



The impact of government subsidies and enterprises' R&D investment: A panel data study from renewable energy in China



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HIGHLIGHTS

- Government subsidies have a significant crowding-out effect on enterprises' R&D.
- The moderating role of the attributes of company ownership is examined.
- A panel threshold regression model is used to explore the influence of subsidy.
- First examining the effect of subsidy in the renewable industry in China.

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ABSTRACT

In this research, we aim to understand the influence of government subsidies on enterprises' research and development (R&D) investment behavior, particularly in China's renewable energy sector. We are also interested in examining how the attributes of enterprise ownership act as a moderating variable for the relationship between government subsidies and R&D investment behavior. Three classical panel data analysis models including the pooled ordinary least squares (OLS) model, the fixed effect model and the random effect model are employed. We find that government subsidies have a significant crowding out influence on enterprises' R&D investment behavior and that the influence is further moderated by the attributes of enterprise ownership. Moreover, a panel threshold regression model is used to demonstrate how the influence of government subsidies on enterprises' R&D investment behavior will change when government subsidies increase. Two thresholds, 0.6% and 10.1%, are identified. We recommend that relevant government departments should motivate enterprise R&D investment behavioral intention by increasing subsidies within a certain range. Different attributes of enterprise ownership should also be considered as part of policy reform and re-structuring relating to government subsidies.

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1. Introduction

The G7 countries have formulated a series of policies to support firms in the renewable energy industry. For example, U.S. President Obama released an ambitious 2016 Federal Government Budget Proposal to invest \$7.4 billion in clean energy technology programs across all agencies (Laporte, 2015). Japan and the European Commission also published relevant policies and national programs to help renewable energy firms achieve sustainable development (see EU renewable energy policy (2015)). Consequently, fierce international energy competition and a quick

increase in China's domestic energy demand have drawn the attention of various Chinese government departments including the State Council of China, the Bureau of Energy and The Ministry of Environmental Protection of China. The Chinese central government has recently urged these departments to collaborate together to consider various policies and specific measures for promoting the development of renewable energy.

Since the Renewable Energy Law of the People's Republic of China was enacted in 2005, the Chinese government announced a series of subsidy policies to boost the renewable energy industry (Shen and Luo, 2015). Generally speaking, government subsidies may be offered through direct or indirect supporting approaches in terms of funding allocation, such as VAT returns, fiscal subsidies, tax incentives for innovation, price control, demand assurance and compulsory allocation (Zhang et al., 2014; Shen and Luo, 2015). Moreover, government can set up specified subsidies for different

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industries and at business development stages, such as subsidies for the development of renewable energy technologies. In this research, the term “government subsidies” mainly refers to public R&D research funding granted by Chinese central and local government departments for enterprises to develop new technologies of renewable energy and relevant innovative activities. This is our research focus because we believe that the development of emerging and cutting-edge renewable energy technologies plays a pivotal role in ensuring green, sustainable, renewable energy development. Recent studies show that the average research and development (R&D) intensity of international renewable energy enterprises is higher than that of Chinese listed renewable enterprises. The average research and development (R&D) intensity of Chinese listed renewable enterprises is only 0.76% and so the main barrier for R&D and innovation in the renewable energy industry in China is cost (Costa-Campi et al., 2014).

Despite the growing significance of government subsidies in solving the shortage of private R&D investment of renewable energy enterprises, there is limited understanding of the impact of government subsidies on renewable energy enterprises’ behavioral intention to strengthen R&D at the micro-level. A systematic literature review of prior studies on renewable energy development and government subsidies was undertaken that resulted in the identification of a research gap. Existing research on renewable energy development has mainly focused on exploring various energy policy instruments and the effect of portfolio standards on climate and energy industry development in developed countries and regions, such as the United States (Menyah and Wolde-Rufael, 2010; Roe et al., 2001; Bang, 2010) and the European Union (Jacobsson et al., 2009; Haas et al., 2004; Reiche and Bechberger, 2004). We contend that such findings may not be the same for China. A few other researchers have further examined the potential macroeconomic influence of renewable energy policies on the energy industry in developing countries (e.g., Zhang et al., 2009; Wang et al., 2010; Cherni and Kentish, 2007; Zhao et al., 2011). As noted earlier, due to the lack of understanding of the exact effect of government subsidies on enterprises’ intention to strengthen R&D investment at the micro-level, it is still unclear how the R&D level of firms with government subsidies is to be compared with that of firms without government subsidies. Specifically we want to know if the relationship between government subsidies and enterprises’ intention to strengthen R&D investment is linearly correlated and if government subsidies complement or substitute private R&D investment. These two questions have important implications for the implementation of appropriate policies of government subsidies in developing countries. There is a dearth of literature investigating the above-mentioned issues.

In this study, we address the gap in prior research by investigating the influence of government technology development subsidies on enterprises’ R&D investment behavior, focusing on China’s renewable energy sector. Moreover, we are also interested in examining how the attributes of enterprise ownership moderate the relationship between government subsidies and enterprises’ R&D investment behavior. Unlike renewable energy enterprises in developed countries, Chinese renewable energy enterprises inherently have different types of ownership due to the unique institutional environment and political background. The amount of government subsidies acquired by renewable energy manufacturers with different attributes of ownership may vary greatly. Specifically, the more a company has a close relationship with the Chinese central government, the more financial support this company can obtain. In addition, we further examine how these factors – including government subsidies, enterprise ownership attributes, and political connections of enterprise owners – work together and demonstrate an interactive effect on enterprise R&D investment.

Our paper proceeds as follows. The next section reviews the theoretical foundation for the study. The third section describes the research methodology employed in the investigation. Section 4 provides the results of our data analysis and this is followed by a summary of our research findings in Section 5. The final section rounds off with a discussion of the contributions and policy implications of our research.

2. Literature review

In this section we consider government subsidies for renewable technology development, their impact on private enterprises, and the influence of firm ownership.

2.1. Government subsidies for renewable energy technology development

The effect of government subsidies for technology development has been extensively examined in prior studies from different aspects, such as increasing the rate of green innovation (Johnstone et al., 2010; Aalbers et al., 2013), improving the value of renewable power technologies (Davis and Owens, 2003), promoting the market diffusion of a niche renewable energy technology (Bointner, 2014) and increasing international trades and domestic R&D (Kim and Kim, 2015).

2.2. Differential effect of government subsidies on enterprises’ private R&D investment

Prior studies show that the actual effect of government subsidies on improving enterprise private R&D investment considerably varies across industries. For instance, Arias and van Beers (2013) found a negative relationship between government subsidies and some renewable energy firms’ R&D in terms of the amount of renewable energy technology inventions and patents, particularly those related to the solar and wind renewable energy sector. Lach’s (2002) empirical data from Israeli manufacturing enterprises in the 1990s indicated that firms were more like to increase their private R&D investment over the long-term provided that they could concurrently obtain funding from the Israeli Ministry of Industry and Trade. In other words, government subsidies should be viewed as an alternative funding source instead of replacing enterprises’ private R&D investment (Koga, 2005). Interestingly, some studies found inconsistent empirical findings where government subsidies have a negative (i.e. crowding-out) (Goolsbee, 1998; Kelette et al., 2000) or limited effect (Wallsten, 2000) on enterprises’ private R&D investment. Moreover, some elements of context (e.g., the background of industries and country characteristics) have a moderating effect on the relationship government subsidies and enterprises’ private R&D investment (Czarnitzki and Toole, 2007; Görg and Strobl, 2007; Czarnitzki et al., 2007).

2.3. Ownership influence on enterprises’ R&D activities and subsidies received

During the economic transition process over the past two decades, China has formed a special institution in which company ownership characteristics directly affect their R&D performance and subsequent innovation activities. Compared with other kinds of enterprises (e.g., private enterprises), state-owned enterprises even stress how to innovate effectively and efficiently because they have huge political resources that are rather useful for obtaining government subsidies (Yu et al., 2010; Wu and Liu Cheng, 2011 and Wu et al., 2012).

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