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Policy mixes for sustainability transitions: An extended concept and framework for analysis

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ABSTRACT

Reaching a better understanding of the policies and politics of transitions presents a main agenda item in the emerging field of sustainability transitions. One important requirement for these transitions, such as the move towards a decarbonized energy system, is the redirection and acceleration of technological change, for which policies play a key role. In this regard, several studies have argued for the need to combine different policy instruments in so-called policy mixes. However, existing policy mix studies often fall short of reflecting the complexity and dynamics of actual policy mixes, the underlying politics and the evaluation of their impacts. In this paper we take a first step towards an extended, interdisciplinary policy mix concept based on a review of the bodies of literature on innovation studies, environmental economics and policy analysis. The concept introduces a clear terminology and consists of the three building blocks elements, policy processes and characteristics, which can be delineated by several dimensions. Based on this, we discuss its application as analytical framework for empirical studies analyzing the impact of the policy mix on technological change. Throughout the paper we illustrate the proposed concept by using the example of the policy mix for fostering the transition of the German energy system to renewable power generation technologies. Finally, we derive policy implications and suggest avenues for future research.

1. Introduction

One of the main challenges in the emerging field of sustainability transitions is to improve our understanding of the policies and politics of transitions, such as for the move towards a decarbonized energy system (Markard et al., 2012). One important requirement for such a transition is the redirection and acceleration of technological change towards sustainability objectives. However, in this context technological change, often characterized by its three major stages of invention, innovation and diffusion (del Río González, 2009b), is faced with multiple market, system and institutional failures and thus requires multi-faceted policy interventions (Lehmann, 2010; Twomey, 2012; Weber and Rohracher, 2012). Responding to this challenge, in recent years scholars and practitioners in fields particularly relevant to eco-innovation (Kemp, 2011; Rennings, 2000) have called for a policy mix which combines several policy instruments (IEA, 2011b; Nauwelaers et al., 2009; OECD, 2007). However, policy mix studies tend to be limited to examining instrument interactions (del Río González, 2006; IEA, 2011a) or the policy processes associated with designing such mixes (Howlett and Rayner, 2007). Furthermore, the terminology applied in these studies is often ambiguous, particularly regarding the desired characteristics of a policy mix.[1]

This limited scope and ambiguous terminology of existing policy mix studies have two major consequences for the analysis of policy mixes and their impacts. First, the narrow scope of policy mix concepts may cause researchers to neglect important policy mix

[1] For instance, given the limitations of the EU emissions trading system, Matthes (2010) (p.6) calls for a "comprehensive, effective, economically efficient, robust, politically achievable, and inclusive climate policy mix." Regarding climate innovations in the power sector Schmidt et al. (2012a) (p.476) stress the need for a "consistent and effective policy mix which is congruent to long-term targets." Likewise, OECD (2007) (p. 22) recommends an increase of "the coherence of the instrument mix" for environmental policy and Nauwelaers et al. (2009) (p.11) underline the "need for coherence, coordination, and effectiveness of policy mixes" for R&D.

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Table 1
Definitions of the term policy mix in the literature.

Source	Definition
Guy et al. (2009) (p.1)	"An R&D and Innovation Policy Mix can be defined as that set of government policies which, by design or fortune, has direct or indirect impacts on the development of an R&D and innovation system."
Kern and Howlett (2009) (p.395)	"Policy mixes are complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years."
Nauwelaers et al. (2009) (p.3)	"A policy mix is defined as: The combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors."
Boekholt (2010) (p.353)	"A policy mix can be defined as the combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors."
de Heide (2011) (p.2)	"A policy mix is the combined set of interacting policy instruments of a country addressing R&D and innovation."
Ring and Schröter-Schlaack (2011) (p.15)	"A policy mix is a combination of policy instruments which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors."

elements or processes in their analyses. This may lead to an insufficient understanding of the role of policy mixes for sustainability transitions, potentially resulting in fragmentary and oversimplified policy recommendations on how to redirect and accelerate technological change. Second, the lack of a uniform terminology could lead to apparently ambiguous findings and may render policy mix analyses difficult to assess, compare and synthesize. Ultimately, these obstacles to integrating our insights on the link between policy and innovation may further reduce the substance and impact of resulting policy advice.

In this study we address the identified lack of a comprehensive, uniformly defined policy mix concept for analyzing the link between policy and technological change, thereby heeding Flanagan et al.'s (2011) call for a reconceptualization of the policy mix for innovation. As a prerequisite of such empirical analysis, we take a first step in identifying and defining the key elements, processes, characteristics and dimensions of such an extended policy mix concept. For this, we review and synthesize the literature on innovation studies, environmental economics, policy analysis and strategic management. In doing so, we aim at deriving a policy mix concept that assists in a more systematic understanding of real-world policy mixes and serves as an integrating framework for empirical analyses addressing the role of policy mixes for technological change. Thereby, such an interdisciplinary analytical framework should enhance our understanding of the role of policy mixes for sustainability transitions and thus enable more precise policy recommendations.

Throughout the paper we illustrate the proposed policy mix concept using the example of the decarbonization of the German energy system, which requires accelerated development and diffusion of renewable power generation technologies (RPGTs) to realize the aspired system transition. The associated policy mix represents a good example with its feed-in law and several other policy mix elements as well as lively policy debates as to the best way to achieve the "Energiewende" (Agora Energiewende, 2012).

The remainder of the paper is structured as follows. In Section 2 we review the literature on policy mixes and their characteristics and derive requirements for an extended policy mix concept. Based on this, in Section 3 we present the three building blocks of the proposed policy mix concept: elements (Section 3.1), policy processes (Section 3.2) and characteristics (Section 3.3). In Section 3.4 we introduce relevant dimensions for delineating policy mixes, while Section 3.5 synthesizes the proposed policy mix concept. Finally, in Section 4 we discuss how the extended policy mix concept may be used as a framework for analysis for investigating the link between policy mixes and technological change (Section 4.1), and how to address the associated challenges of such empirical analysis, including boundary setting and operationalizing the policy mix (Section 4.2). Section 5 derives policy implications and concludes the paper.

2. Literature review

2.1. Policy mix

A growing number of studies in various scientific fields use the term *policy mix*, e.g. Lehmann (2010) in environmental economics, Nauwelaers et al. (2009) and de Heide (2011) in innovation studies, and Howlett and Rayner (2007) in the field of policy analysis.[2] In its most basic form, studies implicitly or explicitly define a policy mix as the combination of several policy instruments (Lehmann, 2012; Matthes, 2010). However, as stressed by Flanagan et al. (2011), a policy mix encompasses more than just a combination of policy instruments; it also includes the processes by which such instruments emerge and interact. As a consequence, studies focusing solely on the interaction of instruments should, more precisely, refer to the term 'instrument mix' (see Section 3.1.3).[3] Table 1 gives an overview of some policy mix definitions, with the more elaborate ones mainly originating from innovation studies and the policy analysis literature.

Three general features emerge from these definitions: First, they typically include the ultimate *objective(s)* of the policy mix, either in an abstract form (Kern and Howlett, 2009) or more typically as a specific objective of a certain policy field, such as innovation (Boekholt, 2010; Guy et al., 2009; Nauwelaers et al., 2009) or biodiversity (Ring and Schröter-Schlaack, 2011). Second, *interaction* is a central feature of the existing policy mix definitions (Boekholt, 2010; de Heide, 2011; Nauwelaers et al., 2009). It has been studied most extensively in the climate and energy fields, where the focus is often on its influence on the effectiveness and efficiency of instruments in the mix (del Río González 2009a, 2010; IEA, 2011b; Sorrell et al., 2003). Third, some of the definitions point to the *dynamic nature* of the policy mix, referring to it as having "evolved" (Ring and Schröter-Schlaack, 2011) and "developed incrementally over many years" (Kern and Howlett, 2009). This reflects that instruments and their meanings may change over time, causing interactions between them to change (IEA, 2011b; Sorrell et al., 2003).

Yet, in the context of sustainability transitions a policy mix concept is needed which goes beyond this narrow scope – interacting

[2] A review of the origins of the term in economic policy and its subsequent uptake in the fields of environmental and later also innovation policy can be found in Flanagan et al. (2011).

[3] This is done, for example, by OECD (2007), Braathen (2007) and Murphy et al. (2012). Similarly, Borrás and Edquist (2013) argue for a distinction between instrument mix and policy mix, while others use the term 'policy mix' interchangeably with 'instrument mix' (Ring and Schröter-Schlaack, 2011).

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