules by introducing specific organizational routines and procedures (e.g. explicit consideration of the future or process of aggregation of diverse interests). Institutions once set up exhibit some everlasting properties. The differences in the relationships between science and government shape and even constrain the development of foresight. Governments, as key players in the national innovation system, have many roles and may even employ foresight as a strategic action in order to cope with uncertainties.

What is important to stress here is that policy output is contingent upon variables such as the critical social conditions, desired innovation rates, specific understandings, particular policy strategies, etc. Instruments such as foresight analyses are secondary to policy strategies because there is a wide variety of options available to policy makers that can be chosen to implement effectively policy objectives. Even when foresight has become the solution for certain problems (in the discourse and the rhetoric of policy making) in some countries, in other countries foresight plays either a partial role or other solutions have been established for similar or even different problems. Solutions adopted do not have a unique and universal value; policy makers adopt those that are most appropriate to given situations. But again, even if at the end of the 1980s policy makers identified the lack of technological leadership and competitive shortcomings as a major policy issue, only in few European countries had foresight become the main solution for tackling them.

3 The contingent nature of technology foresight: some lessons from the Spanish case for understanding the general development of foresight

The demand of foresight, as an information tool for policy makers, has increased rapidly; it even has emerged in some countries as '*the solution*' or has been placed at the centre of the discourse to tackle to the most important problems in science, technology and innovation policies. It is reported that in some countries in Europe, (the UK is the paradigmatic case) foresight, as an organized process or collective consultation on plausible future developments, has been recently used as a main framework for science and technology policy coordination [33].

Nonetheless, the diversity among countries of foresight, in the timing, the forms or the features of future concerns in STI policy is very significant. When comparing the extent of adoption of a policy in different countries some approaches focus on the national 'preconditions' necessary for the policy development (relative levels of income, or other variables) while others insist on the identifiable diffusion process (geographical or cultural). Probably, when observing the adoption of foresight as a practice both processes should be taken into account; that is, the specificity of the institutional arrangements for STI policy and the forces in action which have created the conditions for adopting it. In fact foresight in its forms is emerging as a *local* practice.

In certain countries, a process of imitation, policy transfer [34] or learning from others has occurred. Nevertheless without public intervention in favour of S&T, there is

little chance of governmental involvement in foresight, to be taken either as rhetoric or as a practice. However having STI policy by itself does not guarantee the adoption of foresight, as can be witnessed by the Spanish case. In this section we will reflect on the conditions and factors related to enhancing or precluding the inclusion of foresight in the repertoires of tools of STI policy makers, always with reference to Spain, but trying to enlighten the development of foresight in Europe.

Our objective is explaining why a country like Spain, an early adopter (at least rhetorical adopter) of foresight in relation to STI policies, has not developed a formal foresight exercise brings us to two different insights: one, very simplistic, that blames the less developed countries for not adopting the 'best practices' at the right time or just because they are less developed; however, exploring that argument is not very useful in analytical terms. This leads us therefore to try to understand how the development and use of foresight, as an implicit normative model, is contingent on some forces and dynamics. In the pages that follow we will use the case of the first attempts to bring foresight into the policy agenda in the context of the definition of Spanish RTD (Research, Technology and Development) policy as a way of bringing some light to the general problem of foresight development.

We will begin by discussing the S&T policy context to understand the framing conditions. Then we will present how and when foresight (as rhetoric and as an activity) emerged in Spain. Finally, we will discuss why foresight, although institutionalized has not been such a central tool for policy coordination and policy making as in other countries.

3.1 The context of science and technology policy in Spain

We will begin our discussion of the context of S&T policy in Spain during the mid-1980s to locate our analysis in its specific policy sequence. When Spain became a part of the European Communities, in 1986, the dominant discourse was the so called the 'European Paradox', the recognition of a strong research and science base without the corresponding industrial transfer of this knowledge. Actions in Spain shared the European approach – with some local rhetoric like the idea 'to put the academic research capabilities to work for the social and economic needs' – while government RTD policy concentrated its efforts on improving the quality and quantity of its public R&D base with a huge increase in public spending.

The political impulse culminated in 1986 when the Parliament passed the Law for the Promotion and General Coordination for Scientific Research and Technology Development [35–37], also known as the Law of science. With this Law a National R&D Plan (a four year plan presently in its third edition, 1996–99) was established in order to coordinate, plan and promote R&D activities. Coordination [38] has been a key word in Spanish S&T policy making: the need to coordinate the directions of the research activities of the main actors (firms, universities, public research centres) and the need to coordinate the S&T policy initiatives of the different Spanish public administrations. However the main emphasis of the reform was in the 'administrative coordination', as OECD [39] criticized.

In fact, the National R&D Plan has imitated the basic structure and conception of the European R&D Framework Programs; its priorities included some of the issues and research topics that are the main concern of public decision makers and at the same time, aggregated most of the 'demands' of the research actors involved in the consultative and

decision making processes. In addition to the high level of steering and priority setting, there was a low level priority determination in the implementation process, associated to the research actors' interest, which played a role of aggregation. The Plan, that could be interpreted as part of the emerging strategic science models [40], aimed to confront the needs of coordinating the different research activities and strategies of the actors through prioritizing some of the research fields and topics. Funding incentives to carry on these activities were the main mechanisms for alignment of research actors between themselves and with the government.

At this time an Inter-ministerial Commission for Science and Technology (*CICYT-Comisión Interministerial de Ciencia y Tecnología*) was created whose main responsibility was to design, promote, support and steer the development of R&D activities in public research institutions, and incentivate firms' RTD activities, following the priorities set by the National R&D Plan. After some vicissitudes and rearrangements the CICYT is now chaired by the Prime Minister, the general management of the National R&D Plan has been transferred to the Ministry of Education and Culture, and a newly created Office of Science and Technology (OCYT) directly under the Prime Minister's office, is in charge of issues like coordinating RTD policies, conducting studies or analysing the Spanish S&T capabilities.

Despite that there was an institutionalized locus for S&T policy coordination – the CICYT – since 1986, the fact is there has been no single science and research policy domain in the country besides the coordination rhetoric. The Spanish system is characterized by the sectorial fragmentation of both the R&D activities and the S&T policies. Although big attempts were made during the mid-1980s to establish a single and articulated policy for science, technology and innovation, the initiative clearly did not succeed and different policy domains and strategies, at national and at regional level, are still in action. Nonetheless, recent dynamics in the elaboration of the IV National R&D Plan (2000–2003) could offer new prospects.

3.2 *The emergence of prospective studies in Spain and its institutional arrangements*

In the mid-1980s, foresight and evaluation were considered very important for the government action in S&T policy planning and an administrative locus in government for both activities were institutionalized.

It was during the preparatory work for the draft of the 'Law of Science', in 1985 and later on while elaborating and drafting the First National R&D Plan 1988–91, when the idea of 'prospectiva tecnológica' [41,42] (technology foresight) was brought into the arena of modern Spanish RTD policy [43].

The Law fixed that one of the main criteria used in the process of defining S&T objectives for the various areas and programs was the "identification of future technological developments" (article 4 of the Law), however *no formal procedure* was established and this was left to the criteria and practical arrangements made by policy makers. In fact formal foresight exercises did not play a central role in the selection of priorities at the high level of aggregation; however the drafting of the First National R&D Plan did involve a consultative process with experts, researchers, interested administrations and some firm representatives. At that time, the Government reported that around half a thousand experts were involved in the process of setting priorities, mainly using the procedure of committees and panels.

In the regulative development of the Law of Science, a government decree in 1987 defined the “organizational and administrative structure to support the action of the CICYT and its permanent Commission”. Also a unit called National Agency of Evaluation and Foresight (*ANEP-Agencia Nacional de Evaluación y Prospectiva*) was created, with an organic level of sub-Directorate General. Surprisingly, this high level of institutionalization of foresight function in a bureaucratic organization – ANEP – did not end up in a momentum for a National Foresight process in Spanish S&T policy. The ANEP was a regular administrative unit of government, with no independent budget or resources and its mission included the organization of the evaluation process of the research projects to be funded by the national R&D programs, and the promotion of prospective studies in areas of interest of the CICYT. But in practice, the ANEP concentrated its activity in organizing the administrative infrastructure to facilitate peer review evaluation of the R&D project proposals at a large scale and with sufficient independence to create credibility in the process of public funding of RTD [44].

Certain aspects have contributed to the difficulty for integrating the prospective activities at ANEP into the main stream decision making process for S&T policies. On the one hand, the organizational construction of the ANEP reflected its high capabilities in managing project evaluation and the ability to organize the assessment of the scientific quality of project proposals, taking into account the state of the art scientific development [45]. But consequently, the activities related to foresight remained at the level of producing prospective reports which were highly academically focused, as opposed to having a market view, a necessary aspect needed in the integration of S&T and innovation policies.

On the other hand, the ANEP, which was administratively dependent on the Ministry of Education and Science – instead of Industry – had only academic expertise with little industrial involvement, and thus it was an improbable institutional place for promoting and implementing a large scale and strongly formalized foresight, that by definition needs a strong involvement of users (both industry and policy makers). This institutional arrangement for foresight in the Spanish government contributes to our understanding why in almost all foresight exercises or ‘experiments’, we see that the main players have always remained in the academic circles. What is evident is that unlike other countries, where the industrial actors have played an important role, in Spain this has not been the case.

Since the new conservative government took office in 1996 the situation has changed. The Ministry of Industry and Energy has developed a project to determine the future technological demands for Spanish industry in collaboration with firms and business associations; along these lines the Ministry had organized a network among specialized industrial and technological centres which support specific R&D needs for firms, the Industrial Technology Foresight Observatory (OPTI – *Observatorio de Prospectiva Tecnológica Industrial*), in order to monitor and foresee technological trends and help the Ministry of Industry and the Government in their definition of RTD priorities and strategies.

Also, directly under the Prime Minister’s office is the newly created Office of Science and Technology (OCYT) which will be in charge of coordinating RTD policies, conducting studies and analysing the Spanish S&T capabilities. Included within the definition of the legal competencies of the OCYT, is the responsibility for the “implementation and development of technology foresight in Spain” in coordination with other ministries.

In this new context, the prospective studies have played a much more relevant role in the preparatory activities for the new National R&D Plan (2000–2003). The OCYT has requested a review of the foresight studies in a few technologies to the Institute for Prospective Technological Studies (IPTS) of the European Commission [46], some other sectorial technologies foresight or technology watch studies have been provided by OPTI, and specific studies on the firms technological demands have been elaborated. Apparently in this preparatory work for the new plan, the information on future technological trends has become more relevant. Therefore these evolutions may open the door to changes in relation to the future development of governmental foresight initiatives with a general character in addition to those already developed within considered technological priorities [47].

3.3 Why has foresight being highly institutionalized remained outside the S&T policy planning?

The Spanish situation of foresight development is puzzling. Foresight has been highly institutionalized in a bureaucratic locus since the end of the 1980s, but it has been marginal and remained outside the S&T policy planning until very recently. A final reflection on these issues will confirm some of the arguments raised on the symbolic role of foresight in decision making, on the relevance of the policy context and on the constraints that institutions impose on the development of foresight and other policy solutions.

The complex situation of foresight in Spain could be characterized as follows:

- 1 Spain scores low in the conceptualization of foresight as an explicit process in S&T policy planning; in fact it has not gained relevance in priority setting until recently.
- 2 It also scores low in the degree of formalization of foresight as methodical and systematic production of information and knowledge on future trends and perspectives at national level.
- 3 It scores very low in the methodological developments or technical sophistication of foresight as a tool.
- 4 However, it scores very high in the institutionalization of foresight as a 'function' in Spanish bureaucracy.

Overall, foresight, when present, has been limited to a secondary role as an information product, with no explicit connection to S&T coordination policy through interaction between research and innovation actors.

There are some specific conditions of the Spanish policy context that could contribute to understand why foresight being present (as other information tools) has not played a key role in S&T policy, that is, it did not emerge as the solution to Spanish S&T problems. The general socio-economic conditions, in which the political and policy actors operate, have not enhanced the need to use foresight as a main tool in the legitimization process of the S&T policy making. The problems identified as issues for public intervention were the low level of R&D expenditure and the lack of S&T policy coordination. The 'solutions' employed were increasing public funding and the National R&D Plan. The Spanish context of S&T policy has been one characterized by strong growth of R&D funding, in which the definition of RTD priorities through a National

R&D Plan has been simultaneous to the increase of 'non-prioritized funds'. The CICYT got the credit for the good performance and, until the mid 1990s, very little questioning of S&T policy occurs. Thus support from the public sector or legitimization of policy making resulted mainly from huge increases of R&D funds.

On a more general level, in Europe, funding is becoming restrictive, and at the same time there is a need to select priorities, as well as the social forces that demand accountability and legitimization of public funding. Within this context, foresight that has emerged in other European countries may be responding to these pressures by contributing to the legitimization process and the selection of R&D priorities. Being responsive and accountable are two central elements of the new type of pressures that policy makers have in a context of budget constraints. However this type of pressure in Spain has been less relevant, because the environment of S&T policy has brought significant increases of public funding.

There are also some other issues concerning the concrete institutional arrangements in which foresight emerged. Although foresight was recognized as a relevant mechanism for policy planning, the lack of industrial involvement may have handicapped the setting up of technology foresight, a solution conceptually linked more to technology and innovation policies than to science policy. ANEP remained too closely tied to academic circles, needed for its good performance of peer review evaluations, but missing the link to industry. Consequently, foresight, in general, has been taken on at an academic level, sectorial nature (single technology/science field), using less formal methodologies (discussion groups or experts reports). Institutionalized foresight in a bureaucratic locus has not been able to influence the mainstream S&T policy making process and strategy development, because it has been isolated within the Ministry of Education & Science and separated from the industrial context.

The question we pose is why should rational policy makers become involved in foresight processes as central frameworks for S&T prioritization if the tools in use allow them to steer and aggregate [48], to promote coordination through incentives and to align actors with direct financial subsidies and public sector intervention. What incentives could policy makers have to promote changes that favour the use of foresight as a strategic tool for coordination through interactions, instead of keeping safely to the more traditional, and bureaucratic or interest dominated, policy making process? We only have one strong answer: pressures for adaptation emerging from an environmental, political or policy, change.

We suggest that foresight, especially in a centrally promoted and interactive form, emerges in a policy context in which policy makers react to the process of losing ground in S&T. We should expect much more propensity for emergence of foresight when the general role of government has been reduced in such circumstances as we witness today with a move towards globalization of the economy. In the context of RTD, especially in high technology areas, governments have always had a high level of intervention: direct implementation through public R&D, allocation of funds, coordination and definition of priorities or public procurement because the government functions as the main client for S&T. In Europe, until recently, governments had a very important role in the economy. However, nowadays, we see that foresight emerges during a period where the process of liberalization and privatization has been diminishing the role of government as a key actor in the economy. With these trends of privatization of public firms and liberalization of the markets, S&T research has been directly affected. Government and policy makers may be responding to this decrease in importance with new mechanisms, such as

formalized foresight exercises of consultation and interaction, in order to provide them with the necessary instruments for incentives and influence over private actors and the innovation process.

In Spain, until very recently the main industrial players in RTD development were public companies or governmental customers; in fact in the mid-1980s the Government action to promote technological development was mainly organized directly through big public industrial and services companies. Today, however, Spain has also been involved in the process of privatization and liberalization. This may suggest that, in addition to the restraints that 'competition policy' introduces in the financial incentives for RTD promotion, in recent times government has found advantageous the use of foresight in the context of defining S&T priorities.

4 Assessing our expectations on the effects of foresight in policy making

In this part of the paper we enter into the analysis of the usefulness of foresight. To improve our understanding (both in empirical and prescriptive terms) we suggest to confront foresight with the models and theories of decision making. Mainstream analysis on foresight does not make explicit many of the assumptions on which it is based, but we can say that dominant approaches are coherent with the rational model of decision making.

In spite of the fashion of foresight it is our claim that one of the weaknesses of the dominant views rests upon the low degree of integration of foresight thinking within decision making models and theories of organizational action and policy analysis departing significantly from rational based approaches. We claim that the underlining model of decision making in conventional foresight analysis lacks robustness, especially if we consider the role of information in decisional contexts.

Foresight scholars and policy makers found a relevant distinction between the *output* or the product of the foresight, which is usually information, and the *process* of foresight. Most of the defenders of foresight state that in foresight the relevant issue is the process more than the product, although it is not conceivable to imagine a process that does result in a product.

4.1 The role of foresight as information for decision making

Most of the foresight literature is based on the idea that the aim of foresight is to produce new information (elaborated through a process of making explicit, for experts or layman, expectations on future technological developments) that will be a crucial input for policy makers' decisions.

Hence, good information (in terms of quality and frequency) is essential to improving decision making. However, considering only this side of the problem implies a very ideal view of the decision making process. The implicit model of decision making underlining foresight is viewed as a result of intended rational calculation and is based on an evaluation of alternatives in terms of their consequences for preferences. Foresight as an information output (documents, reports, etc.) can be understood as some of the data that decision and policy makers request to be more informed. In this context, the choice depends on what future alternatives are considered in two aspects: what the future states,

that is conditional to the choice, and how the decision maker will feel about that future world. However, the empirical robustness of the rational model, especially in those circumstances in which information about potential outcomes may not be easily acquired, is questioned [49].

The problem with this model is the loosely coupled relationship that information has with decision making. Decision makers become involved in systematic processes of information producing, gathering and storing for decision making. And foresight in this policy making context could be seen as one more, some people see it as the critical one, of the informational activities. The conventional theory of decision making predicts that actors (and policy makers) search for information to a sensible limit within a balance between the cost of producing information and the benefits that any additional bit of information will produce. There are assumptions that if decision and policy makers act rationally, they will gather and use the information produced through foresight exercises.

However the observed relations between information and decision making are not as easy or clear as the conventional theories predict. Policy makers face not only bounded rationality conditions, uncertainty, information asymmetries and limitations, and heuristic biases but institutional limitations and social judgement. We suggest that there are hard and critical choices made in institutional settings that require a better understanding of the ideologies and normative models that have guided choices. Consequently, decision makers exhibit patterns of behaviour guided by organizational settings that shape the gathering, storage and use of information and foresight exercises. We suggest that foresight and information emerging from it, is embedded in social norms that make it a *symbol* and a *signal* [50,51]. We think that the case of foresight can be additionally enlightened considering the situations in which policy makers treat the gathering and use of information as part of the pursuit of its symbolic meaning in addition to the resolution of decision uncertainties.

We suggest that the symbolic properties of information within organizational settings will help us to understand the conditions from which foresight emerges and especially the forms and ways it is used within these organizations, that is governments. Foresight reports and exercises, as many other information pieces, are also symbols in the overall context of policy making. To have them, to possess information is a symbol and a representation of their competence for the decision making exercise. Moreover the stock and quality of information and its use for justifying the decision making process is a way of symbolizing or signalling that the process is legitimate, particularly when the decisions taken depart significantly from organizational and institutional habits and routines. Foresight has been growing in this organizational context in which a good decision maker is one who makes decisions in a proper way, who exhibits expertise and uses generally accepted information.

Finally, another dimension of information within institutional settings in general, and concerning complex policy choices in particular, is the reduced ability of a single policy actor to determine the decision and to influence in the outcome. Such a context does not offer actors the incentives to become informed and to make intensive use of the information available. We argue that this reduces the motivation of policy makers to allocate cognitive resources to the building of new scenarios and improving information on future technological scenarios. In this context, cognitive costs are understood as the costs involved in the acquiring and interpretation of new data and information plus the social costs associated with seeking new alternatives that will differ from habits and routines.

To summarize, policy contexts and institutional settings in which choices on science and technology are made depart significantly from the deductive rational procedure assumed by current foresight analysis. Moreover, legitimation and social reputation of decision makers stimulates production, and conceit of information, well beyond what is used to resolve substantive uncertainties.

In spite of the above mentioned contextual factors it is important to consider that the dominant type of policies associated with science and technology have properties of distributive policies [52], and they have a special need for legitimation, either based on rational arguments or on consensus building between actors. Therefore, decision making in this policy context is shaped by needs of legitimation of the authoritative decisions (e.g. on R&D priority setting or on allocation of R&D funds). In addition there are also two socio-political contexts in which legitimation of decisions become a crucial issue for policy makers:

- 1 when there is a general questioning of the public action in relation to civil society, as it was the case in the UK during the 1980s, and
- 2 when there is a shortage in public funding and thus a need for selection criteria.

Thus, when legitimacy becomes a necessary property of effective decisions (in bureaucratic environments), the consumption of information is a feasible and sensible strategy for decision makers. In this context, decision makers gather information and do not use it; ask for more and ignore it; make decisions first and look for relevant information afterwards; gather and process a great deal of information that has little or no direct relevance for decisions. Information requested and used is much more likely to become a signal when indeed the criteria for assessing performance moves towards uncertainty and ambiguity, particularly in the case when we are dealing with choices about future trajectories of technological development and possible future consequences of present actions [53,54].

A foresight process could have impact on STI policies because when organizations establish information systems, regardless of the initial reasons, they create a dynamic on their own which shapes the overall process. However we cannot forget that information (especially labelled as technology foresight) could become one symbol or indicator of the legitimate competencies (as other tools also do) of policy makers more than a substantive contribution to decisions.

Because foresight has the properties of information, in such policy contexts and institutional settings, we could expect that foresight information can be replaced by other types of information or tools that will provide symbols of legitimacy for appropriate STI policy making. All these factors are critical to understanding why some policy entrepreneurs promoted, with more impetus, foresight in some countries than in others, but in all cases the level of foresight consumption will depend on the sources, forms and needs of legitimation of policy makers and to what extent competing information tools develop.

4.2 Can foresight be of value for coordinating the innovation system?

In the previous section we have developed a theoretical framework on the role of information in organizational decision making process, that has led us to conclude that foresight is also part of the legitimation process of policy makers .

Considering that the intention to increase the intelligence of decisions has been usually a decisive element in what we expect from human behaviour, in this section we will enter into normative statements about foresight, and we will address the issue of the uses of foresight to improve management of coordination in innovation systems.

We have mentioned the fact that in foresight practices in some countries, a new dimension is added to the traditional mission of information production about the future. There is some insistence that the *process* of foresight, especially when this process means large scale consultation and mobilization of innovation actors, is much more relevant than the simple information product. We [55] already have insisted on the point about the potentials that foresight represents as a key tool in relation to the chances of improving coordination between the different actors of the innovation system.

In this sense there are two aspects, the relationship between choice and action, and then the forms of action finally taken. When traditional assumptions of rational models dominate, the perception of foresight as an information tool for decision making emerges. However if we depart from these models and question the issue of goals, that are pre-existent, we build up some arguments that could provide clues to having a much more realistic connection between choice and action [56]. The traditional models assume that goals come first and action comes later, but choices are at least as much a process for discovering goals as for acting on them [57].

The second problem in foresight as a practice, is the conflict between actors' interests. Government is seeking intelligence in the name of multiple actors, and the preferences and identities of those actors are inconsistent with the preferences or identities of other actors. These inconsistencies lead to difficulties in exchanging information and cooperation, as different actors act intelligently from their own perspective. From this view, interaction is not only a process of information exchange but it is also a process of learning and negotiation with others.

Uncertainty characterizes choice-making in science and technology policies, and to understand decision making under such conditions we must comprehend the role of technological futures that agents construct to make sense of the world around them [58]. Innovation actors have expectations of the future developments that could shape its behaviour [59], and these expectations could be modelled through interaction with other innovation actors [60]. Participation in the foresight process could have a positive role in adjusting the mutual expectations of technological development of the different actors. Then foresight could guide mobilization and organize interaction processes with the aim of collective construction of future technological developments.

If we assume that choice and action are split, the simple model of foresight as information could be seen as a contribution to the practice of foresight; however if we consider that objectives are not previous and given, but that they adapt to time changes, the interaction between actors becomes a central element of the coordination of human behaviour and a plus in the potential uses of foresight to manage the interaction process.

5 Final comments

On the development of foresight in its policy context we have stated that there is a strong association with the needs of legitimization of different STI policies and with the need of reducing uncertainty on decision making. Differences in legitimization issues rather than on levels of uncertainty faced by policy makers will help to better understand

heterogeneity and country specific features.

What remains open is whether foresight in Spain will evolve from the discontinuous foresight studies which have been occurring, and will gain more centrality in STI policy making.

Our general intuition is that we could only expect significant changes in this issue, if there were also some significant changes in the political environment, as in fact happened in the UK in the 1980s, affecting the ability of the public bureaucracy to develop its work; pushing them as policy entrepreneurs. Probably likewise the evolution could be a function of the legitimation needs of policy makers confronting public accountability. And two basic forms of legitimation emerge as relevant: the extension of the 'technical knowledge base' of decisions and the creation of new conditions for aggregation of preferences (and expectations and agendas) of research and innovation actors through interaction and consensus building.

Until recently the aggregation of interests based on any process of policy making was made under the exclusive responsibility of bureaucracy. Attributing to foresight a relevant role in 'aligning expectations' will produce significant transformations, consequences and implications because it goes to the centre of the political process related to aggregating preferences or interest. Political institutions gain their legitimate authority with elections. All the impetus for public accountability, responsiveness, etc. produces strong pressure on public officials. In the UK it was under Thatcher and Major when foresight apparently gained relevance, in a time when the legitimation of public action was in crisis and there was a strategy for limiting the 'public domain', thus the bureaucrats had the need to re-legitimize their choices under the technocratic or external society expert competencies.

In these situations, policy makers need to reassess their legitimation strategy. However this special situation only occurs if some of the political actors question the basic legitimation and criteria for public intervention and STI priority setting. That is, if dominant political actors put into question the basis of legitimate public intervention or they try to improve (taking the results of the aggregation process made by the political system) the way that public action aggregates societal preferences.

As a concluding remark we see that the evolution of foresight, from simple information output to a central aggregation process, relates to the possibilities that foresight has for substituting (replacing-complementing) the basic political features of policy making.

Acknowledgements

This paper has been produced in the context of the research project *Foresight as a Tool for the Management of Knowledge Flows and Innovation*, funded by the IV R&D Framework Program of the European Union (TSER Program – SOE1-CT97-1056) and the III National R&D Plan (SEC-98-1539-CE). The authors acknowledge the comments and criticisms received from Denis Loveridge, Annemiek Nelis, Walter Peissl, Brian Rappert, Arie Rip and two anonymous referees. Usual disclaimers apply.

References and Notes

- 1 This paper was written in the second half of 1998, with final acceptance for publication in June 1999. Since then significant changes in the case taken as exemplar for our argument have occurred (the Spanish R&D political organizational setting). A new Ministry of Science and Technology was created merging the separate policy domains of research, technology and innovation policies. The fourth National R&D Plan was approved, and re-labelled as National Plan for Scientific Research, Technological Development and Innovation (2000–2003). Meanwhile, two industrial technology foresight, or more exactly technology watch reports (*Informe de Prospectiva Tecnológica Industrial*) have been published by the OPTI. However, the main analytical arguments established in the paper on the relationship between foresight and S&T policy context still hold (January 2001).
- 2 We understand foresight in a very general sense as those activities, promoted by any actor, that seek to determine future tendencies in science and technology which result either in isolated reports or documents or those that also include a formalized consultation and interaction process. However in this paper we concentrate our interest in government sponsored foresight exercises.
- 3 European Commission (1995) *Green paper on innovation* propose as the first action to 'develop technology monitoring and foresight', p.38.
- 4 Irvine, J. and Martin, B.R. (1984) *Foresight in Science: Picking the Winners*, Pinter Publishers, London.
- 5 Martin, B.R. and Irvine, J. (1989) *Research foresight: Priority-setting in Science*, Pinter Publishers, London and New York.
- 6 Cuhls, K. and Kuwahara, T. (1994) *Outlook for Japanese and German Future Technology. Comparing Technology Forecast Surveys*, Physica-Verlag.
- 7 Fraunhofer Institut für Systemtechnik und Innovationsforschung (1998) *Delphi 1998, Zukunft Nachgefragt. Studie zur Globalen Entwicklung von Wissenschaft und Technik*. Karlsruhe, FhG-ISI.
- 8 Loveridge, D., Georghiou, L. and Nedeva, M. (1995) *United Kingdom Technology Foresight Program, Delphi Survey*, HMSO, London.
- 9 Foresight Steering Committee (1996) *A Vital Knowledge System. Dutch Research with a View to the Future*, FSC, Amsterdam.
- 10 Ministère de l'Industrie (1995) *Les 100 Technologies Clés pour l'Industrie Française*, Ministère de l'Industrie, Paris.
- 11 Cameron, H. and Loveridge, D. *et al.* (1996) EC Report, *Technology Foresight: Perspectives for European and International Cooperation*. EC/DGXII-PREST, Brussels and Manchester.
- 12 Martin, B. (1994) Report by OECD, 'Technology foresight: a review of recent government exercises', included in the *Special Issue of the OECD Journal STI Review No. 17, 1996 on Government Technology Foresight Exercises*, pp.15–50.
- 13 Gavigan, J.G and Cahill, E. (1997) IPTS Report, *Overview of Recent European and non-European National Technology Foresight Studies*, EC-JRC, Seville.
- 14 Fleissner, P. *et al.* (1998) IPTS Report, *Recent National Foresight Studies. A Review*, EC-JRC, Seville.
- 15 Fondazione, R. (1996) *La Priorità Nazionale Della Ricerca Industriale. Primo Rapporto*, D. Roveda, and R. Viale. (Eds.), Franco Angeli, Milano.
- 16 Aichholzer, G. *et al.* (1998) ITW-OAW, *Technologie-Delphi*, Vol. 3, Institut für Technikfolgen-Abschätzung der Österreichischen Akademie der Wissenschaften, Wien.
- 17 The kind of questions that guide our search are: Is the growing relevance of foresight in different countries the result of some national preconditions or international diffusion? What forces explain the rapid diffusion of foresight as a practice or at least as a concept in the discourses of STI policy makers? Are the benefits of foresight the main causes of the successful diffusion? Is the spread of foresight the result of some isomorphic process of international diffusion of the STI rhetoric, organizational forms or tools? Did foresight

exercises have any identifiable impacts either reshaping STI policies or modifying the strategies of the main innovation actors?

- 18 Kingdon, J.W. (1984) *Agendas, Alternatives and Public Policies*, Little, Brown and Co., Boston, builds up a model based on the 'garbage can model of decision making'.
- 19 Cohen, M.D., March, J.G. and Olsen, J.P. (1972) 'A garbage can model of organizational choice', *Administrative Science Quarterly*, Vol. 17, No. 1, March, pp.1–25).
- 20 Keeler, J.T.S. (1993) 'Opening in the window for reform. Mandates, crises, and extraordinary policy-making', *Comparative Political Studies*, Vol. 25, No. 4, pp.433–486.
- 21 Polsby, N.W. (1984) *Political Innovation in America*, Yale University Press, New Haven.
- 22 Such theoretical framework has a lot in common with the structural contingency theory of organization first developed by Lawrence, P.R. and Lorsch, J.W. (1967) *Organization and Environment: Managing Differentiation and Integration*, Harvard University Press, Cambridge.
- 23 Riker, W.H. (1986) *The Art of Political Manipulation*, Yale University Press, New Haven.
- 24 Carmines, E.G. and Stimson, J.A. (1989) *Issue Evolution*, Princeton University Press, Princeton.
- 25 Hilgartner, S. and Bosk, Ch.L. (1988) 'The rise and fall of social problems: a public arenas model', *American Journal of Sociology*, Vol. 94, pp.53–78.
- 26 Weir, M. (1992) *Politics and Jobs*, Princeton University Press, Princeton.
- 27 Arthur, W.B. (1989) 'Competing technologies, increasing returns and lock-in by historical small events', *Economic Journal*, Vol. 99, pp.116–131.
- 28 David, P. (1985) 'Clio and the economics of QWERTY', *American Economic Review Proceedings*, Vol. 75, pp.332–337.
- 29 Collier, R.B. and Collier, D. (1991) *Shaping the Political Arena*, Princeton University Press, Princeton.
- 30 Rose, R. and Davies, P.L. (1994) *Inheritance in Public Policy*, Yale University Press, New Haven.
- 31 Thompson, J.N. (1994) *The Coevolutionary Process*, The University of Chicago Press, Chicago and London.
- 32 See for example, Elzinga, A. and Jamison, A. (1995) 'Changing policy agendas in science and technology', in S. Jasanoff *et al.* (Eds.), *Handbook of Science and Technology Studies*, Sage, Thousand Oaks and London, pp.572–597.
- 33 Just see the titles of the publications from UK Office of Science and Technology DTI such as *Winning Through Foresight*, etc.
- 34 Wolman, H. (1992) 'Understanding cross national policy transfers: the case of Britain and the US', *Governance: An International Journal of Policy and Administration*, Vol. 5, No. 2, pp.27–45.
- 35 For a full description and analysis of the reforms in science and technology policy in Spain, see [36], in English see [37].
- 36 Sanz-Menéndez, L. (1997) *Estado, Ciencia y Tecnología en España: 1939-1997*, Alianza Universidad, Madrid, p.428.
- 37 Sanz-Menéndez, L. (1995) 'Policy choices, institutional constraints and policy learning: the Spanish science and technology policy in the eighties', *Int. J. Technology Management*, Special Issue on the Evaluation of Research and Innovation, Vol. 10, Nos. 4–6, pp.622–641.
- 38 Sanz-Menéndez, L., Muñoz, E. and García, C.E. (1993) 'The vicissitudes of Spanish science and technology policy: coordination and leadership', *Science and Public Policy*, Vol. 20, No. 6, December, pp.370–380.
- 39 OECD (1986) *Innovation Policy: Spain*, OECD, Paris.
- 40 Rip, A. (1990) 'Implementation and evaluation of science and technology priorities and programs', in S.E. Cozzens, P. Healey, A. Rip and J. Ziman (Eds.), *The Research System in Transition*, Kluwer, Dordrecht, pp.263–280.

- 41 Under the umbrella of *Prospectiva Tecnológica*, a word that in Spanish has strong proximity with the French concept *Prospective* (see for example [42]) and is associated to planning in which we can identify activities of different nature.
- 42 Godet, M. (1985) *Propective et Planification Strategique*, Economica, Paris.
- 43 Although no overall or systemic approach to foresight was taken for general S&T policy, some sectoral R&D policies such as the Agriculture Research Policy (*Programa Sectorial de Investigaciones Agrarias*) had also a significant consideration of the future in their priority setting, or in the Ministry of Industry. Even though the rhetoric of the *Prospectiva Tecnológica* had been present, the real implementation had been weak, discontinuous and dispersed, always in a report form, of different stands: foresight with a highly scientific content, developed from either a very institutionalized administrative locus or big research institutions; or foresight with more focus on the competitiveness of the Spanish industry which involved a deep analysis of critical industrial sectors.
- 44 Sanz-Menéndez, L. (1995) 'Research actors and the state: research evaluation and evaluation of science and technology policies in Spain', *Research Evaluation*, Vol. 5, No. 1, April, pp.79–88.
- 45 In fact, the organizational infrastructure created at the ANEP – a database of more than 6.000 experts in scientific areas – was extremely biased to academic and basic researchers with very little presence of engineers or researchers working at firms.
- 46 IPTS Report by Fleissner, P. et al. (1998) *Recent National Foresight Studies, A Review*, EC-JRC, Seville.
- 47 There are also some regional level initiatives, which include a Foresight Program in the Basque Country (northern region of Spain) and Strategic Technology Plans (RIS-RITTS). These initiatives are seriously associated with policy making, and involve a very broad 'consultation' process with stakeholders in the regions.
- 48 Rip, A. and van der Meulen, B.J.R. (1996) 'The post-modern research system', *Science and Public Policy*, Vol. 23, No. 6, December, pp.343–352.
- 49 Bounded rationality models have relaxed the assumptions of pure rational models, to accept that decision makers face vital limitation in attention, memory, comprehension and communication, and to help confront them they develop a simplification process and editing, decomposition, heuristics and framing.
- 50 Feldman, M.S. and March, J.G. (1981) 'Information in organizations as signal and symbol', *Administrative Science Quarterly*, Vol. 26, pp.171–186.
- 51 Feldman, M.S. (1989) *Order Without Design*, Stanford University Press, Stanford.
- 52 Lowi, T.J. (1972) 'Four systems of policy, politics and choice', *Public Administration Review*, Vol. XXXII, No. 4, July-August, pp.298–310.
- 53 As has been said "gathering information and making decisions are signals and symbols of competence. The possession and exhibition of information symbolizes (and demonstrate) the ability and legitimacy of decision makers" [54].
- 54 March, J.G. (1994) *A Premier on Decision Making: How Decisions Happen*, Free Press, New York, p.226. See Sanz-Menéndez, L. and Cabello, C. (2000) 'Expectations and learning as principles for shaping the future', in N. Brown, B. Rappert and A. Webster (Eds.) *Contested Future: A Sociology of Prospective Techno-Science*, Ashgate, Aldershot, pp.229–249.
- 55 This is the approach of the project FORMAKIN that involves teams from Spain, The Netherlands and United Kingdom led by Sanz-Menéndez, L., van der Meulen, B. and Webster, A. who is acting as coordinator. Information on the project may be obtained on the web site <http://www.iesam.csic.es/proyecto/pr-forme.htm>. See Sanz-Menéndez, L. and Cabello, C. (2000) 'Expectations and learning as principles for shaping the future', in N. Brown, B. Rappert and A. Webster (Eds.), *Contested Futures: a Sociology of Prospective Techno-Science*, Ashgate, Aldershot, pp.229–249.
- 56 See for example Lane, D., Malerba, F., Maxfield, R. and Orsenigo, L. (1995) 'Choice and action', *Santa Fé Institute, working paper 95-01-004*.

- 57 March, J.G. (1973) 'Model bias in social action', *Review of Educational Research*, Vol. 42, pp.413–429.
- 58 Denzau, A.T. and North, D.C. (1994) 'Shared mental models: ideologies and institutions', *Kyklos*, Vol. 47, No. 1, pp.3–31.
- 59 Rosenberg, N. (1976) 'On technological expectations', *Economic Journal*, Vol. 86, pp.523–535.
- 60 van Lente, H. and Rip, A. (1998) 'The rise of membrane technology', *Social Studies of Science*, Vol. 28, No. 2, April, pp.221–254.