Technological Forecasting & Social Change xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

journal homepage: www.elsevier.com/locate/techfore

Institutionalisation of markets: The case of personalised cancer medicine in the Netherlands

Ellen H.M. Moors[a,*], Piret Kukk Fischer[b], Wouter P.C. Boon[a], Frank Schellen[a], Simona O. Negro[a]

[a] Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands
[b] Fraunhofer Institute for Systems and Innovation Research ISI, Germany

ARTICLE INFO

Keywords:
Market formation
Institutionalisation
Technological innovation system
Transition
Personalised cancer medicine

ABSTRACT

The article aims to understand the institutionalisation process of markets for innovative products. To pursue this study of market formation, we analysed the introduction of innovative personalised medicines products: Herceptin® (trastuzumab) for breast cancer and Tarceva® (erlotinib) for lung cancer, which were introduced successively in the Netherlands between 2000 and 2012. We apply the technological innovation system (TIS) approach to understand the development, implementation and diffusion of new markets, including new roles for users and producers, new forms of regulation and novel user practices regarding innovative health technologies. We show that market access became institutionalised as part of the technological innovation system of the first-mover personalised medicine, i.e. the market was formed, paving the way for the later personalised medicine products.

1. Introduction

Sociotechnical transitions are necessary to sustain economic welfare and societal well-being, as well as to tackle grand societal challenges like demographic changes and increasing pressures on public welfare services (EC, 2013; OECD, 2010). Healthcare is one of the areas of society facing challenges associated with high levels of complexity, high stakes and heterogeneity of involved stakeholders. In particular, the pharmaceutical system is in the middle of a transition. For decades, pharmaceutical companies have been successful in developing new drugs, promoting patients' health and increasing shareholder value. The current system of drug development, however, has reached its limits: it is more costly and difficult to develop products that are at least as good, in terms of safety and efficacy, as what is already on the market (Scannell et al., 2012). This leads to the introduction of less-needed products and higher drug prices (e.g., Drummond and Towse, 2014; Kaitin, 2010; Pammolli et al., 2011). At the same time, there is an accelerating demand for healthcare products and technologies, due to ageing populations and increase in chronic diseases in the Western world. To ensure high quality healthcare in the future, there is a need for innovative solutions and even new business models in the pharmaceutical industry (Downs and Velamuri, 2016; Munos, 2009). Stakeholders in healthcare need to rethink how healthcare is organised, regulated and delivered. This makes studying the transition towards a more sustainable healthcare system, in which healthcare is affordable and accessible for everyone in need, highly relevant (Moors et al., 2014).

One technological driver of transitions in the pharmaceutical sector is personalised (or precision) medicine, i.e. tailoring diagnosis and therapy to individual patients based on their predicted response to therapy or risk of disease (Collins and Varmus, 2015). It is expected that tailoring leads to improved treatment efficacy and safety. Despite these high expectations, the developments in personalised medicine has been slower than expected (Joyner and Paneth, 2015; Kukk et al., 2016).

Part of the explanation for the slow advancement lies in the unforeseen scientific and technological challenges related to personalised medicine. The institutional context of the pharmaceutical sector and the market activities of companies, regulators, hospitals, patient organisations in the sector also seem to play a key role (Morlacchi and Nelson, 2011; Nelson et al., 2011). Such a socio-technical-institutional perspective on innovation and transition is well covered by the innovation system framework. An innovation system consists of actors that contribute to the innovation process in various ways, e.g., through knowledge development, supply of financial resources, standardisation and the application of innovation. The actors are constrained and enabled in their actions by the structure of the innovation system that consists of network characteristics, technological artefacts and institutions (Hekkert and Negro, 2009). Since we focus on the emergence of personalised medicine as a specific technological field, we use the concept of technological innovation system (TIS) (Carlsson and

* Corresponding author.
E-mail address: e.h.m.moors@uu.nl (E.H.M. Moors).

https://doi.org/10.1016/j.techfore.2017.11.011
Received 18 February 2016; Received in revised form 16 October 2017; Accepted 11 November 2017

Stankiewicz, 1991). A TIS framework covers actors, networks and institutions that contribute to the generation, development, diffusion and use of new technologies (Edquist, 1997).

Until now, TIS studies have focused more on the knowledge generation of technologies than on the diffusion, development and implementation of new user practices (Dewald and Truffer, 2012; 2011; Grabher et al., 2008). The institutionalisation of markets and regulations for the use of personalised health technologies has not been explored in depth (Kukk et al., 2016). Earlier work has already focused on healthcare transitions, in which the institutional character of radical innovations in healthcare systems and the importance of institutions in market formation were put on the agenda (Kukk et al., 2015). But more detailed insights on how market formation exactly takes place are still missing in the TIS literature. Taking this into account, our aim is to further unpack the market formation component of TIS, and to gain more insight in the institutionalisation process of market formation over time.

In terms of market formation, TIS literature originally focused on characterising the potential target groups and measures needed to create niches in which new technologies can mature, protected from institutional pressures (Hekkert et al., 2007; Hekkert and Negro, 2009). Local markets have also been perceived as being important testing grounds for new technologies (Bergek et al., 2008), or as a way to stimulate certain industry activities by creating 'lead markets' (Edler and Georghiou, 2007). The aim of this paper is to further specify these market formation processes and as such, it builds on recent work in three ways. First, we build on recent advances in the TIS framework and specifically address the current emphasis on the interaction of a TIS and geographical contexts (Bergek et al., 2015; Coenen and Truffer, 2012). Several aspects of the emergence of a TIS have a transnational character, such as knowledge production and entrepreneurial activities. These global activities need to be implemented in national, pre-existing structures and institutions. In terms of market formation, this 'embedding' in local contexts is often depicted as pushing or transferring technologies to new markets (e.g. Moulaert and Sekia, 2010), or being dependent on simple market-pull policies such as public subsidies (Dewald and Truffer, 2011). We elaborate on work by Dewald and Truffer (2012) who emphasise the influence of local contexts by taking a micro-perspective on market formation. This paper adds to their conceptualisation and empirical studies of market formation by unpacking market formation processes while following new, emerging technologies over time. Second, we do not perceive the introduced technology as a standalone product. Often, and especially in the medical sector, validation of the value of a pharmaceutical product is just as important as the compound itself. The data package that validates the use of the product should be regarded as part of the innovation (Steinberg et al., 2015). This is even more prominent in the context of personalised medicine, which concerns more tailor-made and localised data production. Without these data, the product is worthless to potential users: regulation prescribes the necessity of these data for personalised medicine, and medical doctors require personalised medicine products that are proven safe and efficacious. Often users like medical specialists play an active role in the production of these data (DeMonaco et al., 2006; Smits and Boon, 2008). As such, market formation becomes intertwined with activities like knowledge production and gaining legitimacy on a local level. These localised TIS activities that support market formation in the context of emerging technologies have not been studied so far. Third, until now the TIS framework has been mostly applied and developed in the sustainability and energy sectors (e.g. Binz et al., 2014; Hekkert et al., 2007; Negro et al., 2008; Suurs and Hekkert, 2009; Truffer et al., 2012). We contribute to the TIS literature by using the TIS approach to clarify the emergence of technologies and market formation in the healthcare sector. Particularly in the highly regulated healthcare field, institutions play a crucial role. Institutional boundaries and institutional change processes around innovative medical technologies, such as personalised medicines, might play a bigger role in the effective functioning of a TIS than they do in other sectors, such as energy or transport technologies. Market formation is also a salient issue with regard to personalised medicine as this field is a transnational endeavour, where science and big pharmaceutical companies operate on a global scale. Markets for personalised medicines, on the contrary, are organised on a national or local level. This emphasises the significance of better understanding market formation in the national uptake of personalised medicine.

In line with this, the following research question is answered: How does the market formation of personalised medicine innovation systems occur over time?

In order to better understand market formation of personalised medicine innovation systems, we follow two personalised cancer medicines that entered the Dutch healthcare market between 2000 and 2012. Our goal is to understand how market formation of Herceptin® – one of the first medicinal products that was characterised as personalised, produced by Roche and used in breast cancer treatment – has occurred and paved the way for a follow-up personalised medicine product Tarceva® – also produced by Roche and used in lung cancer treatment in the Netherlands.

The outline of the paper is as follows: Section 2 focuses on the development of personalised cancer medicines. It discusses the theoretical background of technological innovation systems (TIS). And it details the process of market formation of personalised cancer medicines. Section 3 presents the methodology. Section 4 applies the TIS approach to the personalised medicine field in order to understand the specific dynamics of health-related market formation in technological innovation systems. It presents the results of the two cases (Herceptin® and follow-up product Tarceva®). Finally, Section 5 discusses the results and gives concluding remarks.

2. Theoretical background

2.1. Personalised medicine

Personalised medicine represents an emerging innovative technology field in biomedical innovations that is based on major advances in genomics, proteomics and metabolomics (Meadows et al., 2015). Personalised medicine is especially promising in the field of oncology. Multiple genetic mutations are present within tumours which cause uncontrollable cell growth (Bates, 2010). Every tumour has a different combination of mutations, which make each of them unique. Increased understanding of how these mutations' combinations contribute to the origin and development of cancer leads to knowledge about targets for new personalised cancer medicines (Greshock et al., 2010). Because patients vary in their genetic make-up and thus in their expression of molecular pathways, targeted therapies only work for a subset of the population. Potentially, personalised medicine enables more effective treatment options with fewer adverse effects and has the potential to reduce the cost of cancer care (Schilsky, 2010).

2.2. Technological Innovation System

Earlier studies in the field of energy transitions (Negro et al., 2007; Suurs and Hekkert, 2009) have shown that the success of a new technology is not only determined by technological characteristics, but also by the surrounding social system that develops, diffuses, implements or rejects new technologies (Jacobsson and Bergek, 2004). Hekkert et al. (2007) label this sociotechnical system as a Technological Innovation System (TIS). The basic assumption is that a well-functioning TIS is required for the dexterous development, diffusion and implementation of the technology in question (Hekkert et al., 2007).

Accordingly, the TIS approach pursues studying the development of the innovation system that supports an emerging technology (Negro et al., 2008). The approach takes into account a wide variety of actors, institutions and networks that contribute to the diffusion and