R&D investment and dynamic efficiency in the electricity market

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Overview

We explore R&D investment for electricity-generating firms in the electricity spot markets and their impact on welfare. We analyse generating firms in dozens of countries in Europe, North America and Asia especially including Korea and Japan. To do so, we present a model endogenizing electricity prices and R&D investment, and apply the model to the electricity spot market data.

Since technical efficiency of an industry is affected by cumulative investments in capital goods and innovations, these impacts can have profound implications for the future reliability of the electricity system (Jamasb and Pollitt, 2008; Joskow, 2006). Reduced investment of the electricity-generating firms may be detrimental to the reliability and the efficiency of the electricity system as well as an obstacle to building innovation capabilities within the industry.

Particularly, environmental technologies in the electricity sector require massive investment.

Many scholars have found that R&D investments in the liberalized electricity sector have dropped after market liberalization. These decreases seem to be viewed largely as undesirable (i.e. under-investment). However, it may be argued that these changes in the R&D investment level may reflect removals of some of duplicative projects and thus imply higher efficiency of the investment. Also the declines of R&D investment may imply the shift of innovation locus to the upstream equipment industry.

At present, it is not clear if the amount of R&D investment of the electricity industry is below, over, or at an optimal level. Thus, we question whether the current electricity market increases or decreases R&D incentives of firms, and whether the level of R&D investment is socially desirable.

✓ Effects of market restructuring on R&D investment

The restructured market may negatively affect energy R&D (Bell and Schneider, 1999; Bell and Seden, 1998; Dooley, 1998) by lowering R&D investment level (Sanyal and Cohen, 2009) as well as by altering a firm's behavior toward innovations (Hattori, 2007; Jamasb and Pollitt, 2009; Sanyal, 2007). Jamasb and Pollitt (2008) conclude that the restructuring of the electricity market may also reduce R&D investment and innovation. The deregulation of the United States (US) electricity retail market led to a decline of overall R&D investment by electricity firms (Sanyal, 2007; Sanyal and Cohen, 2009).

Methods

While market structure, prices, demand and R&D spillovers may influence how much a firm invests in R&D, the sign and size of impacts of them are not clear in theories and rather may be specific to a market or industry. Therefore, we try to estimate the net effect of each on R&D investment. Instead of R&D spillover itself, we construct the measure of firm-level knowledge stock using the R&D investment data to capture the effect of cumulative investment and spillovers of R&D by the others firms and the government. The estimated market conduct parameter may represent underlying market structure. R&D investment, Prices and demand are endogenized in the estimation model

To model the interactions between market competition and R&D investment, we modify Roller and Sickles (2000)'s approach that based on the conjectural variation model, specifies and estimates a structural equation model. The conjectural variation method allows for estimating underlying market competition (market conduct) without assuming the market conduct previously.

While Roller and Sickles (2000) specify a product-differentiated demand function, Berry (1994) suggests the alternative demand specification that is a method for estimating discrete choice model of product differentiation. It gives a simpler way for calculating social welfare.

Berry (1994), however, restricts market competition to Nash competition. The conjectural variation model generalizes market competition, which is derived by profit maximization through pricing competition. Therefore, we apply the conjectural variation to the demand specification of Berry (1994).

Results (expected)

First, we can provide the estimates of the effects of current market competition, electricity prices, demand, and knowledge stock on R&D investment of electricity-generating firms. Thus, we expect to know that current market provides incentives or disincentives of R&D. Second, we can provide the estimates of the effects of R&D investment (or knowledge stock), market structure, demand on electricity prices. Thus, price variations can be explained with R&D investment (or knowledge stock), market structure and demand. Third, we can estimate the impact of R&D investment on social welfare and we expect to see whether current R&D is being under- or over-invested.

Conclusions (expected)

This study provides empirical evidences in the electricity market on what influences electricity prices and R&D investment while considering their endogeneity in the estimation. Also the other objective of the study is to assess empirically whether current R&D level is socially sufficient. If it turns out that the market does not provide sufficient R&D incentive and R&D investment is below socially desirable level, then the next step may be to know how to increase R&D incentives. One may want to rely more on government R&D policies (i.e. public R&D projects, R&D susidies). It is, however, important to bear in mind that government intervention is unlikely to be a panacea because it may crowd out private R&D. We expect our research to provide a innovative methodology to assess the overall effet of research and development activities on energy industry, especially on electricity industry.

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