

## Paper Session

### [C01] Improving the rigour of the Technological Innovation Systems framework: towards a TIS model

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In recent years the Technological Innovation Systems framework has emerged as a useful framework to study the emergence and diffusion of new technologies and sectors. Most studies that apply the TIS framework focus on the emergence and diffusion of new technologies that may contribute to a transition to a more sustainable society. For this reason, the TIS approach has become one of the dominant frameworks within the academic field of sustainability transitions research.

The TIS approach is praised for its usefulness in analysing a wide range of processes that influence the emergence and growth of new technological fields and for its focus on the identification of blocking mechanisms that prevent new industries and technologies to break through. The latter has proven to be very useful for deriving intervention strategies for policy makers and other actors that have an interest in furthering the development and diffusion of novel technologies (Borrás & Edquist, 2013; Weber & Rohracher, 2012; Wieczorek & Hekkert, 2012) Identification of blocking mechanisms and system failures is enabled by the use of so-called system functions: key processes that need to take place in order for innovation systems to function well.

Even though the TIS framework has been adopted by many scholars and used in a wide range of case studies, it has not escaped criticism. Identified weak spots, to name a few, include lack of attention to the micro level, biased or limited view on the role of geography and insufficient conceptualisation of incumbent industries and user structures ('regimes'). These criticisms are useful for improving the TIS framework. Another line of criticism that is much less spelled out in the literature but often raised in academic conferences and workshops is directed at the heart of the framework, at the central concepts of 'system' and 'system function'. The systems perspective appears to be provocative and in some circles deemed to be at odds with agency centred ontologies like constructivist, relational or rational actor perspectives.

The notion of system function is the key reason why the technological innovation systems approach has had such an impact on the academic fields related to innovation, technological change and societal transitions (Markard, Raven, & Truffer, 2012). The introduction of the system function concept shifted innovation systems analyses from a purely structural analysis to a combination of structural and process-oriented analysis. The break-through insight was that it is only possible to evaluate the structural weaknesses in innovation systems by studying the effects of innovation system structures on the innovation process (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008). System functions describe the key processes that are necessary for successful development and diffusion of new products or processes. The concept of system function however is conceived to be even more problematic than the systems concept for two reasons. First, it is confused by some with functionalism in sociology. We will not address this issue here but see the contribution of (Jacobsson & Jacobsson, 2012) on this topic. Second, others see it as a checklist of important processes that lack a deeper underlying logic. A single theoretical perspective that binds the system functions together is absent. (Fuchs, Hinderer, Kungl, & Neukirch, 2012) call it a "more or less arbitrary listing of functions". The reason for this is that the available sets of system functions in the literature are based on reviews of the multidisciplinary scientific field of innovation studies. Some of the system functions are rooted in (evolutionary) economic literature, while others stem for example from organisational studies. The call for conceptual rigor is strengthened by the fact that many different lists, even though some quite similar, are present in the literature. Apparently, it is possible to derive different sets of key processes related to innovation based on different reviews of the same academic field.

The goal of this article is therefore to theorise on the concepts of innovation system and innovation system function in the study of socio-technological change. More specifically we have the ambition to present a coherent technological innovation system model and provide a thorough and consistent theoretical basis for a set of system functions. By doing so we hope to create a more solid basis for case comparisons, cumulative knowledge production and generalization of results. By providing more well-defined concepts and categories, the article also contributes to the emerging field of transition modelling.

## References

- Bergek, a, Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, a. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, 37, 407–429. <http://doi.org/10.1016/j.respol.2007.12.003>
- Borrás, S., & Edquist, C. (2013). Technological Forecasting & Social Change The choice of innovation policy instruments.
- Fuchs, G., Hinderer, N., Kungl, G., & Neukirch, M. (2012). *Adaptive Capacities, Path Creation and Variants of Sectoral Change; the case of the transformation of the German energy supply system*.
- Jacobsson, R., & Jacobsson, S. (2012). The emerging funding gap for the European Energy Sector—Will the financial sector deliver? *Environmental Innovation and Societal Transitions*, 5, 49–59. <http://doi.org/10.1016/j.eist.2012.10.002>
- Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41(6), 955–967. <http://doi.org/10.1016/j.respol.2012.02.013>
- Weber, K. M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change. *Research Policy*,

41(6), 1037–1047. <http://doi.org/10.1016/j.respol.2011.10.015>

Wieczorek, a. J., & Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy*, 39(1), 74–87. <http://doi.org/10.1093/scipol/scr008>

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