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Interactions between systemic problems in innovation systems: The case of energy-efficient houses in the Netherlands

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ABSTRACT

The innovation systems approach offers a framework to identify what inhibits the generation, diffusion and implementation of innovations. It prescribes that interventions should target systemic problems that inhibit the system from functioning well. In current literature, systemic problems are typically identified independent from each other, after which interventions are formulated for each one separately. The following will argue that, next to the problems themselves, also the interactions between the problems are of key importance when designing intervention strategies. We analyze the Dutch energy-efficient housing innovation system and conclude that neglecting interactions between systemic problems may not only lead to inaccurate problem diagnosis, but also to ineffective or even counterproductive interventions.

1. Introduction

Literature on innovation systems advocates that both the complex interaction between actors and the prevailing institutional infrastructure strongly affect the speed and direction of innovation (e.g. Edquist and Johnson, 1997; Chaminade and Edquist, 2010). Although initially the innovation systems approach focused on nations (Lundvall, 1992), additional strands have emerged for sectors (Malerba, 2002), regions (Cooke et al., 1997) and technological domains (Carlsson and Stankiewicz, 1991; Carlsson et al., 2002; Hekkert et al., 2007). Nowadays, the most common term for the latter is Technological Innovation System, or TIS (Bergek et al., 2008; Markard and Truffer, 2008; Jacobsson and Jacobsson, 2014). Since the innovation systems approach helps to identify how innovation can be stimulated, it has become a popular framework with both researchers and policy makers.

The innovation systems framework breaks with the neoclassical policy rationale based on market failures, as the latter is deemed unfit for the non-linear and complex nature of the innovation process. Instead of targeting market failures, interventions should target problems that inhibit the system from functioning well. Problems that may be targeted are, for instance, a lack of seed capital that restricts entrepreneurial startups or a negative image of a technology that inhibits demand.

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Different terms have been used to indicate problems in innovation systems, including systemic problems (Chaminade and Edquist, 2010; Wieczorek, 2014), system failures (Klein Woolthuis et al., 2005; Weber and Rohracher, 2012) and blocking mechanisms (Bergek et al., 2008).[1]

Although especially the term blocking 'mechanism' suggests that feedback plays an important role to understand problems in innovation systems, problems are, to the best knowledge of the authors, not conceptualized as such. Even though some literature mentions that problems in innovation systems reinforce each other (Johnson and Jacobsson, 2001; Klein Woolthuis et al., 2005), the overviews and categorizations of potential problems are presented as lists and thereby suggest conceptual independence (see e.g. Chaminade and Edquist, 2010; Klein Woolthuis et al., 2005; Negro et al., 2012; Weber and Rohracher, 2012). Case studies also reflect this conceptual independence of problems since they generally discuss problems one by one (see e.g. Faber and Hoppe, 2013; Patana et al., 2013; Wieczorek et al., 2013).

The main premise of this paper is that problems in innovation systems often interact, and may form 'mechanisms', that in turn prevent the innovation system to develop. In order to further explore this we carried out a case study of the Dutch energy-efficient housing innovation system. Our aim is to answer the following question: Does an innovation system analysis giving explicit attention to problem interactions yield contrasting or additional insights compared to an analysis of independent problems?

2. Theory

This section will introduce two central concepts from the innovation systems framework, namely system structure and key processes, will explain how these concepts are used to identify problems and formulate interventions, and discuss why this current practice may lead to difficulties during the analysis process. The different innovation systems strands (National, Regional, Sectoral and Technological) will be discussed collectively, because, even though they slightly differ in how they define and use central theoretical concepts, they all follow the same rationale in relation to problems: unsatisfactory system performance is caused by problems that pertain to the system structure.

The structure of any innovation system consists of structural elements that interact. There is a broad consensus in the literature that Actors, Interactions between actors (networks), and Institutions are structural elements of an innovation system. Furthermore, authors often make use of additional elements, such as Technology or Infrastructure in TIS literature (Chaminade and Edquist, 2010; Jacobbson and Bergek, 2011; Jacobsson and Jacobbson, 2014; Klein Woolthuis et al., 2005; Markard and Truffer, 2008; Wieczorek and Hekkert, 2012). It is generally agreed that there are many interactions and feedback loops between these structural elements (Bergek et al., 2015; Carlsson et al., 2002; Chaminade and Edquist, 2010; Edquist and Johnson, 1997; Jacobsson and Jacobsson, 2014; Markard and Truffer, 2008; Wieczorek and Hekkert, 2012). This multitude of interactions and feedback loops between structural elements is what makes an innovation system so complex.

It is difficult to judge or measure whether the structure itself is 'good' or not. For example, if ten entrepreneurs are active in a system, is that sufficient? To tackle this conceptual issue, the focus was shifted from the structure only to a combination of structure and key processes (often called functions). Under this new reasoning, the structure is considered 'good' if these functions are satisfactorily fulfilled. In contrast, if the function fulfillment is unsatisfactory the structure must be considered 'not good', and this will result in a system that does not develop at all or that develops in a 'stunted fashion' (Bergek et al., 2008). Although the use of functions is most prominent in TIS literature (Bergek et al., 2008; Hekkert et al., 2007), they have also been formulated for other innovation system strands (e.g. Edquist and Johnson, 1997; Galli and Teubal, 1997). Since it is easier to judge or measure the quality of functions than the quality of structural elements, their addition has made the framework more practical for analysts.

Structure and functions are two sides of the same coin, or as Markard and Truffer have put it: "two intertwined sides of the same object, the system" (p. 601). Due to the mutual dependence of structure and functions, the preferred approach to identify problems in innovation systems is to perform a combined structural/functional analysis (Bergek et al., 2008; Wieczorek and Hekkert, 2012). Both Bergek et al. (2008) and Wieczorek and Hekkert (2012) propose a stepwise analysis approach, and although the prescribed steps slightly differ, they have much in common: (1) an overview of the system structure is created, (2) the current system performance is determined through a functional analysis (3) for the weak functions the underlying problems that pertain in the system structure are identified, and (4) interventions are formulated to alleviate these problems, thereby improving the function fulfillment and thus the system performance. Functions are in this way placed 'in between' the system structure and system performance.

Literature on innovation systems mentions in some places that problems interact. For instance, "[...] there is a range of obstacles [...], which may act independently but are likely to reinforce one another" (Johnson and Jacobsson, 2001), or "Most problems in the innovation system will not be uni-dimensional but will consist of a complex mixture of causes and effects [...]" (Klein Woolthuis et al., 2005). Despite this, problem interaction has not yet received much conceptual attention. For instance, literature that discusses potential problems in innovation systems relates most problem categories to single structural elements (a.o. Chaminade and Edquist, 2010; Klein Woolthuis et al., 2005; Negro et al., 2012; Weber and Rohracher, 2012). Chaminade et al. (2012) puts it this way: "almost each author has his or her own list of potential systemic problems" (p.1477), to subsequently add that the types of problems discussed in literature "can be pinned down

[1] These terms have nuances of meaning to which we come back in the Theory section.