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**Understanding Technology Foresight:
the relevance of its S&T policy context**

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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 in the reflection 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.

1. Introduction

A new spectre is haunting Europe: the spectre of Foresight. In the last decade Foresight [1] has become a fashionable word in documents and conversations of science and technology policy makers all over Europe [2]. After the reincarnation of the future studies in the modern form of foresight in the mid-eighties [3], [4], the design and implementation of some exemplars (as the German Delphi [5], [6], the UK Technology Foresight [7], the Dutch Foresight Program [8], or the French Key Technologies [9]), and some general reviews [10], [11], [12], [13], 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 [14], Austria [15], Hungary, Sweden,...), not to mention Australia, New Zealand, etc.

What is fuelling the renewed interest of governments on technology foresight? Scholars have embraced this new fashionable faith with the impetus of the converse, 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 the problems posed by the new challenges of STI policies (for example international competitiveness and the concerns on 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 this fashion, the dominant approaches are biased by the normative assumptions and prescriptive propositions of Foresight, while very little attention is given to address 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[16].

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 decisions 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 the foresight in governmental environments in Europe. In the following section some general properties of the policy making process are explored to help us to conceptualise the emergence of foresight as a 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 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 organisational context. Information or Foresight can be substantive inputs for the decision making process but they also play a central role on the legitimation of decisions and policy makers. Finally we will develop some reflections on the future of foresight and its potential, that is, as process of actor interactions that could help to improve the coordination of the 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 on 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 section three 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 policy process.

Kingdon [17] 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 depend 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 [18] and they represent the preconditions for merging or matching of the different streams, but connecting them is dependent on the actions of policy entrepreneurs [19]. 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 [20], in such that the policy entrepreneur or "human agency" is a central element in the explanation because of their ability to introduce manipulation [21].

However the process of issue definition [22] 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 do social phenomena become "policy problems", that is how public attention is focused [23]. Equally relevant is to discern how do specific understandings of problems emerge and consolidate, and through what channels do 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 the policy options. The availability of appropriate solutions can then be influenced by earlier policies, which direct exploration on new innovation 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, can not be taken in isolation because they are part of a *policy sequence* [24] 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 [25], [26], trajectories of development and critical junctures [27] and policy inheritance [28]. In that way, we insist in how actions taken at one time can make some 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 specialisation (between problems and alternatives, and between policy and politics) and mutual dependency, in the context of “reciprocal evolutionary change in interacting elements” [29]. Our specific set of policies associated to STI have been evolving (and co-evolving) in the last decades [30]. Science and Technology policies have received pressures for adaptation from the emergent problems of “competitiveness” and “innovation”, centering 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 emerged 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 organisational routines and procedures (e.g. explicit consideration of the future or process of aggregation of diverse interest). Institutions once set up exhibit some everlasting properties. The differences in the relationships between science and government shaped 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 the 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 eighties policy-makers identified the lack of technological leadership and competitive shortcomings as a major policy issue, only in few European countries foresight had 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, (UK is the paradigmatic case) Foresight, as an organised process or collective consultation on plausible future developments, has been recently used as a main framework for science and technology policy coordination [31].

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 [32] or learning from others has occurred. Nevertheless without the 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 follows we will use the case of the first attempts to bring foresight into the policy agenda in the context of the definition of the Spanish RTD 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 institutionalised has not been such a central tool for policy coordination and policy making as in other countries.

a) *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 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 [33], 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 [34] had 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 [35] criticised.

In fact, the National R&D Plan has imitated the basic structure and conception of the European R&D Framework Programmes; 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' interests, which played a role of aggregation. The Plan, that could be interpreted as part of the emerging strategic science models [36], aimed to confront the needs of coordinating the different research activities and strategies of the actors through prioritising 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 & 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 institutionalised 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 characterised 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.

b) 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 institutionalised.

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, were when the idea of "*prospectiva tecnológica*" [37] (technology foresight) was brought back into the arena of modern Spanish RTD policy [38].

The Law fixed that, one of the main criteria used in the process of defining S&T objectives for the various areas and programmes was the "identification of future technological developments" (art 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, administrations interested 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 "organisational and administrative structure to support the action of the CICYT and its permanent Commission". 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 institutionalisation of foresight function in a bureaucratic organisation -ANEP- did not end up in a momentum for a National Foresight

process in the Spanish S&T Policy. The ANEP was a regular administrative unit of government, with no independent budget or resources and its mission included the organisation 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 organising 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 [39].

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 one hand, the organisational construction of the ANEP reflected its high capabilities in managing project evaluation and the ability to organise the assessment of the scientific quality of a project proposal, taking into account the state of the art scientific development [40]. 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 of the Ministry of Education & 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 formalised 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 understand 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 & Energy is developing a project to determine the future technological demands for Spanish industry in collaboration with firms and business associations; along these lines the Ministry had organised a network among specialised 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), now under preparation. 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 [41], some other sectorial technologies foresight 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 general character in addition to the already developed within considered technological priorities [42].

c) Why foresight being highly institutionalised remained outside the S&T policy

planning?

The Spanish situation of foresight development is puzzling. Foresight being highly institutionalised in a bureaucratic locus since the end of the eighties, and 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 characterised as follows: 1) Spain scores low in the conceptualisation 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 formalisation 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 institutionalisation of the 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 the 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 legitimisation 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 characterised 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-prioritised funds". The CICYT got the credit of the good performance and, until mid nineties, very little questioning of the S&T policy occurs. Thus support from the public or legitimisation of policy making resulted mainly from huge increases of R&D funds.

On a more general level, in Europe, funding is also becoming restrictive, and at the same time there is a need to select priorities, as well as the social forces that demand accountability and legitimisation of public funding. Within this context, Foresight that has emerged in other European countries may be responding to these pressures by contributing to the legitimisation 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 recognised as relevant mechanism for policy planning, the lack of industrial involvement may have handicapped setting up technology foresight, that is a solution conceptually linked more to technology and innovation policies than to science policy. ANEP remained too closely tied to the academic circles, which was needed for its good performance of the peer review evaluations, but was 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). Institutionalised foresight in a bureaucratic locus had not been able to influence the main stream S&T policy making process and strategy development, because it had 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 prioritisation if the tools in use allow them to steer and aggregate [43], 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 an strategic tool for coordination through interactions, instead of keeping safe 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 loosing 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 we witness today without move towards the globalisation 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 main client for S&T. In Europe, until recently, the governments had a very important role in the economy. However, nowadays, we see that foresight emerges during a period where the process of liberalisation and privatisation has been diminishing the role of the government as key actor in the economy. With these trends of privatisation of public firms and liberalisation 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 formalised foresight exercises of consultation and interaction, in order to provide them with the necessary instruments for incentives and influence over the private actors and innovation process.

In Spain, until very recently the main industrial players in RTD development were public companies or governmental customers; in fact in mid-eighties the Government action to promote technological development was mainly organised directly through big public industrial and services companies. Today, however, Spain has also been involved in the process of privatisation and liberalisation . 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. Main stream analysis on foresight does not make explicit many of the assumptions in which it is based on, 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 organisational 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, that usually is 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.

a) *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 [44].

The problem with this model is the loose couple relation that information has with decision making. Decision makers become involved in systematic processes of information producing, gathering and storing for decision. 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 up 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 model that have guided choices. Consequently, decision makers exhibit patterns of behaviour guided by organisational 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* [45], [46]. 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 organisational settings will help us to understand the conditions from which foresight emerges and especially the forms and ways it is used within these organisations, 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 symbolising or signalling that the process is legitimate, particularly when the decisions taken depart significantly from organisational and institutional habits and routines. Foresight has been growing in this organisational 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 contexts do 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 summarise, 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 to science and technology have properties of distributive policies [47], 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 R&D funds). In addition there are also two socio-political contexts in which legitimation of decisions become a crucial issue for policy makers: (i) 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 eighties, and (ii) 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 the 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 afterward; 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 [48].

Foresight process could have impact in STI policies because when organisations establish information systems, regardless of the initial reasons, they create a dynamic by 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 understand 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.

b) 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 organisational decision making process, that has lead 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 mention the fact that in foresight practices in some countries, a new dimension is added to the traditional mission of information production about future. There is some insistence that the *process* of foresight, especially when this process means large scale consultation and mobilisation of innovation actors, is much more relevant than the simple information product. We [49] 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 a 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 have a much more realistic connection between choice and action [50]. 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 [51].

The second problem in Foresight as a practice, is the conflict between actors' interest. 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 point of view. 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 characterises 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 [52]. Innovation actors have expectations on the futures developments that could shape its behaviour [53], and these expectations could be modelled through interaction with other innovation actors [54]. Participation in the foresight process could have a positive role in adjusting mutual expectations on technological development of the different actors. Then foresight could guide mobilisation and organise interaction processes with the aim of collective construction of the 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 they adapt to time changes, the interaction between actors become a central element of the coordination of human behaviour and a plus of 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 legitimation of different STI policies and with the need of reducing uncertainty on decision making. Differences in legitimation issues rather than on levels of uncertainty faced by policy makers will help to better understand heterogeneity and country specific features.

For the implications 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 what in fact happened in UK in the eighties, affecting the ability of the public bureaucracy to developed its work, pushing them as policy entrepreneurs. Probably likewise the evolution could be a function of the legitimation needs of the policy makers confronting the public accountability. And two basic forms of legitimation emerge as relevant: the extension of the “technical knowledge base” of the 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 in any process of policy making was made under the exclusive responsibility of the bureaucracy. Attributing to foresight a relevant role in “aligning expectations” will produce significant transformations, consequences and implication because it goes to the centre of the political process relating to aggregating preferences or interest. Political institutions gain their legitimate authority with elections. All the impetus for public accountability, responsiveness, etc. produced strong pressure on the 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-legitimise 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.

References and notes

[1] We understand foresight in a very general sense as those activities, by any actor, that seek to determine future tendencies in science and technology which either result in isolated reports or documents or those that also include a formalised consultation and interaction process. However in this paper we concentrate our interest in government sponsored Foresight exercises.

[2] For example, in the European Commission (1995) *Green paper on innovation* the first of the action proposed is “develop technology monitoring and foresight” (p.38).

[3] J. Irvine & B.R. Martin (1984) *Foresight in Science: Picking the Winners*. London: Pinter Publishers.

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[7] See for example one of the reports, D. Loveridge, L. Georghiou & M. Nedeva (1995) *United Kingdom Technology Foresight Programme. Delphi Survey*. London: HMSO.

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- [15] ITW-OAW (G. Aichholzer *et al.*) (1998) *Technologie-Delphi*. 3. vols. Wien: Institut für Technikfolgen-Abschätzung der Österreichischen Akademie der Wissenschaften.
- [16] 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, organisational forms or tools? Did foresight exercises have any identifiable impacts either reshaping STI policies or modifying the strategies of the main innovation actors?
- [17] J.W. Kingdon (1984) *Agendas, Alternatives and Public Policies*. Boston: Little, Brown and Co. build up a model based in the "garbage can model of decision making" (M.D. Cohen, J.G. March & J.P. Olsen (1972) "A Garbage Can Model of Organizational Choice", in *Administrative Science Quarterly* vol. 17, n 1, March, pp. 1-25).
- [18] J.T.S. Keeler (1993) "Opening the window for reform. Mandates, crises, and extraordinary policy-making", in *Comparative Political Studies*, vol. 25, n.4, pp. 433-486.
- [19] N.W. Polsby (1984) *Political innovation in America*. New Haven: Yale University Press.
- [20] Such theoretical framework has a lot in common with the structural contingency theory of organisations first developed by P. R. Lawrence. & J.W. Lorsch (1967) *Organization and Environment: Managing Differentiation and Integration*. Cambridge: Harvard University Press.
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- [31] Just see the titles of the publications from UK Office of Science and Technology-DTI such as *Winning through Foresight*, etc.
- [32] H. Wolman (1992) "Understanding Cross National Policy Transfers: The Case of Britain and the US", in *Governance: An International Journal of Policy and Administration*, vol. 5, n. 2, pp. 27-45.
- [33] For a full description and analysis of the reforms in Science and Technology Policy in Spain, see: L. Sanz-Menéndez (1997) *Estado, ciencia y tecnología en España: 1939-1997*. Madrid: Alianza Universidad, 428 pp. In English see L. Sanz-Menéndez (1995) "Policy choices, institutional constraints and policy learning: The Spanish Science and Technology policy in the eighties", in *Int. J. of Technology Management*, Special Issue on the Evaluation of Research and Innovation, vol. 10, nos 4/5/6, pp. 622-641.
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policy: coordination and leadership”, in *Science and Public Policy* vol.20, n.6, December, pp. 370-380.

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[37] Under the umbrella of *Prospectiva Tecnológica*, a word that in Spanish has strong proximity with French concept *Prospective* (see for example, M. Godet (1985) *Propective et planification strategique*. Paris: Economica) and is associated to planning in which we can identify activities of different nature.

[38] However, no overall or systemic approach to Foresight was taken for general S&T policy, some sectoral RTD 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 disperse, always in a report form, of different stands: Foresight with a highly scientific content, developed from either a very institutionalised 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.

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[40] In fact, the organisational infrastructure created at the ANEP –a database of more that 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.

[41] IPTS (Report by P. Fleissner *et al.*) (1998) *Recent National Foresight Studies. A Review*. Seville: EC-JRC.

[42] There are also some regional level initiatives, which include a Foresight Programme in the Basque Country (northern region of Spain), and Strategic Technology Plans (RIS-RITTS). These initiatives are seriously associated to policy making, and involve a very broad “consultation” process with stakeholders in the regions.

[43] A. Rip, & B.J.R. van der Meulen (1996) “The post-modern research system”, in *Science and Public Policy* vol 23, nº 6, December, pp. 343-352.

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[48] As it have been said “gathering information and making decisions are signals and symbols of competence. The possession and exhibition of information symbolises (and demonstrate) the ability and legitimacy of decision makers” (J.G. March (1994) *A premier on decision making: How decisions happen*. New York: Free Press pp. 226).

[49] This is the approach of the project FORMAKIN that involves teams from Spain, The Netherlands and United Kingdom lead by L. Sanz-Menéndez, B. van der Meulen and A. Webster whom is acting as coordinator. Information on the project may be obtained at the web site <http://www.iesam.csic.es/proyecto/formakin.htm>.

[50] See for example D. Lane, F. Malerba, R. Maxfield and L. Orsenigo (1995) “Choice and Action”, Santa Fé Institute, working paper 95-01-004.

[51] See J. G. March (1973) “Model Bias in Social Action”, in *Review of Educational Research* vol. 42, pp. 413-429.

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