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Electricity sector liberalisation and innovation: An analysis of the UK's patenting activities

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ABSTRACT

Liberalisation has had a marked effect on innovative activities in the electricity industry. In particular, electricity reforms have resulted in a reduction in R&D spending in the sector. R&D and patenting activities are respectively regarded as innovative inputs to and outputs from technological progress. The present paper examines the effect of the reforms on patenting activity in the UK electricity sector. The results indicate that electricity related patents in non-nuclear and renewable technologies have increased in the post-liberalisation period. We attribute this trend to the increased commercialisation of the sector. While this development is positive, we argue that a lasting decline in R&D will in the longer run reduce technological progress and innovation in the sector. In order to maintain the pace of innovation, we discuss the need to design a new framework for innovation systems that is commensurate with the functioning and incentive mechanisms of a liberalised sector.

1. Introduction

The liberalisation of electricity sectors around the world which began in the early 1990s has transformed the organisation and operating environment of the electricity supply industry (ESI). In the UK in particular, liberalisation has resulted in important structural changes, the introduction of competition in the wholesale generation and retail supply markets, regulatory reform and the creation of an independent regulator. Those significant changes achieved some improvement in the technical efficiency of the industry. However, in the long run, innovation is the primary source of continued efficiency and productivity improvement in the sector.

Evidence suggests that liberalisation has, at least partially contributed to a decline in R&D. A survey of the industrial literature in Jamasb and Pollitt (2008) suggests that most aspects of electricity reform theoretically and empirically have had a negative effect on R&D in the sector. The electricity industry has a rather low R&D intensity and a lasting decline in innovative activities of the sector is a cause for concern for long-term technical change and achieving climate change and energy policy objectives in the sector. However, the effect of liberalisation on patenting activity as an important quantitative indicator of output of innovative efforts is not well understood. This paper aims to further investigate the link between liberalisation and innovation.

The literature concerning patents on the one hand and innovation and technical change on the other can be classified into three categories; first, concerning the legislation and functioning of the patent system; second, studying the rationale of the system, and finally, using patents as technical information (Basberg, 1987). The latter category is in turn divided into three types: (i) the studies of patents and technological change measured by patents and economic development, (ii) those addressing diffusion of technology across countries, and (iii) those analyzing the process of innovation and the relationship between R&D, patents, and productivity. The emergence of liberalisation and privatisation of infrastructure and network industries around the world since the early 1990s has given rise to the need for new types of studies - such as Johnstone et al. (2008) and Jamasb and Pollitt (2008) - that examine the effect of reforms and energy policies on innovation in general, and R&D and patents, in particular.

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Innovation can broadly be defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD, 2005, para. 146). For the purpose of this study, we refer to innovation as the process of technological progress in which basic and applied research and development (R&D) are the main inputs and with patents being an important indicator of the output of the process. This paper presents an empirical study of the effect of electricity sector liberalisation on patenting activity in the UK. We assess this impact by examining the changes in patenting activity before and after the liberalisation of the sector in the 1990s. The UK was a pioneering country in implementing an extensive electricity sector liberalisation program making it a particularly suitable case for such a study.

The next section presents the structure and main actors of the UK electricity sector, and reviews the relevant studies on the relationship between liberalisation, innovation, and patenting in the electricity sector. Section 3 describes our methodology for analyzing patents. Section 4 presents the analysis of patents by major actors in the UK electricity sector prior to and after liberalisation. Section 5 presents the results of patenting activities at the sector level and for two renewable technologies. Section 6 discusses aspects of developing a suitable framework for the energy technologies innovation system in the post-liberalisation electricity sector. Finally, Section 7 concludes the study.

2. Electricity sector liberalisation, innovation, and patents

2.1. Background to the UK electricity sector reform[2]

The electricity system consists of generation (production and conversion), (long-distance) transmission, distribution, and (retail) supply functions. These activities are inherently interdependent and often providing justification for creating vertically integrated structures of the sector. Whereas generation and supply activities are potentially competitive activities, transmission and distribution functions are natural monopolies requiring regulation and oversight. Furthermore, the strategic importance of the sector in modern economy and society often led to public ownership or control.

The 1990 electricity sector liberalisation involved the following major steps: restructuring, privatisation, regulation, and competition. More specifically, this required the vertical unbundling of the generation, transmission, distribution, and retail activities and the privatisation of major actors. Hence, in England and Wales, generation and transmission, owned until then by the Central Electricity Generation Board (CEGB),[3] was divided into generation companies and the National Grid Company (NGC). The CEGB was in charge of supplying the 12 independent Area Electricity Boards (AEBs) responsible for the distribution and supply (retailing) of electricity. The introduction of competition in the wholesale electricity market necessitated further divestiture of generation assets, with the separation of nuclear from fossil generation and the creation of new generators such as Nuclear Electric, Scottish Nuclear, Magnox Electric, British Energy, PowerGen, and National Power.

The role of AEBs was redefined in steps which led to legal separation of their distribution and supply functions in 2000, and the emergence of distribution network operators (DNOs).[4] The NGC owned by the Regional Electricity Companies (RECs) took over CEGB's role in transmission. Furthermore, the introduction of competition in generation was complemented by the establishment of competitive wholesale and retail markets as well as the creation of an independent regulator, the Office of Electricity Regulator (Offer), which later merged with the Office of Gas Regulator (Ofgas) to form the Office of Gas and Electricity Markets (Ofgem). Fig. 1 shows the main actors prior to and after the 1990 reform.

The reforms of the electricity sector also brought changes on R&D spending. In the years preceding liberalisation government R&D in the sector had begun to decrease. In particular, the single largest spending on R&D was on nuclear power technology which from the 1940s to 1970s had links to military applications.[5] However, from the mid-1980s, nuclear R&D spending began to decline as a result of cutbacks in costly research projects. Fig. 2 shows government energy R&D spending on nuclear and other major categories.

As can be seen from the figure, nuclear power was not the only area to face a decline in R&D spending over this period. Indeed, this decline was broad based and included spending reduction in all major categories. We also note that it began in the mid-1980s, prior to liberalisation. In recent years, against the backdrop of security of supply and climate change policy targets, the spending level shows signs of revival in particular on renewable energy, although the increase is from a low base (Fig. 3).

There is only limited data on the R&D spending of privatised electricity companies in the aftermath of liberalisation. This is partly due to the lack of a common definition of what constitutes R&D and partly because of potential commercial sensitivity of such data (Griliches, 1990; Jamasb and Pollitt, 2008; Taylor, 2001). It appears, however, that the new entrants to the competitive generation markets (Independent Power Producers, IPPs) do not spend notable amounts on R&D. Evidence from electric utilities in the US and Japan indicates that their R&D spending declined in response to deregulation of the sector (Cohen and Sanyal, 2004; Jamasb and Pollitt, 2008; Sanyal and Cohen, 2004). Fig. 4 shows the R&D spending from major electricity generation and transmission companies in the UK before and after liberalisation.

The R&D spending data of the distribution utilities shows a clear decline in R&D by the privatised utilities in this sector. It should be noted that, as natural monopolies, distribution utilities have been subject to an incentive regulation regime following the liberalisation. This means that private utilities are not likely to invest in R&D beyond what they would be allowed by the regulator (Jamasb and Pollitt, 2008). As a result, since 2005, the introduction of the Innovation Funding Incentive (IFI) which allows distribution (and subsequently transmission) utilities to spend up to 0.5% of their revenue on R&D has had a positive effect on spending levels by distribution utilities (Fig. 5).

2.2. Liberalisation and innovation

Evidence suggests a close relationship between R&D and scientific publications on the one hand and patenting activity on the other, which justifies the examination of patents to assess inventive activities. The rate of return on R&D investments has been found to be persistently high, with estimates of the social rate of

[2] This sub-section draws extensively from Simmonds, 2002; Jamasb and Pollitt, 2007; Jamasb et al., 2008. For an extensive discussion, see Surrey (1996). For an international perspective, see Joskow (1998).

[3] In Scotland, generation, transmission, distribution and supply were carried out regionally by the North of Scotland Hydro-Electric Board (NSHEB) and the South of Scotland Electricity Board (SSEB) and in North Ireland, by Northern Ireland Electricity (NIE).

[4] There are twelve DNOs in England and Wales, and two in Scotland.

[5] The public R&D figures are exclusive of R&D spending on military applications. In addition, the outcomes of defence related R&D would not normally lend themselves to patenting.