INNOVATION STRATEGIES OF ENERGY FIRMS

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Overview

The energy sector is undergoing a major transformation. This transformation of the energy sector is due to the combination of different technologies and the application of innovations coming from other sectors (Gallagher et al., 2012). Investment by energy firms in innovation may have substantial economic and environmental impacts and benefits. Innovation appears to be a key issue for energy firms in facing challenges regarding energy efficiency, the mitigation of climate change and competitiveness (Anadon, 2012; Eurelectric, 2013) Nevertheless, the amount of R&D investment in energy technologies appears to be low (GEA, 2012) although recently a small recovery seems to have taken place (Jamasb and Pollit, 2015).

Internal R&D is a main input and driver of the innovation process but innovation involves other activities such as capital purchases and other current expenditures related to innovation. While some papers have analysed the R&D activities of energy firms, few of them have examined the different types of innovation activities. The three main innovation activities in quantitative terms as well as because of their effects on the introduction of new products, services and processes are internal R&D, external R&D and the acquisition of advanced machinery, equipment or software. In this paper we first analyse the main characteristics of the firms regarding their decisions to invest in each of these three innovation activities and how these characteristics differ. In this analysis, we take the potential persistence of innovation activities into account. Second, we examine the role that different innovation objectives have on these decisions. Third, we analyse whether there is some complementarity between these three innovation activities.

Methods

To carry out the empirical analysis we rely on data for private energy firms from the Technological Innovation Panel (PITEC) for Spanish firms for the period 2004-2013. To analyse the decisions of the firms to invest in internal R&D, external R&D and acquisition of advanced machinery we use panel triprobit models. These models allow the examination of potential complementarity between these three decisions. In our specifications, the dependent variable is dichotomous and corresponds to the decision to engage or not in one of the three innovation activities considered. We have carried out three different estimations for each of these innovation activities.

The independent variables of the three estimations are as follows. First, we have included a lag of the dependent variable to control for potential persistence of innovation activities. Second we consider, according to the literature on the determinants of the decision to engage in R&D and innovation in firms in general (Cohen, 2010) but also specifically in energy firms (Costa et al., 2014; Salies, 2010), size, age, public financing, foreign capital and belonging to a group as explanatory variables. Third, we include a set of variables regarding the objectives of innovation in order to examine the motives that drive decisions to invest in each of the three categories. We consider, according to the available information, four groups of motives for innovating (product innovation, process innovation, the reduction of environmental impact and meeting environmental, health and safety regulations). Finally, we have also included the potential lack of funds within the firm.

Results

The results of the estimations show the persistence of R&D decisions in energy firms, similarly to the empirical analyses of manufacturing activities. This persistence also takes place in investment in advanced machinery.

Regarding firm characteristics, the results show significant differences for the three innovation activities. First, the estimations confirm the importance of a certain size in undertaking R&D projects while firms of all sizes acquire advanced machinery. Second, age does not seem to have a significant influence on R&D and innovation decisions

although older firms seem to be more likely to acquire advanced machinery. Third, public funds have a positive effect particularly on the decision to invest in R&D within the firm.

The results of the estimations also show significant differences in the effects of the objectives of innovation on decisions to engage in the different innovation activities. R&D, both internal and external, is particularly related with environmental motives and meeting regulatory requirements. Instead, the process innovation objective is the main factor in the acquisition of advanced machinery. These results suggest that R&D and to acquire advanced machinery are intended to address different technological and market challenges. The results also show that financial obstacles do not seem to be an important barrier hampering innovation in the energy industry.

Finally, the results support, as recent literature on R&D decisions show, the existence of interdependencies between doing internal R&D and acquiring R&D services. On the other hand, the decision about whether to invest in R&D or in advanced machinery is independent which again suggests that these investments pursue different innovation objectives.

Conclusions

The energy industry is experiencing substantial transformation and technological change. The objective of this paper is to improve our understanding of the innovation activities of energy firms. We have, first, examined the main characteristics of energy firms regarding their choice of innovation strategy. In this analysis we have considered the main three innovation activities, internal R&D, external R&D and the acquisition of advanced machinery. Second, we have analysed the role that different innovation objectives play in the decisions of energy firms to invest in R&D and innovation.

The main conclusions from the analysis carried out are as follows. First, innovation investments are highly persistent. Second, the characteristics of the energy firms that invest in each of these innovation activities are different. Third, financial costs do not seem to be an important barrier in the energy industry to engaging in innovation. The results also show that there are significant differences in the effects that the objectives of innovation have on decisions to engage in the three different innovation activities. While R&D is addressed to environmental objectives and meeting regulatory requirements, the objective of process innovation is the main driver of the acquisition of advanced machinery and equipment. Finally, the results suggest the existence of interdependencies between doing internal R&D and acquiring R&D services but not between R&D and the acquisition of advanced machinery.

The results have some policy implications regarding how to foster innovation in the energy industry. First, our results suggest that public support to private R&D as well as environmental regulation requirements are positively related with the R&D engagement of private firms. Second, to face the innovation challenges requires that energy firms combine internal and external R&D sources and increase cooperation on innovation between firms in the energy sector and those in other industries and also with public institutions and agents.

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