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Evaluating systemic innovations: The case of clean energy technologies

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1. Motivation

In recent years European innovation policy has increasingly focused on stimulating innovation to address grand societal challenges such as climate change and demographic ageing (Alkemade et al. 2011). When successful, these policies influence the direction of innovation. Scholars have argued that the innovations needed to address these grand societal challenges are characterised by an interdisciplinary and systemic nature (Smits and Kuhlmann, 2004; Wieczoreck, 2012; Farla et al. 2010). Stimulating systemic innovation is difficult as it requires the combination of different technological and/or application fields. As technological change is cumulative and path dependent and new technologies are often closely related to older technologies in the same field (Atkinson and Stiglitz 1969, Nelson and Winter 1982; Dosi 1982), the stimulation of systemic innovation might be more successful in countries or for companies that already have a strong position in the relevant technology fields.

Due to the inherent complexity of systemic innovation and because the desired societal transformations are long term processes it is difficult to evaluate European innovation policy. Insight in the patterns of systemic innovation and innovation policy are however an import element of the policy cycle and needed in order for policy learning to take place. In this paper we aim to gain such insights by analyzing clean energy patents as an (intermediate) innovation indicator. In a recent study the European patent office has identified the set of patents related to clean energy technologies (UNEP/EPO/OECD, 2010). In this paper we analyze this patent set in order to evaluate the systemic character of these patents. In order to evaluate the properties of the clean energy technology patent set we focus on two related measures, technological diversity and technological distance.

When a set of technologies has a more systemic character this might be reflected by a larger *technological diversity* of the technologies in this set. That is comparing the technological diversity of the set of clean energy patents to the technological diversity of energy patents in general can provide insights regarding the systemic nature of clean energy technologies. The general diversity index proposed by Stirling (2007, 2010) distinguishes three aspects of diversity: variety, balance and disparity. Variety described the number of different classes of elements in the system. Balance describes how the different technologies are divided over the different classes. The most difficult aspect of diversity to calculate is the disparity that describes how different the different technological options actually are. An adequate measure of technological diversity thus relies on a classification of technologies and a measure of the distance between classes, that is, a measure of *technological distance*.

2. Approach/Results/Conclusions

Although technological distance is acknowledged as important in the study of technological change it is difficult to measure and most approaches are technology-specific (Stirling 2010, Markard and Truffer, 2006). In this paper we use a general measure of technological distance: the global technology map (Schoen et al, 2012). As our classification of technologies we use an extended version of the WIPO classification of technological fields, unfolding the 35 classes to 389. The global technology map depicts how these technological fields are connected. The distance between areas of technology is based on the analysis of the co-occurrence of IPC codes assigned to individual patent documents. The more often a code is assigned to patent documents within one area together with codes of another area, the stronger the relationship between those codes or the shorter is the (technological) distance between the technological areas to which these codes belong.

The global technology map thus provides a "bottom up" measure of the technological distance between different technological fields. As a next step we project the clean energy technology patents on the technology map. More specifically we are interested in (1) the extent to which the clean energy technology patents are so-called "bridging patents" that is patents that connect different technological fields, and (2) the extent to which clean energy patents build upon a more diverse set of patents than overall energy patents. Subsequently we consider which countries and companies are able to establish such bridges.

Projecting the clean energy technology patents on the global technology map gives an indication of the systemic character of these patents, by comparing the average technological distance (shortest path on the technology map) of the clean energy technology patents with the average distance between all patents in this field.

3. References

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