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# Foresight as a Driver of Innovation System Transformation

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Katharina de Melo

FHWien der WKW, Währinger Gürtel 97, 1180 Vienna, Austria  
E-mail: katharina.demelo@fh-wien.ac.at

**Abstract:** This paper develops a mechanism-based framework to analyse how participatory, policy-oriented foresight processes may generate impact in innovation systems. Rather than focusing on outputs or direct attribution, it conceptualises impact as emerging through underlying mechanisms at individual, group, and system level. Drawing on social constructivism and the systems of innovation perspective, the analysis highlights cognitive reframing and anticipatory learning at the individual level, collective sensemaking and trust formation at the group level, and processes of diffusion, network reconfiguration, and institutional adaptation at the system level. For each level, expected observable changes, plausible time horizons, and alternative explanations are specified. By linking mechanisms to indications of impact, the framework provides a structured basis for empirical investigation and contributes to greater conceptual clarity in understanding how foresight processes may influence innovation systems over time.

**Keywords:** Foresight; Innovation systems; Social constructivism; Learning; Social learning; Network formation; Innovation policy; Anticipatory governance; System transformation; Impact mechanisms

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## 1 Introduction

Innovation systems are characterised by conditions of high uncertainty, long time horizons, and systemic interdependencies between multiple actors. In such contexts, foresight processes are being employed as strategic instrument to support decision-making of policymakers and innovation managers. Since the 1990s, foresight processes have been adopted across Europe at organizational, regional, national, and supranational levels, often with a strong policy orientation. The literature on foresight impacts and the assessment of these impacts describes expected outcomes of foresight processes, functions of foresight processes as well as first conceptual approaches to connecting foresight processes to impact at different system levels.

However, there is still a lack of conceptual understanding of the mechanisms through which impact from foresight processes can be created in innovation systems. This is particularly relevant from an innovation management perspective, as foresight processes are frequently expected to justify public investment and guide innovation trajectories. While evaluations tend to focus on tangible outputs such as reports, scenarios, or policy recommendations, less visible effects such as learning, network formation, or changes in actor behaviour may be more decisive for long-term impact. Against this background, the paper addresses the challenge of linking foresight processes to impact on innovation

systems via learning, network building and behavioural change. It applies and extends the conceptual framework for analysing impact of foresight processes in research and innovation systems developed by Jarmai (2015). Rather than seeking to measure impact directly, it is the aim to conceptualize the mechanisms through which foresight processes may generate impact in innovation systems over time.

### *Previous approaches to assessing output and impact of foresight activities*

The literature recognizes foresight processes as future-oriented, participatory processes that combine analytical and prospective methods to explore possible futures and inform strategic action (Da Costa et al., 2008; Miles et al., 2008; Martin, 1995). Foresight processes are embedded in a socio-economic context and are both shaped by and shaping this contextual system. They can support decision-making by informing, facilitating, and counselling decision-makers (Schartinger and Weber, 2007; Havas et al., 2010). Expected outcomes of foresight processes include visions, roadmaps, and policy recommendations, as well as increased ownership of results, and increased cooperation between, and knowledge diffusion beyond, the foresight process participants. In line with broader innovation policy objectives, foresight is also expected to promote collaborative learning and strengthen links between organizations by connecting heterogeneous actors (Breschi and Malerba, 2009).

To structure the debate of how to measure the outcomes and impact of a foresight process, Georghiou (2001) distinguishes three generations of foresight evaluation. The first focused on prediction accuracy and diffusion of results, the second emphasized uptake in decision-making, and the third aimed to identify the emergence of a “foresight culture.” More recent approaches adopt a broader perspective. Calof and Smith (2012) distinguish between case studies, evaluation frameworks, and analyses of impact-enhancing factors. Similarly, Barré and Keenan (2008) differentiate between process quality and impact in terms of learning and strategic action. According to the conceptualisation by Schartinger and Weber (2007), impact of foresight processes unfolds over time – immediate, intermediate, and long-term – and across the three functions of informing, facilitating, and counselling decision-makers simultaneously. Case-specific as well as generic approaches highlight both the diversity of foresight impacts and the difficulty of capturing them systematically. Furthermore, evaluations tend to focus on observable outputs, while process-related outcomes such as learning, trust-building, and network formation remain under-theorized. Finally, long-term system-level effects are difficult to attribute due to time lags and multiple influencing factors. As a result, there is limited conceptual clarity regarding how foresight processes translate into observable change in innovation systems. This gap constrains both theoretical development and practical application. The conceptual framework of Jarmai (2015) aims to close this gap by applying social constructivism theory and connecting the features of participatory, policy oriented foresight processes to learning and networking effects at individual, group and system level.

Against this background, this paper aims to explore the concrete mechanisms through which participatory, policy-oriented foresight processes can influence actors, interactions, and long-term dynamics in innovation systems – and how and when these impacts can be analysed empirically.

## **2 Methodology**

The paper builds on the conceptual framework developed by Jarmai (2015) and extends it by specifying the mechanisms through which foresight processes may generate impact on innovation systems over time (section 4). The theoretical and conceptual analysis builds on the foresight literature and social learning theory as well as the systems of innovation perspective. This perspective is particularly suitable because it emphasizes interaction, communication, and shared meaning in shaping knowledge and social reality. Accordingly, a foresight activity is understood not as a predictive tool but as a process through which futures are socially constructed.

Building on this perspective, the paper explores mechanisms linking foresight processes to innovation system-level outcomes, highlighting how foresight processes can shape perceptions, relationships, and decision-making practices among actors. In line with existing approaches, the analysis distinguishes forms of impact according to their reach and time of appearance. For each level of impact – individual, group, system – core mechanisms, forms of expected observable change, plausible time horizons and alternative explanations/confounders are articulated.

## **3 Conceptualising foresight impact on actors and relationships**

Social constructivism theory, which focuses on how meaning is produced and applied through social interaction, provides a useful lens for analysing how foresight processes influence actors and relationships (Jarmai, 2015; Fuller and Loogma, 2009). Following the logic of social constructivism, social structures and dynamics emerge from interaction and interpretation (cf. Miebach, 2010). Actors assign meaning to “things” (i.e. objects as well as people, institutions, actions or values) through interaction, and these meanings guide behaviour.

Following this course of reasoning, interactions by participants in a foresight process can lead to a reproduction or an adaptation of existing social structures and dynamics. Both moderated and informal interactions during a foresight exercise define present and future challenges, visions and options for action. They can support the recognition of other stakeholders’ goals and perspectives and facilitate actors’ reflections on their own roles and perspectives.

To bridge the gap between social action and change at system level, it is necessary to connect interaction between individuals to system structures and dynamics. This can be achieved by analysing learning processes at individual, group and organisational levels as well as the formation/adaptation of relationships between individuals and groups. To provide a conceptual basis in this regard, the following sub-sections summarise key aspects of learning and network development at the different levels as presented in Jarmai (2015).

### *Learning at individual level*

From the perspective of social constructivism theory, learning at the level of an individual actor takes place in form of the active and subjective construction of knowledge (Miebach, 2010; Fuller and Loogma, 2009). It is understood as a process that takes place in a social context and is heavily influenced by an individual’s previous

knowledge. The constructivist perspective emphasizes the individual's active role in this process and postulates that cognition and knowledge always result from actions taken by a social actor. Factors including prior knowledge and frames of references shape the meaning attributed to an action.

To analyse the impact of foresight exercises, two aspects of interaction in terms of communication are particularly interesting: First, the constructive perspective on learning and interaction through communication allows the connection of present communication with (anticipated) future actions and thus enables the analysis of one central aspect of any foresight activity. Second, through this connection of past or present communication with (possible) future developments, the constructivist perspective attributes shaping power to the act of communication itself. Communication turns into a means of exerting influence on the communicating actors' environments (Leeuwis and Aarts, 2011). This influence can become observable in form of the creation of shared meaning, of altered relationships between actors, or in form of modified power relations. Learning at the individual level can therefore be understood as heavily influenced by the individual's previous knowledge and frames of reference. Furthermore, applying the concept of "cognitive dissonance" (Festinger, 1956), which describes feelings of threat or at least uncomfot when individuals cannot satisfactorily process new information within established patterns of thinking, individuals are more likely to adapt established patterns of thinking (i.e. learn) when dealing with an acute challenge, which they are unable to solve based on what they already know (Miebach, 2010). In other words, learning at individual level is more likely for those individuals who believe that they will benefit in the long run.

### *Learning at group level*

Following van Mierlo et al. (2010), learning at the group level can be described as the emergence of feelings of mutual involvement, joint responsibility, trust, competence, and interdependence. They result from the intense interactions within a group of people in a temporary setting, such as constituted by a foresight activity. Social learning theory explains how actors develop complementary goals, insights, and interests in the course of their interaction (Leeuwis, 2004).

Learning at group level can develop in several ways. One important aspect is the development of shared meaning and mutual understanding. In order to interact in a meaningful way, participants of a foresight activity must create a common reality (Siebert, 1998), which is achieved through efforts to understand each other's perspectives. Due to the interaction of heterogeneous actors from different stakeholder groups, organizational backgrounds, or regions, new shared meaning about present developments and possible futures can emerge. Another way in which learning develops is through the formation of trustful relationships. The creation of shared meaning and mutual understanding, as well as an increased awareness of interdependencies between actors and behaviours, is conducive to building trust within the group (Sydow and Windeler, 2000). Finally, learning at the group level can be fostered through the experience of difference. Participatory foresight activities aim to bring together a variety of actors representing different organizations, regions, sectors, and cultures, each contributing their own specific prior knowledge. Recognizing that others may make different observations, draw different conclusions, or identify additional possibilities can stimulate a reflexive and self-critical form of learning (Bateson, 1972).

### *Change at system level*

Change at the system level can be understood as the ultimate goal of a foresight activity. For such change of patterns and relationships to take place, knowledge created at individual or group level during the foresight activity must be translated into (adapted) communication and behaviour of actors in the innovation system. Berger and Luckmann's (1966) sociology of knowledge can be applied to bridge this gap between (social) learning and social structure. It focuses on the question of how subjective sense can become intersubjectively shared meaning and preserve or adapt existing social structure or lead to the emergence of new social structure.

One way of triggering system learning leads through the foresight participants' home organisations; i.e. the organizations that were being represented by the respective participants and that the participants "returns to" after the foresight process ends. The individual participant of the foresight process takes on the role of potential transmitter between the foresight process and his or her home organization. During the foresight process, they experience individual and group learning processes. When returning to their respective home organizations after the end of the foresight process, these individuals may exert influence on their home organizations by translating this new knowledge either through the dissemination of information or through showing adapted behaviour. The extensive body of knowledge on organizational learning offers additional insights regarding such translation processes. In the case of knowledge from foresight processes, the knowledge qualifies as knowledge created, rooted, and regarded as valid in a context other than the context in which it is used (Wittke et al., 2012). Organisations are therefore faced with the challenge of re-contextualizing the externally created knowledge if they wish to integrate it in their organizational reality.

Another form of change in an innovation system can be created by means of new or adapted networks between individuals, organizations or clusters. Furthermore, connections between existing networks and formation of new ones are frequently desired secondary effects of foresight processes. Participatory foresight processes aim to aid network building by including methods of moderated and private interaction between stakeholders (Havas et al., 2010; Amanatidou and Guy, 2008; Da Costa et al., 2008). In the ideal case, the temporary foresight system becomes a starting point for networks, which keep on developing after the foresight process has come to an end. We can differentiate between new links between similar actors, new links between different actors, and improved quality of existing relationships. Lundvall (1985) argues that increases in quantity as well as in quality of linkages between actors in an innovation system are likely to improve the efficiency of innovation activities. Networks are generally assumed to aid development of creative ideas by combining complementary knowledge of heterogeneous actors. Another factor of networks concerns their ability to facilitate collective action and coordination of tasks. Both effects are mutually reinforcing: as information can provide actors with new opportunities, cooperative behaviour may become necessary to explore these opportunities. Since innovation processes depend on experimentation, constant adaptation, and learning from experience, research and innovation systems will profit from all kinds of diversification. This includes new entrants, different types of technologies and applications as well as new perspectives and knowledge (cf. Bergek et al., 2008).

Finally, innovation governance must address the inherent uncertainty in these processes, with policymakers increasingly expected to manage gaps in knowledge.

According to Smits and Kuhlmann (2004), uncertainty can be reduced either by providing information or by creating instruments and environments that enable experimentation and learning, with growing emphasis on participatory and communicative approaches. Foresight processes exemplify such approaches by engaging diverse stakeholders – across organizations, regions, sectors, and cultures – in interactive settings that foster knowledge exchange, and collaboration. By strengthening linkages between knowledge producers, funders, and users, and by building a shared knowledge base, these processes can enhance system efficiency and mutual understanding of different actors’ perspectives and motivations. As platforms for learning and networking, foresight processes facilitate the exchange of ideas about future developments and support coordinated action toward common goals; ultimately helping to reduce uncertainty in the innovation system.

#### **4 Core mechanisms and indications of impact**

Building on the conceptualisation of learning and interaction processes outlined in chapter 3, this chapter specifies the core mechanisms through which participatory foresight processes may generate impact at individual, group, and system level. For each level, the analysis distinguishes (a) the underlying mechanism, (b) expected observable changes, (c) plausible time horizons, and (d) alternative explanations or confounding factors. This mechanism-based approach follows a contribution logic rather than assuming direct attribution, acknowledging the complexity and multi-causality of change in innovation systems.

##### *Individual level: cognitive reframing and anticipatory learning*

At the individual level, the central mechanism is cognitive reframing through exposure to diverse perspectives and anticipatory knowledge. As argued from a social constructivist perspective, individuals actively construct meaning based on prior knowledge, expectations, and interaction with others. Foresight processes introduce new information, alternative interpretations, and future-oriented narratives, which may challenge existing frames of reference and trigger learning processes.

Expected observable changes at the level of individual actors include:

- Shifts in problem framing or interpretation of key issues;
- Increased awareness of long-term dynamics and uncertainties;
- Increased awareness of interdependencies within the system;
- Changes in expectations about future developments;
- Reported moments of cognitive dissonance and resolution / moments of surprise;
- Altered individual decision-making heuristics or strategic orientation.

Observable changes may become apparent immediately during or shortly after the foresight process, with potential medium-term effects if learning translates into sustained behavioural change. Alternative explanations and possible confounding factors at the

individual level may include exposure to similar knowledge or debates prior to the foresight process, which could independently shape participants' perspectives, as well as parallel learning processes, e.g. within the individual's organization, that influence cognition and behaviour beyond the foresight activity. In addition, personal career incentives or participation in external training programmes may affect how individuals engage with and apply new insights. Finally, selective perception due to strong pre-existing beliefs may lead individuals to filter incoming information, thereby reinforcing existing frames of reference rather than enabling substantive learning (see also chapter 3).

#### *Group level: collective sensemaking and trust formation*

At the group level, the key mechanism is collective sensemaking through structured interaction, leading to the emergence of shared meaning and relational change. Through dialogue and exposure to heterogeneous perspectives, participants co-create interpretations of present challenges and possible futures. This process is closely linked to the development of trust and mutual understanding within the group of participants.

Expected observable changes at group level include:

- Alignment of problem definitions and priorities;
- Development of shared visions and narratives;
- Increased mutual understanding of roles, interests, and interdependencies;
- Emergence or strengthening of trust among participants;
- Formation of new relationships or intensification of existing ties.

Such observable changes may become apparent during or immediately after the foresight process. Effects concerning the formation of new relationships or intensification of existing ties can persist beyond the formal duration of the foresight activity. Alternative explanations and confounding factors at the group level include pre-existing relationships or networks among participants, which already provide a certain level of mutual understanding and trust, independent of the foresight process itself. Importantly, the quality of facilitation and overall process design is likely to significantly shape outcomes in terms of relationships and may outweigh the influence of the foresight content per se. External collaboration incentives, such as funding schemes or policy programmes, can further encourage cooperation and alignment among actors.

#### *System level: diffusion, network reconfiguration, and institutional adaptation*

At the system level, impact emerges through the translation and diffusion of learning and relational changes into organizational practices, networks, and institutional structures. Individual participants act as intermediaries who transfer knowledge and perspectives into their home organizations, while newly formed or strengthened relationships contribute to broader network dynamics. Over time, these processes may influence agendas, routines, and governance structures within the innovation system.

Expected observable changes at system level include:

- Traceable incorporation of foresight outputs or narratives into policy documents, strategies, or organizational practices;
- Shifts in dominant discourses;
- Emergence of new collaborations, partnerships, or cross-sectoral initiatives;
- Changes in network structure (e.g. increased density, new bridging ties);
- Establishment of follow-up activities.

Such observable changes may take several years to unfold, due to the time needed for translation and institutional embedding. Alternative explanations and possible confounding factors at the system level include concurrent policy reforms or external shocks, such as crises or technological breakthroughs, which could significantly influence innovation dynamics independently of the foresight process. Similarly, funding programmes or regulatory changes can shape actor behaviour and collaboration patterns across the system. Broader socio-economic trends may also redirect innovation priorities and agendas over time.

## 5 Discussion

The conceptual framework presented in this paper can be used to empirically investigate the impact of participatory, policy-oriented foresight processes. As argued in section 4, impact at the individual as well as at the group level can become apparent during and immediately after a foresight exercise, while impact at the system level may take several years to manifest.

### *Empirical investigation of core mechanisms*

At individual level, shifts in problem framing or interpretation of key issues, increased awareness of long-term dynamics, uncertainties and interdependencies within the system, changes in expectations about future developments, moments of cognitive dissonance and surprise as well as altered individual decision-making heuristics or strategic orientation can all, for example, be explored through semi-structured interviews with foresight participants shortly after their participation<sup>1</sup> in a foresight process. As described in Jarmai (2015), interviews should focus on interview partners' memories and perceptions and include inquiries about motivation to participate in the foresight process and prior expectations as well as about novel and surprising information about contents or other participants. A (multiple) case study approach can be employed to collect information about single cases (single-case analysis) as well as across comparable cases (cross-case analysis). Information collected in semi-structured interview can be triangulated e.g., with information gathered in documentation about the foresight process itself or through interviews with organizers or facilitators of the foresight process.

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<sup>1</sup> If possible, interview partners could also be interviewed before their participation in the foresight process, to compare assessments before and after their participation, ask about their motivation and expectations in "real time" and not only rely on their memories and perceptions.

At the group level, alignment of problem definitions and priorities, development of shared visions, narratives and increased mutual understanding of roles, interests, and interdependencies and emergence or strengthening of trust among participants are best observed through participatory observations during the foresight process (cf. Schartinger et al., 2011); optionally in combination with semi-structured interviews conducted shortly after the conclusion of the foresight process. Information can again be triangulated with information gathered in documentation about the foresight process itself or through interviews with organizers or facilitators of the foresight process. Data about the formation of new relationships or intensification of existing ties can, for example, be collected via questionnaires inquiring about the levels of acquaintance to all participants of the foresight process (or a particular activity) and analysed to map out networks before and after the respective intervention (ibid.).

Analysis at the system level can, for example, focus on influence on participants' home organizations or on influence on policies, organizational strategies and actions within the innovation system. To empirically analyse the former, one might apply the conceptual lens provided by heuristics of change processes in organizations and develop (multiple) case studies on different types of organizations (e.g., for-profit, non-profit, public); to identify generic as well as variable enabling and obstructing factors for the translation of knowledge from a foresight process. To empirically analyse the latter, one could, for example, set up a broadly based survey of decision-makers in an innovation system and inquire about their basis for decision-making, without ex-ante mentioning any foresight processes. Another possibly approach could make use of tools to analyse large amounts of data and set up a computer-supported search for results of foresight processes in policy and strategy documents within an innovation system.

### *Implications for management practice*

From an innovation management perspective, the framework suggests that the value of foresight processes lies not only in their tangible outputs, but in their capacity to shape cognition, relationships, and decision-making practices over time. For companies, this implies moving beyond treating foresight as a purely analytical input toward understanding it as a process-based intervention. From the perspective of a company, participation in foresight processes can support cognitive reframing and anticipatory learning by exposing actors to diverse perspectives and systemic interdependencies. As foresight knowledge qualifies as externally generated knowledge, it requires re-contextualization within the organization after the end of the foresight process.

In addition, foresight processes provide opportunities for network building and strategic positioning within innovation systems. Innovation managers can use participation to establish and strengthen relationships with less well-known actors of the innovation system. At the same time, foresight outputs can inform strategic decision-making under uncertainty by structuring thinking about alternative futures and enabling the testing of strategic options across different scenarios. In this way, foresight can strengthen an organisation's capacity to deal with uncertainty and strategically position itself in the innovation system.

## 6 Conclusions

The paper contributes to innovation management discourse by developing a conceptual framework that explains how participatory, policy-oriented foresight processes can generate impact in research and innovation systems. Grounded in social constructivism and the systems of innovation perspective, it shifts attention from linear cause-effect models toward a relational and process-oriented understanding of innovation, consistent with views of innovation systems as dynamic, socially embedded, and path-dependent.

A central finding is that foresight impacts innovation systems through process-related mechanisms at individual, group, and system levels. At the individual level, participation facilitates learning by exposing actors to alternative perspectives and long-term dynamics, thereby influencing interpretation and decision-making. At the group level, foresight enables collective sensemaking, supporting the development of shared understandings, alignment of expectations, and coordination across heterogeneous actors. At the system level, foresight contributes to gradual structural change through the diffusion of insights, network reconfiguration, and shifts in policy agendas, institutional routines, and dominant narratives. These effects are indirect, cumulative, and unfold over extended time horizons.

The framework highlights the importance of considering both process and product outputs and provides a basis for future empirical research on foresight impact, particularly regarding learning processes, network dynamics, and long-term institutional change. By explicitly distinguishing between foresight outputs and system-level impact, it advances conceptual clarity around non-linear, process-based mechanisms that are often underrepresented in innovation management research. In doing so, it redirects attention from product-centric impact claims to relational and process-oriented pathways that are more plausible in complex, long-horizon innovation systems.

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