Energy Policy 102 (2017) 7–15

Contents lists available at ScienceDirect

Energy Policy

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

Promoting clean energy technology entrepreneurship: The role of external context

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ARTICLE INFO

Keywords:
Environmental entrepreneurship
Clean energy technology
Venture capital funding
Environmental policy

ABSTRACT

This study examines how political, social and economic factors influence clean energy technology entrepreneurship (CETE). Government policies supporting clean energy technology development and the development of markets for clean energy create opportunities for CETE. However, the extent to which such opportunities lead to the emergence of new clean energy businesses depends on a favorable external context promoting CETE. This study employs a novel dataset combining indicators of the policy and social context of CETE with information on clean energy technology startup firms in the USA to provide empirical evidence that technological and market conditions supporting clean energy induce more extensive CETE under contexts where local attention to clean energy issues and successful firms commercializing clean energy technologies are more prominent. By establishing that CETE is contingent upon a supportive local environment as well as technology and market opportunities, the study holds relevance for policy makers and clean energy technology firms.

1. Introduction

Advances in clean energy technology development are important to address contemporary environmental challenges such as global warming and air pollution that stem from the current reliance of the energy system on fossil fuels. By themselves, however, these advances are not sufficient to address these challenges. Technologies that facilitate the use of renewable energy or reduce energy consumption and pollution also must be commercialized and successfully diffused before they can precipitate positive environmental outcomes (Marcus, 2015). Clean energy technology entrepreneurship (CETE) concerns the discovery, evaluation and exploitation of goods and services that incorporate novel clean energy technologies to reduce harmful environmental externalities associated with conventional energy production, distribution, and consumption (Eckhardt and Shane, 2003; Venkataraman, 1997). Entrepreneurship in this domain involves identifying a market opportunity for a clean energy technology and developing a viable business model to exploit it (Teece, 2010). CETE is an essential step in the adoption and diffusion of the advanced technologies upon which a clean energy future depends.

Understanding CETE requires comprehending why some opportunities for clean energy technology are recognized and developed whereas others are not. While research on entrepreneurial opportunity development once tended to focus mainly on characteristics of the entrepreneur (Short et al., 2010), recent studies have begun to examine the influence of the external environment (Tolbert et al., 2011). In relation to CETE, market failures associated with knowledge externalities are compounded by the additional challenges of addressing the negative externalities of environmental pollution (Jaffe et al., 2005) and those that arise from policy uncertainty (Marcus et al., 2011). Because government and broader societal actors play an important role in helping to mitigate these challenges, the external context is particularly germane to CETE. Accordingly, this study examines how the external context of entrepreneurs influences clean energy technology entrepreneurship.

The objective of the study is to assess to the extent to which CETE is contingent on a favorable external context. Favorable political, social and economic factors play a role in not only creating opportunities for entrepreneurs to develop into new businesses, but in creating conditions supportive of that development. The study explores the extent to which technological opportunities and market opportunities, which promote CETE, vary across locations depending on contextual factors, specifically local attention to clean energy issues and evidence of clean energy business viability. The central claim is that local attention to clean energy and evidence of the viability of clean energy technology businesses positively moderate the relationship between the existence

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http://dx.doi.org/10.1016/j.enpol.2016.11.045
Received 30 March 2016; Received in revised form 22 November 2016; Accepted 27 November 2016

of clean energy entrepreneurial opportunities in a location and the extent of CETE in that location. This argument is tested using a novel dataset combining indicators of the policy and social context of CETE with information on clean energy technology startup firms in U.S. states that received VC investment funding between 2000 and 2006.

Focusing on local attention to and verification of the viability of clean energy businesses contributes to research on the role of institutions in promoting entrepreneurship. Entrepreneurship research highlights the role of entrepreneurs and their social networks in commercializing technologies (Short et al., 2010). However, while inward-looking factors such as the traits and social networks of entrepreneurs themselves have received ample attention, the influence of the external environments in which entrepreneurs are embedded has been relatively understudied (Tolbert et al., 2011). The present study helps to fill this gap by leveraging the clean energy context to identify two important contextual influences on clean energy technology entrepreneurship. At the same time, this study highlights the salience of US states as relevant units of analysis for understanding how differences in institutional environments impact local CETE. It aligns with recent arguments from researchers delving into organizations and the natural environment who have emphasized the importance of jurisdictional differences at sub-national levels as change incubators for sustainable development (Hoffman and Jennings, 2015).

Increased understanding of how the external context influences CETE is also relevant to policy makers concerned with promoting the adoption of clean energy solutions. The importance of technological advance has led governments around the world to implement policy measures aiming to promote the development and diffusion of clean energy. Prominent examples include the provision of subsidies for clean energy research and development and the creation of market demand for such technologies through the use of such policy mechanisms as feed-in-tariffs and renewable portfolio standards. Some policies have been successful in promoting clean energy technology development (Johnstone et al., 2010). However, the results of policy adoption have not everywhere lived up to expectations with respect to the hoped for diffusion of those technologies nor the associated environmental benefits to the energy system (Marcus et al., 2011). Greater attention to the role of external context in promoting CETE necessary to realize societal gains can provide some insights into the reasons for such failures and help to guide future policy initiatives toward where they can have a more meaningful impact.

2. Literature review

2.1. Technological and market opportunities

Entrepreneurship in any domain is contingent on the presence of opportunities that entrepreneurs discover (Eckhardt and Shane, 2003) and transform into realized products and services (Alvarez and Barney, 2007). This process consists of a number of distinct steps (Ardichvili et al., 2003). Entrepreneurs must be aware of both technological potential and market need. They have to identify a match between potential and need and must develop business models to capitalize on that match (Casson, 1982; Eckhardt and Shane, 2003; Shane and Venkataraman, 2000). The existence of clean energy technologies and market opportunities, therefore, are necessary conditions for clean energy technology entrepreneurship to emerge (Shane, 2003). However, such supportive conditions do not exist everywhere to the same extent. In particular, local policy and social conditions can create important differences in the degree to which there are technological and market opportunities across geographic and political boundaries.

The diffusion of technological knowledge tends to be geographically constrained (Jaffe et al., 1993). Because technological entrepreneurship involves incorporating technologies into novel products and services offered by new enterprises, entrepreneurship is more extensive in regions where potentially relevant technologies are more abundant. The benefits of local technological development in promoting local entrepreneurship are well-established (Dosi, 1982; Malerba and Orsenigo, 1997; Siegel et al., 2003, 2004; Van de Ven et al., 1999). Beyond the quantity of locally available technology, the ability to understand that technology is perhaps just as important. Novel technologies often consist of a substantial amount of tacit knowledge. As such, the ability to understand and apply technologies is contingent on the ability to connect with local actors who can transmit this tacit knowledge (Jaffe et al., 1993). Moreover, greater levels of local scientific research help to distinguish between promising and unpromising future research areas (Fleming and Sorenson, 2004), which can further improve the odds of local entrepreneurial success. In short, local knowledge development has the potential to improve the quantity and quality of startup businesses that can develop these technologies into viable enterprises. Accordingly, CETE is likely to be more extensive in the presence of greater technological opportunities.

However, even the most advanced technologies are of little use if potential entrepreneurs are unable to identify customers willing to pay for novel products and services. In the absence of potential markets, entrepreneurs can neither create nor capture value from the provision of new technologies (Teece, 2010). In the case of clean energy technologies, the development of market opportunities is particularly challenging because traditional energy industries and technologies are heavily subsidized. Throughout the value chain, from extraction to production to consumption, fossil fuels receive considerable government support. According to Aldy (2011) subsidies for oil, gas, and coal production activities from the US federal government amount to over US$ 4 billion annually. These and other forms of support for the use of fossil fuels tilt the playing field against clean energy entrepreneurs.

Governments around the world have played an important part in balancing the playing field by creating the markets for clean energy technologies. Legislation intended to provide assistance to US manufacturers producing their own electricity, particularly the Public Utilities Regulatory Policies Act of 1978, created the opening for the emergence of US renewable energy production (Russo, 2001). In the transportation sector, fuel economy standards played a critical role in the use of fuel-efficient technologies (Lee et al., 2011). Policies such as feed-in-tariffs for electricity generated from renewable sources in several European countries and tax credits for wind energy production in the US have been instrumental in creating potential customers for products and services incorporating clean energy technologies. Accordingly, by generating such market opportunities for clean energy technologies these and similar government actions can be expected to increase the extent of local CETE.

The above background suggests that the presence of clean energy technology and market opportunities in the local environment are necessary conditions for CETE. In this sense, the factors supporting CETE align with research on innovation diffusion that emphasizes how factors that promote the development of new technologies and factors that promote the creation of commercial markets for those technologies are both critical components for fostering innovation (Bonaccorsi and Thoma, 2007; Dosi and Nelson, 2010). However, to the extent that entrepreneurship plays a major role in bridging the gap between the development of new technologies and their successful commercial deployment, the presence of technologies and the existence of markets may not be sufficient for promoting adoption and diffusion of clean energy technologies. Attending to how the presence of an external context that is conducive to entrepreneurial activity can explain why (Tolbert et al., 2011). Local attention to clean energy and evidence of clean energy business viability are two particularly salient features of the external context to CETE this study explores.

2.2. Local attention to clean energy issues

Opportunity awareness is an essential feature of the entrepreneurship process of technological development (Alvarez and Barney, 2007;