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Exploring technology diffusion in emerging markets – the role of public policy for wind energy

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HIGHLIGHTS

- Explorative qualitative and quantitative study of project developers in emerging markets.
- Identifies influencing factors for technology diffusion regarding wind farms.
- Predictable public authorities and well-implemented public processes attract intern. project developers.
- Feed-in-Tariffs and grid access guarantees are particularly appealing.

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ABSTRACT

This study challenges the implicit assumption of homogeneity in national institutional contexts made in past studies of (renewable) energy policy. We propose that institutional differences matter by focusing on several technology-specific and generic policy factors that can foster technology diffusion through private sector activity. More specifically, we explore perceptions of early adopters in emerging economy contexts using wind park project developers as an example. By applying a parsimonious method for our questionnaire as well as qualitative data we make several contributions: Methodologically, we introduce Maximum Difference Scaling to the energy policy domain. Empirically, we identify several public influences on private investment, and assess their relative importance. This leads to new insights challenging findings from industrialized economies; we identified additional institutional barriers to diffusion, hence, the requirement of a combination of technology-specific and generic policy measures.

1. Introduction

Despite being established technologically, wind power is still relatively uncommon in many emerging markets. As in other infrastructure industries, there is a strong role for policy inducing innovation (Nemet, 2009; Huberty and Zysman, 2010) and to impact its success at the firm level (Lee, 2009). However, it is much less understood how policy makers can influence the step in between, in other words which public measures trigger adoption and diffusion of innovative technologies. Moreover, diffusion of established technologies is to some extent taken-for-granted, yet there are several barriers to adoption, particularly in emerging markets (Popp, 2010, Kemp and Oltra, 2011).[1] In order to better understand this kind of diffusion one has to go beyond industrial economies. Finally, investigating proven technologies in the context of emerging markets is of great practical relevance with regard to climate change mitigation (Kristinsson and Rao, 2008, Hargadon, 2010).

Building on extant literature our research question is: which factors influence early adopters of an established technology in a highly regulated emerging market? In innovation studies, "diffusion is commonly used to describe the process by which individuals and firms in a society/economy adopt a new technology" (Hall, 2005). As part of this diffusion process, societies have to balance public and private interests while developing the appropriate institutional framework conditions. To do so, on the one hand social and environmental externalities have to be investigated. In this context, Jefferson (2008), Tampakis et al. (2013), Islam (2014), Vanschoenwinkel et al. (2014) conceptually and empirically highlight the need for involving the local communities at the grass root level instead of public top-down decision making, while Aitken (2010) challenges existing positive perceptions by academia and public policy towards wind farm developments. Other scholars contributed to the debate by

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[1] By barriers to adoption we solely mean market and institutional barriers; focussing on established technologies we can abstract from technological barriers.

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quantifying the social perspective in Spain and the US respectively (Alvarez-Farizo and Hanley, 2002; Jacquet, 2012). On the other hand, market conditions and private risk-/return structures need to be analyzed. In this study, we focus on the implementation of wind farms through project developers that typically precede private (foreign direct) investment (FDI) studied e.g. by Athreye and Cantwell (2007).

Hence, project developers are early adopters of new technology and they also highly dependent on public policy. Focusing on these business aspects, we refrain from analyzing the question of balancing positive and negative externalities of environmentally friendly technologies as researched by Sovacool (2009) and Aitken (2010).

While there is widespread agreement that favorable policies can help adoption and diffusion, there is no consensus what exactly "favorable" means. Even in industrial countries such as Spain it is debated if the successful renewable energy diffusion can be attributed either to the Feed-in-Tariff mechanism[2] (Ringel, 2006; Söderholm, 2008) or to other framework conditions (Dinica, 2008; Stenzel and Frenzel, 2008; Carley, 2009). Moreover, only limited knowledge exists regarding preferences of private sector actors for different policy options for renewable energy, even more so in emerging economies. Recent work extended analysis to wind developers in the EU and USA (Butler and Neuhoff, 2008; Lüthi and Prässler, 2011), yet still do not address adoption in emerging markets. By contributing to closing this gap, we advance the understanding of technology diffusion by exploring generic and renewable energy-specific policy measures on diffusion in emerging markets from a private sector adopters' perspective.

We have chosen wind energy as a technology focus, because it is one of the cheapest renewable energy technologies, hence most suitable for implementation and manufacturing in emerging economies (Lewis and Wiser, 2007; IEA, 2008). Beyond these points the technology is well established in many industrial economies such as Denmark, Spain, Germany (Garud and Karnoe, 2003; Kristinsson and Rao, 2008). However, while large emerging economies such as China and India are currently very active in implementing the technology, smaller emerging markets are still in a nascent stage. Therefore, the latter economies offer a suitable framework for our study. In this context, our research analyzes the relation of the public and the private sector by investigating private decision-making and the role of policy at the early adoption stage. Our main contribution is to identify the role of public policy in triggering adoption and diffusion of new (renewable energy) technologies in emerging markets; more specifically, we evaluate qualitatively and quantitatively private sector perceptions of various policy measures.

The rest of the paper is structured as follows: first, we analyze theoretical concepts and approaches in the context of energy policies (2). This forms the basis for a section on method and data (3). The findings of both qualitative and quantitative data that we gathered during the process are presented in detail in chapter 4 and discussed in chapter 5. The paper concludes with implications in chapter 6.

2. Conceptual background

Rogers (1995, p. 5) defined diffusion as "the process by which an innovation is communicated through certain channels over time". The innovation may be a process, an idea, a concept, product, or a set of these, which is newly available to potential adopters. In our case, the innovation is energy infrastructure which is new not because of technological innovation, but on account of deployment in a new region with little or no legacy in applying this technology.

Based on the work of Metcalfe (1988), the diffusion literature can be divided in two dominant streams: firstly, those characterizing the mechanisms and patterns of diffusion. This approach looks mainly at the rate and total amount of adoption in a given population within a time period. Secondly, those seeking to understand and to characterize the decision-making structure and process regarding product adoption. This approach focuses on the individual decision-making based on rational choice. Geroski (2000) and McEachern and Hansons (2008) further elaborated on the issue.

The first type of aggregate analysis of the diffusion of technology or more specifically energy infrastructure was very useful to gain a general understanding about FDI in emerging markets (Athreye and Cantwell, 2007), the impact of market reforms and political uncertainty (Henisz, 2002; Allard et al., 2012) or policy mechanisms in major renewable energy markets – usually industrialized countries. One key observation is the strong impact on the diffusion curves of changes or differences within the national policy framework (Wong, 2005; Späth and Rohracher, 2010; Dewald and Truffer, 2011; Tang et al., 2013). Broadly speaking, these studies analyze aggregate market data to find out which policy mechanism would best support market deployment (Jacobsson and Bergek, 2004; Ringel, 2006; Kristinsson and Rao, 2008; Mostafaeipour, 2010; Sovacool, 2010). However, any support mechanism by itself lends a rather narrow perspective that cannot fully explain deployment (Carley, 2009; Foxon and Pearson, 2007). For instance, the success of the Spanish market was initially attributed to the implementation of a Feed-in-Tariff (Ringel, 2006; Söderholm, 2008). However, Dinica (2008) and Stenzel and Frenzel (2008) revealed that other factors such as proactive Spanish utilities and public–private partnerships drove the diffusion. Moreover, the main reasoning for a quota system with tradable certificates is to achieve a defined renewable energy target at lower costs compared to a Feed-in-Tariff (Haas et al., 2004). Later studies show that the opposite is true (Lipp, 2007; Bergek and Jacobsson, 2010; IEA, 2008). One can conclude that even in the well-studied context of industrial economies with available and reliable aggregate market data the role of public policy is ambiguous. Therefore, one can neither replicate the study designs in emerging markets due to inferior secondary data availability and quality nor assume transferability of any directionality of above-mentioned results.

The second type of diffusion analysis based on Metcalfe (1988) seems to be more appropriate for the selected focus of analysis. In fact, the micro-level analysis of individual decisions to adopt new technologies furthers our understanding of diffusion patterns. Complementary to the aggregate approach, the micro-level perspective allows exploring why and when adoption occurs. Here, models and approaches available include a wider array of factors that arguably influence the decision to adopt (McEachern and Hansons, 2008; Islam, 2014). In the field of energy infrastructure the micro level perspective was first proposed by Wiser and Pickle (1998) who highlighted that many policies are not effective in terms of market growth as they do not meet the needs of investors, which was supported by Enzensberger et al. (2002) who classified the broad term investors on a conceptional level. The investment risk and the related financing costs were identified as key factors that affect the market deployment (Butler and Neuhoff, 2008; Gross et al., 2009; Sovacool, 2010; Lüthi and Prässler, 2011). We built on these findings by evaluating influencing factors in the new context of emerging and developing countries.

[2] We define Feed-in-Tariff as a government guaranteed fixed price that is payed to the renewable energy plant operator for each kWh that is sold to the national electricity grid (Ringel, 2006). The price is guaranteed for a certain period of time, typically 20 years.