



Challenges for technology diffusion policy to achieve socio-economic goals



Sven Wydra

Fraunhofer Institute for Systems and Innovation Research, Breslauer Str. 48, D-76139 Karlsruhe, Germany

ARTICLE INFO

Article history:

Received 21 January 2014

Received in revised form 16 November 2014

Accepted 12 December 2014

Available online 7 January 2015

Keywords:

Socio-economic goals

Technology diffusion

Policy design

Biobased products

Health technologies

ABSTRACT

The aim of this contribution is to analyze the challenges for technology diffusion policies to achieve expected socio-economic goals and to deduce conclusions for an adequate policy design. Based on hypotheses from theoretical contributions, we review two rather distinct technology fields. One is biobased products, the other health technologies with bioethanol and magnetic resonance imaging respectively as case studies in order to derive rather general insights regarding those policies. The case studies highlight the difficulties in achieving the aimed societal goals by promoting technology diffusion. The dominant innovation design (e.g. techniques or resources used) which diffuses or its application fields (e.g. indication, patient characteristics) differ from those assumed in impact assessments and side-effects which occur in other markets. The direct linkage of policy measures to societal criteria may avoid some of those undesired developments but may have side effects of their own, such as trade distortions or shifting the environmental burden to other activities. However, there is considerable scope for improvement in policy design compared to the status-quo. Overall, a more balanced policy mix regarding various socio-economic goals is vital and unintended side effects have to be considered more in decision making.

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1. Introduction

In some (high-tech) sectors, policy steers technology diffusion intensively by regulations such as mandates, fixed-in-tariffs, reimbursements, etc. Frequently, these measures are justified by a combination of expectations for positive societal effects (e.g. substitution of fossil resources, positive environmental effects, effects on health) as well as a long-term economic impact by promoting related domestic industries. However, there are numerous examples in different sectors, where policy interventions were indeed successful in pushing technologies onto the market, but the economic and societal impact has been rather disappointing. Some recent examples in various countries

are the disputed state-induced diffusion of biofuels, photovoltaics or some health technologies. While rather high additional public costs connected to these policies arise, the environmental, health and domestic economic impacts are regarded as disappointing.

The aim of this contribution is to analyze the challenges facing technology diffusion policies which are expected to achieve socio-economic goals. Moreover, we draw conclusions for an adequate policy design. This focus is in line with recent research concerning outcome orientations of innovation systems. So far, innovation system analysis has focused on the performance of the innovation system per se, but less on certain outcomes. This may lead to significant failures in selecting an adequate policy design. As Mahroum [1], p.8] states: "The disjoint between innovation policies and socioeconomic goals has resulted in a negative impact on policy outcomes. For instance, an

E-mail address: sven.wydra@isi.fraunhofer.de.

innovation policy intervention might be successful in removing specific barriers (e.g. high market price) to the adoption of a desired solution (e.g. fuel cell vehicles), but the solution itself does not achieve the ultimate desired outcome (e.g. urban pollution).” Several recent research contributions deal with questions about the overall governance of innovation systems towards certain desired socio-economic outcomes [1,2]. In order to extend this research strand, we focus on the design of concrete policy instruments, since policy makers usually have the strongest influence on this decision level. In particular, we analyze the potential of direct linkages of the diffusion of policy instruments and socio-economic goals, i.e. the coupling of measures with socio-economic criteria that have to be fulfilled by the actors to be eligible for funding (e.g. sustainability criteria, cost-health benefit). However, as discussed in detail in Section 2.1, the analysis of the socio-economic impact of technology diffusion policy is highly complex because of the interplay of different diffusion factors, goal conflicts, etc. For example it is not clear whether certain disappointing outcomes of policies are to blame on the selection and design of policy instruments for a certain technology, and/or arise because inferior technologies have been chosen or because of an unfavourable interplay together with other impact factors. The consequences of these complexities for this paper are twofold. Firstly, the article takes an experimental perspective. We review various trends of innovation policy to formulate hypotheses concerning effective outcome-oriented technology diffusion policy and test these hypotheses for two empirical case studies. We review two rather distinct technology fields with advanced biobased products and health technologies in order to derive rather general insights regarding those policies. Policies towards societal outcomes are intensively discussed in both fields and technology assessments for impact analysis and potential deduced criteria play an important role.

Secondly, we focus on specific technologies in certain contexts in order to reduce the complexity and to obtain more clear-cut implications. For that purpose we select the examples of bioethanol for biobased products and MRI for health technologies to analyze technology diffusion and related support. By selecting technologies which are promoted heavily, we are able to concentrate on the mismatch between the diffusion and the expected results. More precisely, we focus on those technologies, for which technology assessment have brought about some promising indications. This indicates that it is not the technological characteristics per se, but the unfavourable use of technology which may lead to poor socio-economic results. In addition, there is evidence that not only a few, but several socio-economic goals have not been reached through technological diffusion. This may indicate that it is not the confliction of some goals, but the interplay of policy and contextual factors that leads to poor results.

The rest of the article is organized as follows. Section 2 begins with a discussion about the conceptual framework and a review of several research strands for technological diffusion policy and their societal outcomes. On that basis several hypotheses are formulated. In Section 3 the two case studies are presented. In Section 4, we discuss the

results of the case studies regarding the hypotheses and discuss the policy implications. Section 5 summarizes the main findings and deduces further research questions.

2. Technology diffusion policy and socio-economic outcomes: review and hypotheses

2.1. Conceptual framework

Existing research about technology diffusion has focused intensively on explanatory factors for technology diffusion. One is technology policy which may also influence the other factors. Regarding the impact of technology diffusion standard models often assume a direct translation of technological advantages (e.g. higher productivity) into macroeconomic outcomes. However, to the knowledge of the author no model exists which simultaneously links policy to the technology diffusion and its impacts on different economic and societal goals. The development of a conceptual framework for a multicriteria outcome of policy measures for technological diffusion is difficult as different complexities arise.

- *Goal conflicts:* There is no doubt that for many technologies and policies tensions to fulfil many socio-economic goals at the same time may exist. For example, the most sustainable technology solutions for certain demands may not be the most economic ones. Policies often face the trade-off between providing short-term incentives for economic activity and long-term incentives for the development of potentially superior technologies.
- *Technological diffusion factors:* A wide range of factors impacts technology diffusion, such as information, compatibility and observability of innovations, etc. [3]. Hence, policy is certainly not the only influence on technology diffusion paths.
- *Potential impact of policy on diffusion and outcomes:* Even if policy is able to directly steer technology diffusion, its impact is not unambiguous. One risk of specific policy intervention is the well-known argument of the risk to pick the wrong winner. Accordingly, public agencies are not successful in selecting winners because they have no superior sources of expert knowledge than private actors. Moreover, public agencies may give more weight to political considerations than to market signals and their decisions are biased [4]. But even in case of a successful selection of promising technologies, the impact of policies may be limited. For example, McLaughlin [5, p.172] concluded that “The consequences of even the best planned, best supported, and most promising policy initiatives depend finally on what happens as individuals throughout the policy system interpret and act on them”. Policies adopted according to rationality-based decision making processes can still be swayed in different directions by the conditions governing their implementation.
- *Time lags for impact realization:* It is undoubtedly true that widespread technology diffusion is a prerequisite for the realization of expected technology effects.

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