

# Evidence & Policy

## A model of the temporal dynamics of knowledge brokerage in sustainable development --Manuscript Draft--

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<b>Abstract:</b>	I develop a conceptual model of the temporal dynamics of knowledge brokerage for sustainable development. Brokerage refers to efforts to make research and policy making more accessible to each other. The model enables unbiased and systematic consideration of knowledge brokerage as part of policy evolution. The model is theoretically grounded in earlier work on policy evolution, knowledge brokerage and the temporal characteristics of late-modern society. It outlines a dynamic process of cyclic destruction and emergence of brokerage. The case of brokerage for sustainable development in the European Commission illustrates the potential empirical application of the model.	
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## 1 Background and previous work in the area

Knowledge brokerage refers to efforts to make research and policy making more accessible to each other with various mechanisms of knowledge sharing and transfer (Meyer, 2010; Michaels, 2009; Sheate and Partidário, 2010; Turnhout et al., 2013; Ward et al., 2009). Earlier research has categorized knowledge brokerage on the basis of suitability for decision making (Michaels, 2009; Ward et al., 2009) or relationship between knowledge production and use (Turnhout et al., 2013). A blind spot in this work, however, is timing – a crucial issue for the practicing policy maker (Owens et al., 2006; Pawson, 2002a; 2002b). To improve timing, it is necessary to understand how brokerage relates to the evolution of policy over time. In this paper I ask: What is the role of different types of knowledge brokerage in the temporal dynamics of sustainable development policy?

Bad timing in knowledge brokerage can lead to awkward situations. I learned this as a member of the European Commission's 7<sup>th</sup> Framework Programme Advisory Group for Environment (especially Climate) during 2008-2012. The group's mandate was to provide strategic advice to the Commission on scientific and technological priorities within the environment and climate theme, including emerging and unforeseen policy needs. In February 2009, in the aftermath of the global financial crisis, the group's members received an intensive debriefing from Commission officials, followed by a request to brainstorm how EU research during 2010 might contribute to Europe's economic recovery – urgently. The Advisory Group responded after a 2-day brainstorming session in Brussels: "Since future financial and environmental crises are inevitable, research to support the design of future recovery packages should begin now" (Depledge et al., 2009: 21). This was a polite way of stating the obvious: research calls to be announced a year from now can do little to alleviate the present economic crisis.

The policy maker who needs to act now may perceive scientifically relevant knowledge to be irrelevant and to emerge too slowly. Yet the existence of common ground between science and policy is well known. Efforts to conduct socially robust and relevant transdisciplinary research at the interface of science and society have been termed Mode 2 –science (Gibbons et al., 1994) and post-normal science (Funtowicz and Ravetz, 1991). Sheila Jasanoff calls such activity co-production of serviceable truths by researchers, policy makers and stakeholders (Jasanoff, 1990). Andrew Jamison puts the issue in terms of expertise and characterizes individuals interfacing between science and policy as "hybrids" capable of intellectual engagement (Jamison, 2001). The existence of intellectually oriented policy makers and policy oriented researchers is a prerequisite for successful science-policy links.

At the most general level, knowledge brokerage is about making research and practice more accessible to each other (Ward et al., 2009). Knowledge brokers are "people or organizations that move knowledge around and create connections between researchers and their various audiences" (Meyer, 2010: 118). Brokerage has become a strong driver of sustainability discourses as well (Sheate and Partidário, 2010). According to Michaels (2009: 995), the role of brokerage in environmental policy is "to enable decision makers to acquire, value and consider expertise that they would not otherwise obtain or incorporate into their decision making."

Although the temporal conflict between science and policy has been recognized in earlier research on brokerage (see e.g. Owens et al., 2006) and evidence-based policy (Pawson, 2002a; 2002b), it has not been investigated in detail. Instead, to explain the interaction of science and policy in general, researchers have focused on the nature of scientific evidence, the politics of policy making,

the operation of power in the policy process (Juntti et al., 2009), and the supply of knowledge produced by science and its demand within policy (Sarewitz and Pielke, 2007). Those who have focused specifically on knowledge brokerage have developed techniques (Meyer, 2010; Sheate and Partidário, 2010) and typologies (Michaels, 2009; Turnhout et al., 2013; Ward et al., 2009) for brokerage, and matched different types of brokerage with different policy issues and settings (Michaels, 2009). Time, however, has remained in the background.

The objective of this paper is to develop a theoretically grounded conceptual model for understanding the temporal dynamics of the interaction between research and policy. The model would bring realism to the expectations of researchers and policy makers concerning the potential of knowledge brokerage to influence policy and alleviate the tensions between agendas and time frames. I will highlight the key concepts of the model with a critical review of the European Commission's ability to deal with sustainability crises, such as the financial crisis of 2008. The episode between the Commission and the Advisory Group during the financial crisis can be summarized in two key deficiencies in science-policy interaction: a failure to recover from unexpected and unwanted policy disintegration, and a failure to trigger major positive policy transformations in anticipation of the coming crisis. I first develop a hypothetical model of the temporal dynamics of knowledge brokerage and describe the case data on brokerage in sustainable development within the Commission's research administration (Section 2). I then illustrate the potential usefulness of the model with the data, diagnose the observed problems and propose remedies to them (Section 3). Finally, I summarize the key findings and discuss the strengths, weaknesses and applicability of the model (Section 4).

## **2 Data and methods**

### **2.1 Research approach**

To ensure clarity of exposition, I will present the development of the model of the temporal dynamics of knowledge brokerage as an inductive exercise. In other words, the model is presented as a hypothesis synthesized from existing theories to explain the observed knowledge brokerage in sustainable development within the European Commission. In reality, however, the research approach followed an abductive logic. The brokerage observed in the European Commission is explained with a model that appeared as a viable explanation on the basis of both the observed empirical evidence and existing theories, but the model is accepted as only one possible, and thus tentative, explanation. Additional justification for abducting the model from the single case of brokerage in the Commission comes from the fact that EU research policy has consistently over the years been guided by the goal of making science relevant for tackling societal challenges. Brokerage in the Commission can thus be considered a reasonable candidate for a paradigmatic case of science-policy brokerage, i.e., a case that is likely to have metaphorical and prototypical value for understanding the issue at hand (Flyvbjerg, 2001: 79-81).

The abductive process followed what Alasuutari (1996) has termed the hourglass model of the case research process, which starts with a broad theoretical framework that places the case in a larger context and validates the choice of the case, continues by analysing in detail the case as a world of its own, and finally assesses the results of the case study in a broader and transformed theoretical framework. Following the hourglass model, I started out by considering the request by the European Commission to study their brokerage activities in the field of sustainable development in a larger context. It was clear that the Commission's activities were not just any case but rather a paradigmatic case of knowledge brokerage, given the influential role of European Commission's science policy and its tendency to emphasize the importance of science-policy interaction in virtually all of its

research funding. I then continued by analysing the Commission's brokerage in sustainable development, as detailed in Section 2.3. In the analysis, the written and oral interviews were treated as sources of expert perception of the problems of brokerage and solutions to them. Finally, I assessed the results of the study by elaborating the original theoretical approaches to brokerage on the basis of the empirical findings. The transformations of the model of the temporal dynamics of brokerage during the research process are evident in the different stages of documentation of the research results. The first version of the model is apparent in the unpublished report submitted to the Commission in December 2009 (Hukkinen, 2009). Since then the model has undergone several revisions, culminating in the present article, in a thought process that has strived to make sense of expert perceptions of the problems and solutions of brokerage.

## 2.2 Model of the temporal dynamics of knowledge brokerage

To better understand the temporal connections between research and policy in sustainable development, a model of the temporal dynamics of knowledge brokerage is needed. I will hypothesize here such a model by integrating Baumgartner and Jones's (1991) theory of policy evolution, Adam's (1998) theory of timescapes, and recent theorizations of knowledge brokerage (Meyer, 2010; Michaels, 2009; Sheate and Partidário, 2010; Turnhout et al., 2013; Ward et al., 2009). I begin this integrative work by treating brokerage as a key component of policy evolution. I therefore adopt the overall structure of the theory of policy evolution as a template for describing the temporal evolution of brokerage. I then identify different types of brokerage with terminology borrowed from theories of knowledge brokerage; specify the temporal aspects of brokerage with concepts borrowed from the theory of timescapes; and introduce new concepts with which to facilitate the visual presentation of the temporal characteristics of brokerage.

The flow of thought underlying the model of the temporal dynamics of brokerage is as follows. Policies have been shown to undergo periods of extreme stability and short bursts of rapid change as a result of a feedback between policy *image*, or the beliefs and values concerning a policy, and policy *venues*, or the political institutions in which policy action takes place (Baumgartner and Jones, 1991). Since knowledge is a key factor underlying the shaping of beliefs and values (Stern et al., 1999), knowledge brokerage – or the effort to make research and policy more accessible to each other (Ward et al., 2009) – can be understood as a special form of the feedback between policy image and policy venues. The temporal dynamics of knowledge brokerage are therefore likely to follow the broad pattern of policy evolution, undergoing stages of rapid destruction and longer term stability. I will next go through the details of how I transformed the theory of policy evolution into a model of the temporal dynamics of knowledge brokerage.

Baumgartner and Jones (1991) summarize their theory of policy evolution in four proposals: (1) When policy issues have been assigned to policy subsystems, increasing attention to a policy issue is related to an increasingly negative policy image. (2) The policy venues most susceptible to the changing policy image change first, with other venues accepting the issue on their respective agendas sequentially. (3) Venue expansion and image change occur quickly and simultaneously in a feedback. (4) The creation of a policy subsystem takes place when there is high positive attention and little participation in single policy venue, while the destruction of a subsystem takes place with high negative attention and shifts in venues. Baumgartner and Jones (1991, 2009) base the theory on long-term data on the evolution of the U.S. nuclear industry and other policy fields.

I argue that knowledge brokerage takes the center stage in policy evolution. The key driver of change in the theory of policy evolution is the feedback between policy image and policy venue. In many contemporary policy issues characterized by intensive knowledge production and demand,

this feedback *is* knowledge brokerage. On one hand, specific venues have been established to handle the interaction between research and policy. On the other hand, image, or the set of beliefs and values underlying a policy issue, is underpinned by research-based knowledge concerning the mechanisms that threaten the values and the actions with which to alleviate the threats, as proposed by the value-norm-belief theory of environmental concern (Stern et al., 1999). Baumgartner and Jones (2009: 289) themselves emphasize that “disruptive dynamics are a function of how political systems process information.” That there are other factors as well underpinning beliefs and values does not diminish the crucial role of knowledge. It therefore makes sense to consider knowledge brokerage as a key feedback driving policy evolution.

I am now in a position to reformulate the Baumgartner and Jones (1991) theory of policy evolution from the perspective of a key component of the evolution, namely, knowledge brokerage. In the reformulation, the term “policy” in the theory of policy evolution is replaced with “brokerage” to signify the subset of policy evolution that is underpinned by research-based knowledge. Brokerage takes place as a feedback between brokerage image, or the substantial areas of brokerage that contribute to beliefs and values, and brokerage venue, or the institutional arrangements of brokerage. The result is a verbal description of the *model of the temporal dynamics of knowledge brokerage*:

- (1) When brokerage issues have been assigned to brokerage subsystems (such as sustainable development), increasing research attention on brokerage issue is related to an increasingly negative brokerage image. Brokerage issue refers to those aspects of a policy that are underpinned by research-based knowledge, and brokerage image to the beliefs and values supported by brokerage. Thus, increasing research attention on an issue also increases the likelihood of studies that are critical of the predominant beliefs and values.
- (2) Brokerage venues change sequentially in an order of decreasing susceptibility to changing image. Brokerage venue refers to the institutional arrangements of brokerage. Thus, venues with the least resistance to a change in image are likely to change first.
- (3) Venue expansion and image change occur quickly and simultaneously in a brokerage feedback.
- (4) New brokerage subsystem emerges under high positive research attention with little participation in single brokerage venue; brokerage subsystem is destroyed under high negative (critical) research attention in shifting brokerage venues.

Put concisely, the model outlines a dynamic process of cyclic destruction and emergence of brokerage subsystems. The destruction phase begins when brokerage with heterogeneous image progresses from one venue to another in rapid sequence, climaxing in brokerage with heterogeneous image taking place simultaneously in several venues. The stabilization phase begins when brokerage venues with heterogeneous image disappear sequentially one after the other, climaxing in brokerage with homogeneous image taking place in only a few venues. This cyclic evolution can be visualized by teasing out the key variables from the four stages of the verbal description of the model. These variables are the patchiness of brokerage, the speed of brokerage sequence, and the intensity of brokerage (Figure 1).

[INSERT FIGURE 1 HERE]

*Patchiness of brokerage* measures the institutional and substantial dispersion of science-policy interaction: when brokerage has low patchiness, it is homogeneous in terms of substance and takes

place in only a few institutional venues; when brokerage has high patchiness, it covers heterogeneous policy fields and multiple institutional venues. Patchiness of brokerage thus conflates the two key notions of the verbal description of the model of the temporal dynamics of knowledge brokerage, namely, image (i.e., the substantial areas of brokerage) and venue (i.e., the institutional arrangements within which brokerage takes place). I have borrowed the term from ecology, where habitats can spatially range from continuous to patchy to isolated. In a patchy habitat, areas with favourable and unfavourable conditions for organisms are interspersed (Begon et al., 1990: 486). Analogously, brokerage venues are like areas in a patchy habitat and brokerage image stands for the conditions in an area. Following the logic of statement 4 of the verbal description of the model, brokerage can range from one with homogeneous image and single venue (low patchiness) to one with heterogeneous image and multiple venues (high patchiness). A simple arithmetic indicator of patchiness would be the number of brokerage topics multiplied by the number of brokerage venues (Figure 1).

*Speed of brokerage sequence* measures the “clock speed” of science-policy interaction: when high in speed, brokerage activities have a short time frame and take place in rapid sequence one after the other; when slow in speed, brokerage activities have a long time frame and take place largely simultaneously. Time frame refers to the characteristic durations of activities and processes, while sequence refers to the ordering of activities in time, such that no sequence means simultaneity (Adam, 1998, 2000, 2004). Speed of brokerage sequence follows the logic of the verbal description of the model, according to which brokerage ranges from one with a rapid sequence and a short time frame in the destruction phase to simultaneous brokerage with a long time frame in the stabilization phase (statements 3 and 4). Since sequence speed is directly proportional to the number of brokerage activities and inversely proportional to the time frame of a brokerage activity, a simple arithmetic indicator for the sequence speed would be the number of brokerage activities in a given time period divided by the duration of a single brokerage activity (Figure 1).

Finally, *intensity of brokerage* measures the degree of integration in science-policy interaction: when low in intensity, brokerage consists of supplying knowledge users with relevant expertise; when high in intensity, brokerage involves the tight institutional integration of knowledge production and use (Michaels, 2009; Turnhout et al., 2013; Ward et al., 2009). Michaels (2009) has developed a classification of brokerage strategies in environmental policy that is useful for measuring the intensity of brokerage. The strategies are – in an order of increasing intensity of relationship building and resource commitment – informing and consulting, matchmaking, engaging, collaborating, and capacity building (Figure 2).

[INSERT FIGURE 2 HERE]

*Informing* aims to disseminate content, whereas *consulting* recruits expert advice on the problem identified by the client. *Matchmaking* identifies the expertise needed, its providers and the best ways to make the connections. In *engaging*, one party frames the discussion according to the terms of reference and involves other parties as needed. In *collaboration*, parties frame the process of interaction together and negotiate substance on a distinct policy problem. In *capacity building*, parties jointly frame the process of interaction and negotiate substance with the intention of addressing multiple dimensions of a policy problem and considering its broader implications (Michaels, 2009: 997-999). Ward et al. (2009) present a classification of knowledge brokerage that is essentially the same as that of Michaels but simpler: information management (corresponding to informing and consulting in the Michaels scheme), linkage and exchange (corresponding to matchmaking, engaging and collaboration) and capacity development (corresponding to capacity building). The classification by Turnhout et al. (2013) into supplying, bridging and facilitating is

closely related but highlights the repertoires of knowledge brokering – that is, differences in the relation between knowledge production and use and the activities of knowledge brokers.

To sum up, Figure 1 presents a simplified graphical version of the model of the temporal dynamics of knowledge brokerage. The graphical form is borrowed from the adaptive cycle of systems ecology (Holling, 2004), but its variables are obviously different. As a key component of policy evolution, knowledge brokerage is hypothesized to undergo cyclic change between destruction and stability. The destruction phase begins with patchy low-intensity brokerage taking place in rapid sequence and is completed when brokerage becomes simultaneous. Stabilization begins when the patchy low-intensity brokerage activities disappear sequentially one by one and consolidate in a few high-intensity activities. During stability, high-intensity brokerage takes place in only a few venues simultaneously (Figure 1). I will next present data from the European Commission's research administration with which I illustrate the use of the model in Section 3.

### **2.3 Knowledge brokerage in the European Commission's research administration**

In the fall of 2009 I had an opportunity to consider the intricacies of knowledge brokerage in the European Commission's research administration when the Directorate General (DG) for Research asked me to investigate science-policy links within DG Research in the sustainable development work that they funded under the 7<sup>th</sup> Framework Programme (FP). DG Research officials justified the need for a study with a dilemma they had observed in their policy work between conflicting agendas and time frames. Conflicting agendas arise because scientifically relevant knowledge is not necessarily relevant for policy making, while policy relevant topics are often scientifically uninteresting (see also Lightowler and Knight, 2013; Sebba, 2013). Conflicting time frames arise when the policy maker needs to make decisions immediately while the researcher thinks in terms of several years. The temporal conflict encompasses the agenda conflict: probing the unknowns of science usually takes time, while solving the known problems of policy usually demands decisions sooner rather than later (Pawson, 2002a; 2002b). The Commission's 7<sup>th</sup> FP offered ideal empirical material for considering knowledge brokerage, because it was fundamentally a brokerage programme with its aims to "enhance research and innovation capacity" by funding "frontier research" on science and technology, and facilitating "cooperation between universities, industry, research centres and public authorities" (Commission, 2005).

The request to study brokerage within DG Research came against a backdrop of considerable earlier efforts within the EU to link science with policy. In recognition of the untapped potential to put research into policy practice, the EU Sustainable Development Strategy of 2006 called for bridging the gap between science, policy-making and implementation (Council of the European Union, 2006). An effort to streamline the links between science and policy within the EU system followed. Whereas the 6<sup>th</sup> FP had separate activities on scientific support to policy, the 7<sup>th</sup> FP discontinued them and introduced the concept of mainstreaming the science-policy interface. An expert report to the Commission used the concept of brokerage to recommend a wide range of measures for enhancing links between research results and policy making (Georghiou et al., 2009).

In my work for the DG Research I asked the following broad questions: How are science-policy links dealt with in DG Research? What are the experiences from the activities? How can they be improved? The questions were developed in collaboration with senior officials from the DG Research/Directorate I Environment/Sustainable Development (Dir I/SD) who commissioned the study. The questions were not theoretically driven but rather arose from the policy concerns of the Dir I/SD officials. Development of solutions to the observed issues however initiated the theoretical

considerations presented in this article. Responses to the questions were obtained in writing and in oral interviews:

(1) Written responses to a letter sent on 15 May 2009 by Dir I/SD officials to the other directorates within DG Research, with the request to explain (a) how their 7<sup>th</sup> FP Work Programmes have attempted to bridge the gap between science and policy, (b) what other means they have used to address the gap and (c) how they have addressed the gap with contacts to relevant policy DGs. Of the 8 directorates approached, 7 responded (D international cooperation, F health, G industrial technologies, H transport, J nuclear energy, K non-nuclear energy, L social sciences and humanities). The responses came in the form of letters signed by the heads of directorates, who based their answers on the Commission's normal procedure in internal information requests such as this by consulting the responsible mid-level officials in the respective directorates.

(2) Interviews organized during 14-15 September 2009 with the help of Dir I/SD with personnel from 8 key DG Research Directorates (E biotechnologies and agriculture, F health, G industrial technologies, H transport, I environment, J nuclear energy, K non-nuclear energy, L social sciences and humanities) on (a) whether they think there is an untapped potential of policy relevant research in policy-making, (b) how they see the main differences between 6<sup>th</sup> FP scientific support for policy measures and 7<sup>th</sup> FP mainstreaming activities and (c) how they handle links with the relevant policy DGs. Five of the 8 interviews were conducted as a group interview with 2 senior officials from the directorate; three interviews were with just one senior official. Two senior officials from Dir I/SD responsible for commissioning the study were present in all interviews. I took written notes during the interviews and distributed a draft of the final report (Hukkinen, 2009) for comments among the interviewees.

The responses given to the written questions and the oral interview questions were analysed by structuring the text in each response letter and each set of interview notes as a problem solving heuristic: 1. description of existing science-policy interaction, 2. evaluation of experiences from the interaction, 3. recommendations for improving the interaction. The responses were thus treated as expert diagnoses of the relevant facts of the situation (in stage 1. of the heuristic) and as expert evaluations of the necessary steps to a desirable future state (in stages 2. and 3. of the heuristic). Structuring the responses in terms of a diagnostic-evaluative heuristic yielded a set of rich descriptions of the dynamics of various knowledge brokerage activities within the Commission.

In this article, I use the case of science-policy links in DG Research in the field of sustainable development to illustrate the potential use of the model of knowledge brokerage. Given the considerable influence that the Commission with its 7<sup>th</sup> FP wielded on the topics and resources of knowledge brokerage in member states, this was a paradigmatic case of knowledge brokerage (Flyvbjerg, 2001: 79). Since I draw only on a small number of interviews with evaluative reflections by the Commission's research officials, the data is not used to validate the model. Instead, the information is used to refine the theoretically derived variables of the model and to illustrate the potential empirical application of the model in future.

### **3 Findings**

#### **3.1 Modalities of brokerage between research and policy in European Commission's DG Research**

The written and oral responses from officials in DG Research Directorates revealed a diverse set of structural and procedural arrangements facilitating the science-policy interface in sustainable

development within the Commission. The arrangements can be classified in an order of increasing intensity into the brokerage strategies identified by Michaels (2009) (Table 1). I describe each brokerage strategy in terms of the variables of the hypothesized model of brokerage dynamics. This enables me to illustrate the application of the model by placing each brokerage strategy in the graphical formulation of the conceptual model presented in Figure 1.

[INSERT TABLE 1 HERE]

*Informing and consulting* activities within DG Research took the form of organizational practices that aim to mainstream the linkages between science and policy (Table 1). As one DG Research official put it: “I’m on the phone with the policy DGs every day.” Even more significant are direct contacts between policy makers in policy DGs and coordinators of EU-funded research projects. While some interviewees were more than happy about such contacts “because they are good for policy,” others felt that the DG Research directorates were bypassed in the policy cycle and the policy DGs did not get the best policy-relevant information through such direct contacts. Direct contacts have been facilitated with policy briefings between project coordinators and policy makers to discuss research project results. Some interviewees felt that the EU Joint Research Centre system is an organizational instrument that could be used more in brokerage. In addition to the day-to-day organizational practices, impact assessments and evaluations conducted *ex ante*, *ex post* and during projects are a key method for incorporating research-based knowledge in policy-making within the Commission. Often the evaluations are collaborations between DG Research and the policy DGs. The interviewees mentioned valuation studies of environmental externalities, environmental indicator development and foresight studies as further examples of successful brokerage, because they are “crucial for having policy impact”. Finally, workshops, seminars and conferences bringing together researchers and policy makers, both within the Commission and in the member states, were mentioned as successful brokerage methods.

As a form of informing and consulting, organizational practices are a low-intensity brokerage activity (Figure 2). Organizational practices have intermediate patchiness, because their venues are many but image is homogeneous, when judged on the basis of the interviewees’ positive evaluations concerning their usefulness for sustainable development policy. Brokerage sequence has an intermediate speed, because the practices range from day-to-day activities to assessments and studies lasting several months (Figure 3).

[INSERT FIGURE 3 HERE]

*Matchmaking* within the Commission takes place through personnel and knowledge infrastructures (Table 1). Some interviewees felt that the science-policy interface “requires a new breed of people” capable of digesting policy-relevant research, anticipating forthcoming policies and integrating the two in successful brokerage. In addition to new expertise, the importance of database development required in brokerage was emphasized. Investment in databases and personnel constitute investment in information infrastructure and knowledge infrastructure, respectively. The interviewees reminded that contemporary obsession with projects and programs as the only means for bureaucracies to achieve things veils the fact that the right people with the right knowledge are key ingredients in getting things done.

Personnel and knowledge infrastructures are an intermediate-intensity brokerage activity (Figure 2). Since infrastructure arrangements take place within the same venue (DG Research) and were perceived by the interviewees to have a positive homogeneous image of sustainable development, patchiness is low. The speed of brokerage sequence is low, because investments in personnel and

knowledge infrastructure typically overlap each other and have a time span of several years (Figure 3).

*Engaging* is achieved with programs (Table 1). Programs have a time span of several years (7 years for FPs, for example), because they define the longer term operating principles for administration. One example mentioned in the interviews is to align the work program priorities of a research program with the Commission's policy priorities. Another example is the experimental non-budgeted policy program on Marine and maritime research policy, in which brokerage was facilitated with an advisory group including stakeholders (one outcome being the joint call on Ocean of tomorrow). The interviewees also pointed out that the LIFE-program in the field of environment has facilitated brokerage between science and policy by building on research results obtained in projects funded under 7<sup>th</sup> FP. The Advisory Groups for 7<sup>th</sup> FP themes, such as the one for Environment and Climate that I participated in, are another example of engagement.

Programs have intermediate intensity as a brokerage activity (Figure 2). Patchiness is low, because the venues are few (DG Research and its Directorates) and the image relatively homogeneous (because of substantial alignment with sustainable development policy priorities). The speed of brokerage sequence is low to intermediate, because the programs have a time span of several years and often run in parallel (Figure 3).

*Collaboration* type brokerage has been built into projects conducted under various EU funding instruments (Table 1). Some 7<sup>th</sup> FP research projects have been designed to include researchers, policy makers and stakeholders as project partners. A watershed management project, for example, may have the explicit objective of developing the regulatory and management regime for the watershed during the project. The project is designed with intensive deliberation over regulation and management among researchers, regulators, local professionals, entrepreneurs and other stakeholders, all of whom are also formal project partners. Sometimes these types of activities are called translational research, for example in the efforts to develop public health measures or new drugs that require highly integrative activities among researchers and various stakeholders.

As a form of collaboration, projects have an intermediate to high intensity (Figure 2). Projects are patchy, because the venues are numerous (research units across the EU) and image relatively heterogeneous (despite broad adherence to program goals, the substance of research is by definition unpredictable). The speed of brokerage sequence is intermediate to high, because projects follow one another and have a time span of 1-4 years (Figure 3).

*Capacity building* with institutional experiments holds the greatest potential of leading to lasting brokerage (Table 1). At the same time, as experiments they are vulnerable to the contingencies of politics and administration. European technology platforms (ETPs) are multidisciplinary and multi-professional forums consisting of researchers, industry representatives, policy makers and other stakeholders. Their purpose is to set the agenda for research and policy in a particular technology area. They are also forward-looking, sometimes over several decades. Parallel to ETPs, social platforms have been developed that define the research agenda in the field of social sciences and humanities and oblige research institutes in a particular field to engage with stakeholders. There are plans to fuse ETPs and social platforms.

As a form of capacity building, institutional experiments have the highest intensity of the brokerage strategies observed in the Commission (Figure 2). Their patchiness is relatively low: venues are few (two at the time of the interviews, with plans for a merger) and image relatively homogeneous (although there are several thematic platforms, they have been aligned with EU's sustainability

policies). Speed of brokerage sequence is low, because the platforms are ongoing, long-term activities (Figure 3).

### **3.2 Position of brokerage in the evolution of EU's sustainable development policy**

Placing the observed brokerage strategies within the model of the dynamics of brokerage does two things (Figure 3). First, it places the brokerage activities in sustainable development in a theoretical framework and provides a systematic albeit tentative diagnosis of the position of brokerage in the evolution of EU's sustainable development policies. Second, it helps to specify the problems of brokerage and develop potential solutions.

The observed brokerage for sustainable development (Figure 3) is consistent with the model (Figure 1) when judged on the basis of the position of different intensities of brokerage in the cycle of brokerage. The position of organizational practices yields an ambiguous interpretation: as a low-intensity brokerage activity, organizational practices are contributing to either disintegration or solidification of brokerage related to sustainable development (activity 1 in Figure 3). The intermediate-intensity brokerage activities of personnel and knowledge infrastructures (2 in Figure 3) and programs (3 in Figure 3) maintain the stability of brokerage for sustainable development, as does the high-intensity brokerage activity of institutional experimentation (5 in Figure 3). Finally, the position of the intermediate-intensity brokerage activity of projects (4 in Figure 3) in the cycle of brokerage indicates that projects have a destabilizing effect on brokerage for sustainable development.

The observations in Figure 3 also provide tentative solutions to the observed problems of brokerage, namely, the general problem of temporal mismatch between research and policy making, and the specific problem of research-based crisis response (recall Section 1). As to the general problem of temporal mismatch, the analysis shows that the Commission's brokerage strategies have a fairly good coverage of different sequence speeds and intensities of brokerage. The strategies are also appropriately positioned at least in the stable phases of policy evolution: high-intensity strategies are applied to build up and maintain stability.

A major concern, however, is managing the different phases of destruction in policy subsystems. The concern has two aspects. On one hand, using brokerage as a tool for recovering from unexpected and unwanted policy destruction; on the other, using brokerage to trigger major positive transformations in policies (Figure 4). Recovering from unexpected negative policy destruction would, according to the model, call for brokerage of intermediate intensity, speed and patchiness (the upward movement from the destruction phase to the beginning stabilization phase in Figure 4). In other words, a destroyed policy subsystem, which is characterized by simultaneous, patchy and low-intensity brokerage, requires thinning out existing low-intensity brokerage activities sequentially and increasing the intensity of the remaining brokerage. Triggering positive policy transformation would call for low-intensity brokerage with high sequence speed and patchiness (the downward movement from beginning destruction to destruction phase in Figure 4). Such activity would critically question the status quo of sustainable development policy.

[INSERT FIGURE 4 HERE]

The episode that the Advisory Group for Environment and Climate went through after the 2008 financial crisis is consistent with these model predictions. On one hand, the fact that the financial break-down was perceived as a serious socio-economic sustainability crisis shows that there had been no low-intensity brokerage activities to destabilize the accepted wisdom of how to manage

global financial and economic affairs. Had there been such activities, there would have been at least some indication that things might go wrong and the event would arguably not have been termed a crisis. Thus, the lack of appropriate brokerage in the phase leading from beginning of destruction to destruction contributed to the financial crisis being so unexpected and incomprehensible. In the case of the financial crisis such remedies might have included for instance high level expert reports to the Commission prepared from alternative critical perspectives to the predominant strategies of handling financial downturns. On the other hand, the fact that the Commission's policy makers were scrambling for advice after the financial crisis and that the Advisory Group was at a loss in providing such advice is evidence of the absence of higher intensity brokerage to consolidate knowledge on how to recover from crisis. Thus, the lack of appropriate brokerage in the phase leading from destruction to emerging stability contributed to the inability to recover from the financial crisis. A remedy could have been, for example, a high level advisory group pooled from Europe's top social scientists and tasked with a mission to guide the Commission with research based evidence on a path toward socio-economic recovery (Figure 4).

### **3.3 Improving the temporal sensitivity of science-policy brokerage for sustainable development in European Commission**

Remedies to the two gaps identified in Section 3.2 in the Commission's knowledge brokerage in sustainable development can be specified further. The first gap – recovering from unexpected negative policy breakdown – requires brokerage of intermediate intensity, speed and patchiness. In practice, this means brokerage that is adequately resourced and focused to quickly tease out relevant intelligence from the plethora of information generated during the frenzy of patchy low-intensity brokerage that characterizes a crisis. Of the existing brokerage strategies, programs such as the EU's Advisory Group system would have the right intensity for this purpose, but its sequence speed and patchiness are too low (activity 3 in Figure 3). Echoing the format of the Advisory Group for Environment and Climate, I propose an organizational intervention to facilitate cumulative learning from rapid response: the *policy operations room (POR)* (activity 3 in Figure 4).

POR is an engagement response to the difficult need to find coherence in the diverse and contradictory brokerage activities that characterize the breakdown of a policy subsystem in sustainable development, and to do so reasonably quickly to avoid a prolonged crisis. Precisely the same tensions have been observed and successfully resolved in reliable management of complex technologies, organizations and ecosystems with conflicting service objectives and time frames (Perrow, 1999; Rochlin, 1997; Roe and Schulman, 2008; van Eeten and Roe, 2002). Reliable management has been achieved by bringing together a wide range of technical, scientific and managerial expertise in the same physical control room, and having the experts make management decisions with specific boundary conditions and time limits (van Eeten and Roe, 2002). Although the agendas and time frames often differ in detail between policy-making and management, the mechanisms of the challenge and the principles for its resolution are analogous. In fact, sometimes there is no difference between policy-making and reliable management, as illustrated by the quick-fix policies patched together in reaction to the latest financial crisis (Sorkin, 2009).

Brokerage in a POR for sustainable development would bring together a multidisciplinary range of researchers and a multi-professional range of policy makers with expertise on a particular sustainable development challenge. The task of POR is to make policy within a specified field of sustainable development, within a specified time frame. PORs would come in handy during future crises, most of which are likely to be environmentally related. An example of an experimental POR is the brokerage response to the Deepwater Horizon oil spill in the Gulf of Mexico on 20 April 2010. One month after the oil spill the US Department of the Interior established the Strategic

Sciences Working Group to assess how the oil spill may impact the ecology, economy and people of the Gulf. The group included scientists from diverse disciplines working in academic, governmental and non-governmental organizations. It did not conduct scientific investigations but rather provided rapid scientific assessment for decision makers of the potential consequences of the spill. As such, the group filled a temporal knowledge gap between the emergency response phase and the recovery phase of a crisis (Machlis and McNutt, 2010).

The second gap in the Commission's brokerage – triggering major positive policy transformations – requires low-intensity brokerage with high sequence speed and patchiness (activity 1 in Figure 4). Such brokerage helps not only to find quick and effective responses to urgent policy challenges, but also to destabilize existing dogma in sustainable development. Here experiences gained from the variety of low-intensity organizational practices, such as assessments, studies and workshops, can be exploited (Section 3.1). The benefit of organizational practices is that they can be tailored together relatively quickly to meet specific policy needs. The results of such organizational practices on sustainable development are the material from which PORs can accumulate brokerage knowledge for dealing with future policy contingencies.

#### **4 Discussion of the implications of the research**

In this paper, I have developed a model of the temporal dynamics of knowledge brokerage. The model is theoretically grounded in earlier work on policy evolution, knowledge brokerage, and the temporal characteristics of late-modern society. The potential use of the model was illustrated with a case study on brokerage conducted in the European Commission's research administration in the field of sustainable development. According to the model, brokerage undergoes cyclic change between destruction and stability. Destruction begins when patchy low-intensity brokerage takes place in rapid sequence and is completed when brokerage becomes simultaneous. Stabilization begins when the patchy low-intensity brokerage activities disappear sequentially one by one and consolidate in a few simultaneous high-intensity brokerage activities.

The weakness of the model is that at this stage it is only theoretically grounded. The potential use of the model was illustrated with a case example from the 7<sup>th</sup> FP brokerage activities, which however is based largely on qualitative recollections of EU officials during interviews. No effort was made to place the brokerage activities along a specific timeline over the tenure of the 7<sup>th</sup> FP. Furthermore, the definition of sustainable development was not explicit but was rather left at the discretion of the interviewees and thus opening up the possibility of mutually inconsistent understandings. Finally, it appears that EU brokerage activities during the relatively short time period (7 years, 2007-2013) of the 7<sup>th</sup> FP were locked in a stability regime, which effectively ruled out the possibility of observing any evolutionary transition in brokerage.

The weaknesses of this research instruct the design of future empirical work. The model should be validated and tested with data on a specific case of brokerage for sustainable development. The brokerage data should be substantially and temporally specific, including details on the topic and venue (to observe patchiness), speed and duration (to observe sequence speed), intensity, and date of brokerage activities (to observe evolution over time). The time period observed should be long enough to capture regimes of stability and disruption in sustainable development.

The key strength of model is that it facilitates unbiased, systematic thinking on brokerage by considering it as a key component of policy evolution. Such systematics is particularly useful for policy relevant research conducted under the FPs and continued under the Horizon 2020 – programme. As a result of the evolutionary perspective, brokerage cannot always be seen as a

constructive activity that maintains existing policy subsystems or builds up new ones. It should also have a destabilizing and destructive function in policy subsystems. The key recommendations of the case study on European Commission's brokerage in sustainable development reflect this dual property. On one hand, EU's policy subsystem of sustainable development requires low-intensity brokerage activities with high sequence speed and patchiness to destabilize the accepted wisdom of EU's sustainable development policies. This will inevitably be a challenge for the Commission's research administrators and policy makers, as the required organizational practices may question for example the fundamental principles of Horizon 2020, such as economic growth and resource efficiency. On the other hand, making sense of the tensions that result from the destabilizing organizational practices will require brokerage programs of intermediate intensity, speed and patchiness. The purpose of these programs, as highlighted in the proposed PORs, is to revise the knowledge base for sustainable development policy by weeding out the scattered brokerage activities of the destructive phase and consolidating the remaining ones (Figure 4).

Considering the intensity of brokerage in light of the broader temporal dynamics of brokerage reveals counter-intuitive results. Capacity building as the most intensive form of brokerage is often presented as the suitable strategy for poorly understood emergent policy issues (Figure 2; Michaels, 2009). Yet there is an inherent paradox in the notion of institutionalizing responses to something that is by definition unknown. A similar tension between institutional specification and flexibility has been observed in brokerage in the healthcare sector (Chew et al., 2013). The solution proposed here is to respond to emergent policy contingencies with the POR, a brokerage strategy that is only moderately intensive, while anchoring it in the low-intensity brokerage of informing and consulting. The core idea of the POR is to learn from the quick successes and failures of informing and consulting by engaging experts in programmatic activity on an ad hoc basis. Recognition of the paradox of institutionalizing responses to unknown policy challenges has subtle implications for the brokerage framework developed by Michaels (2009). The wicked problems of emergent policy settings do not simply go hand in hand with high levels of relationship building and resource commitment, as implied by Figure 2. Instead, they require a combination of much relationship building (to maintain a rich knowledge base for emergent policy contingencies) and low resource commitment (to avoid rigid governance structures that prevent flexible policy response).

The model and its testing have broader implications. First, since the Commission wields considerable influence on the funding structures and substantial themes of European research, the model is likely to be applicable in the EU member states and not just within the Commission. Second, since the model treats brokerage as a component of the feedback that drives policy evolution more generally, it is likely to be applicable in knowledge brokerage in general and not just in sustainable development. Future work should focus on rigorous testing and refinement of the model in diverse policy environments.

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## References

Adam, B, 1998, *Timescapes of Modernity: The Environment and Invisible Hazards*, London: Routledge

Adam, B, 2000, *The Temporal Gaze: The Challenge for Social Theory in the Context of GM Food*,

British Journal of Sociology, 51, 1, 125-142

Adam, B, 2004, *Time*, Cambridge: Polity Press

Alasuutari, P, 1996, Theorizing in qualitative research: A cultural studies perspective, *Qualitative Inquiry*, 2, 4, 371-384

Baumgartner, F R, Jones, B D, 1991, Agenda dynamics and policy subsystems, *The Journal of Politics*, 53, 4, 1044-1074

Baumgartner, F R, Jones, B D, 2009 [1993], *Agendas and Instability in American Politics*, second ed, Chicago and London: The University of Chicago Press

Begon, M, Harper, J L, Townsend, C R, 1990, *Ecology: Individuals, Populations and Communities*, second ed, Boston, MA: Blackwell Scientific Publications

Chew, S, Armstrong, N, Martin, G, 2013, Institutionalising knowledge brokering as a sustainable knowledge translation solution in healthcare: How can it work in practice? *Evidence & Policy*, 9, 3, 335-351

Commission of the European Communities, 2005, *Communication from the Commission: Building the ERA of knowledge for growth*, COM(2005) 118 final, 6 April, Brussels: Commission of the European Communities, [online] URL: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0118:FIN:EN:PDF>

Council of the European Union, 2006, *Renewed EU Sustainable Development Strategy*, 9 June, 10117/06, Brussels: European Union

Depledge, M, Bartonova, A, Cherp, A, d'Arras Suez, D, Bastioli, C, Bizek, V, Brunner, P H, Cassar, M, Cramer, W, Frankl, P, Hukkinen, J, Karlsson, M, Kelly, M, Kundzewicz, Z W, Linnerooth-Bayer, J, Narbona Ruiz, C, Nilsson, K, Schulze, E-D, Tubiana, L, Van Ypersele, J-P, 2009, *Report of the Environment Advisory Group*, Brussels December 2008 – December 2009, Advisory Group of FP7 Theme 6 “Environment (including climate change)”, Brussels: European Commission Directorate General Research

Flyvbjerg, B, 2001, *Making Social Science Matter*, Cambridge: Cambridge University Press

Funtowicz, S O, Ravetz, J R, 1991, A New Scientific Methodology for Global Environmental Issues, in: Costanza, R (Ed), *Ecological Economics: The Science and Management of Sustainability*, New York: Columbia University Press, 137-152

Georghiou, L, Esterle, L, Hubert, C, Kuhlmann, S, 2009, *Gearing European research towards sustainability – RD4SD Exercise*, Brussels: European Commission DG Research

Gibbons, M, Limoges, C, Nowotny, H, Schwartzman, S, Scott, P, Trow, M, 1994, *The new production of knowledge: the dynamics of science and research in contemporary societies*. London: Sage

Holling, C S, 2004, From complex regions to complex worlds, *Ecology and Society*, 9, 1, 11, [online] URL: <http://www.ecologyandsociety.org/vol9/iss1/art11>

- Hukkinen, J.I., 2009, *Science-policy brokerage: Enhancing connectivity between research and policy-making in sustainable development*, Report to European Commission's Directorate-General Research, Directorate I – Environment, Helsinki: University of Helsinki
- Jamison, A, 2001, *The Making of Green Knowledge: Environmental Politics and Cultural Transformation*, Cambridge: Cambridge University Press
- Jasanoff, S, 1990, *The Fifth Branch, Science Advisers as Policymakers*, Boston, MA: Harvard University Press
- Juntti, M, Russel, D, Turnpenny, J, 2009, Evidence, politics and power in public policy for the environment, *Environmental Science and Policy*, 12, 207-215
- Lightowler, C, Knight, C, 2013, Sustaining knowledge exchange and research impact in the social sciences and humanities: Investing in knowledge broker roles in UK universities, *Evidence & Policy*, 9, 3, 317-334
- Machlis, G E, McNutt, M K, 2010, Scenario-building for the Deepwater Horizon oil spill, *Science*, 329, 1018-1019
- Meyer, M, 2010, The rise of the knowledge broker, *Science Communication*, 32, 118-127
- Michaels, S, 2009, Matching knowledge brokering strategies to environmental policy problems and settings, *Environmental Science and Policy*, 12, 994-1011
- Owens, S, Petts, J, Bulkeley, H, 2006, Boundary work: knowledge, policy, and the urban environment, *Environment and Planning C*, 24, 633-634
- Pawson, R, 2002a, Evidence-based policy: In search of a method, *Evaluation*, 8, 2, 157-181
- Pawson, R, 2002b, Evidence-based policy: The promise of 'realist synthesis', *Evaluation*, 8, 3, 340-358
- Perrow, C, 1999, *Normal Accidents*, Princeton, NJ: Princeton University Press
- Rochlin, G I, 1997, *Trapped in the Net: The Unanticipated Consequences of Computerization*, Princeton, NJ: Princeton University Press
- Roe, E, Schulman, P R, 2008, *High Reliability Management*, Stanford, CA: Stanford University Press
- Sarewitz, D, Pielke Jr, R A, 2007, The neglected heart of science policy: reconciling supply of and demand for science, *Environmental Science and Policy*, 10, 5-16
- Sebba, J, 2013, An exploratory review of the role of research mediators in social science, *Evidence & Policy*, 9, 3, 391-408
- Sheate, W R, Partidário, M R, 2010, Strategic approaches and assessment techniques – Potential for knowledge brokerage towards sustainability, *Environmental Impact Assessment Review*, 30, 278-

Sorkin, A R, 2009, *Too Big To Fail*, New York, NY: Viking Press

Stern, P C, Dietz, T, Abel, T, Guagnano, G A, Kalof, L, 1999, A value–belief–norm theory of support for social movements: the case of environmentalism, *Human Ecology Review*, 6, 2, 81-97

Turnhout, E, Stuiver, M, Klostermann, J, Harms, B, Leeuwis, C, 2013, New roles of science in society: Different repertoires of knowledge brokering, *Science and Public Policy*, 40, 354-365

van Eeten, M J G, Roe, E, 2002, *Ecology, Engineering, and Management: Reconciling Ecosystem Rehabilitation and Service Reliability*, Oxford: Oxford University Press

Ward, V, House, A, Hamer, S, 2009, Knowledge Brokering: The missing link in the evidence to action chain? *Evidence and Policy*, 5, 267-279

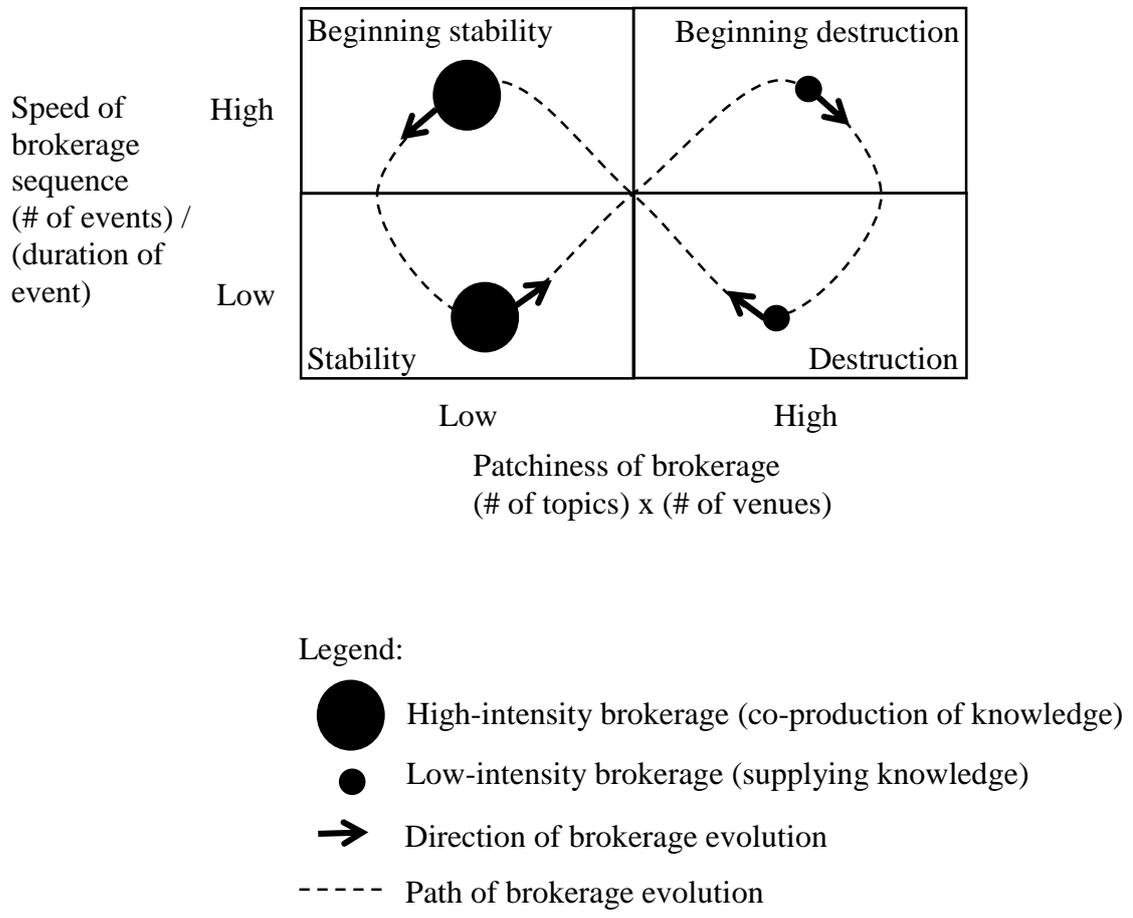


Figure 1. Model of the temporal dynamics of knowledge brokerage

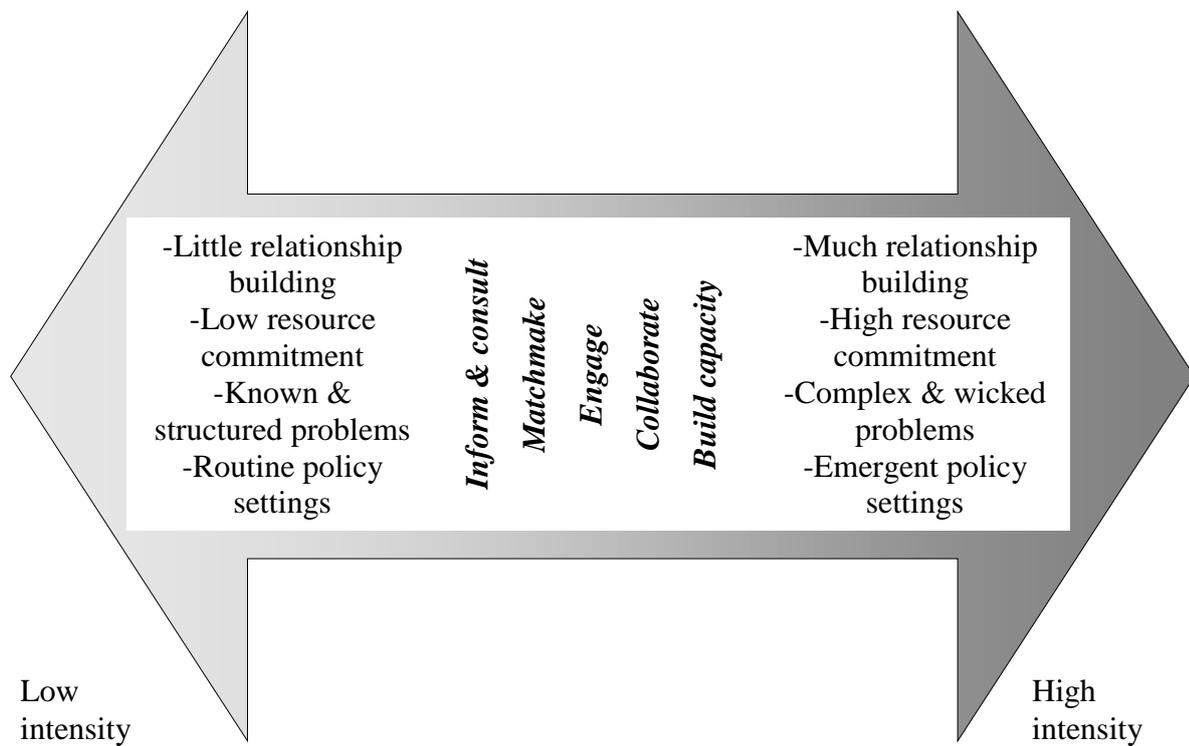
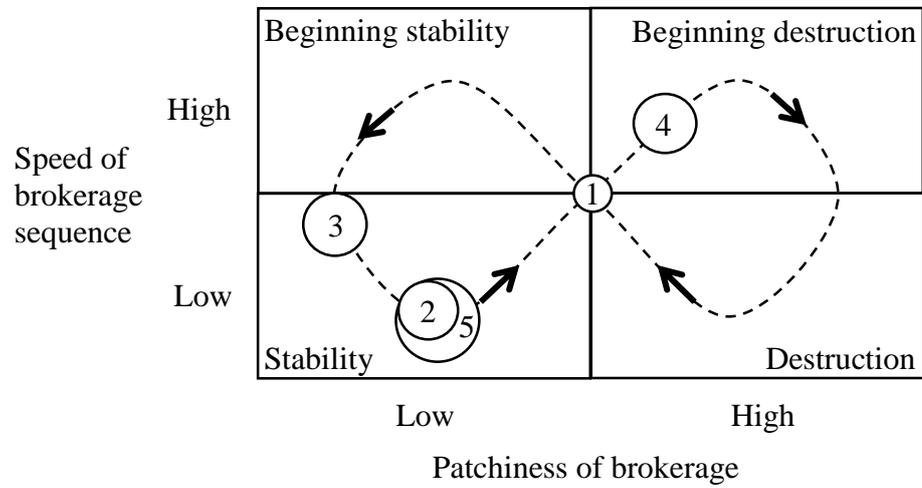


Figure 2. Intensity of brokerage strategies (summarized from Michaels, 2009)

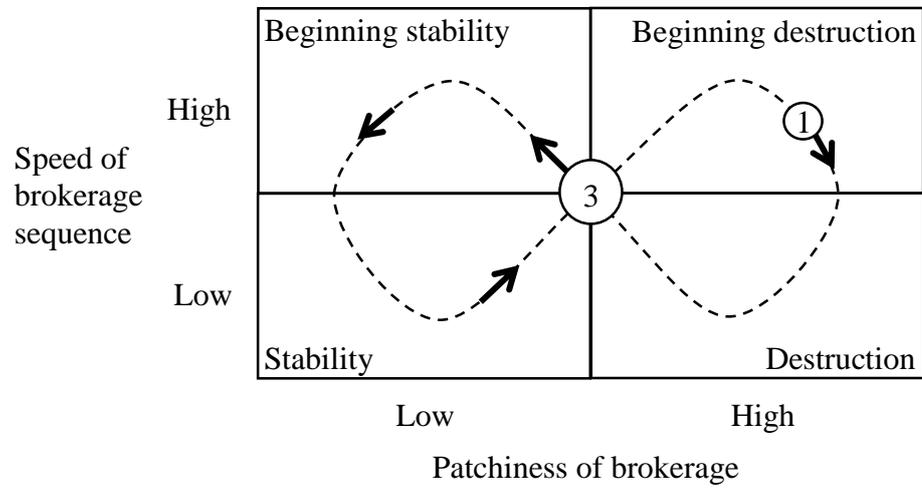


Legend:

- 1. Organizational practices
- 2. Personnel and knowledge infrastructures
- 3. Programs
- 4. Projects
- 5. Institutional experiments

-  Low-intensity brokerage
-  Intermediate-intensity brokerage
-  High-intensity brokerage

Figure 3. Observed temporal dynamics of European Commission's brokerage in sustainable development



Legend:

- 1. Organizational practices (assessments, studies, workshops)
- 3. Programs (Policy Operations Room, POR)

○ Low-intensity brokerage

○ Intermediate-intensity brokerage

Figure 4. Remedies to the European Commission's brokerage strategies in sustainable development

Table 1. Knowledge brokerage strategies in European Commission's Directorate General for Research

<b>Brokerage strategy</b>	<b>Objective</b>	<b>EU example</b>
Inform and consult	Disseminate content, seek out experts for advise	Organizational practices: direct contacts, policy briefings, Joint Research Centre (JRC) consulting, impact assessments, valuation studies, indicator development, foresight studies, workshops, seminars, conferences
Matchmake	Identify expertise and make connections	Personnel and knowledge infrastructures: hiring new expertise, database development
Engage	One party frames the discussion and involves other parties as needed	Programs: FP work program priorities, policy programs, LIFE program
Collaborate	Parties jointly frame the interaction and negotiate substance to address distinct policy problem	Projects: research projects, translational research, impact studies, scenario exercises, dissemination and exploitation
Build capacity	Parties jointly frame the interaction and negotiate substance to address multiple dimensions and future implications of policy problem	Institutional experiments: European Technology Platforms (ETPs), European Social Platforms