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How national institutions influence technology policies and firms' knowledge-building strategies: A study of fuel cell innovation across industrialized countries

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ABSTRACT

The central thesis advanced in this study is that firms' knowledge-building strategies can be usefully explained by the variations in their national institutional contexts. Using an inductive approach, a study of fuel cell innovation across the U.S., France, Japan and Norway demonstrates how countries' socio-political institutions – characterized by their levels of statism and corporatism – contribute to variations in technology policies pertaining to investment, collaboration, internationalization, and diversity. These technology policies are sources of advantages (and disadvantages) for firms, with implications for their knowledge-building strategies. The proposed theoretical framework is especially relevant in the context of industry emergence and R&D internationalization.

1. Introduction

A cross-national comparison of technology policies demonstrates that large variations in key dimensions such as the nature of R&D investments, collaboration, internationalization, and technological impact, persist even within the group of industrialized countries (OECD, 2007). How can we explain these variations in innovatory approaches and what are their implications for the knowledge-building strategies of firms in an emergent technology sector? Understanding the determinants of the cross-national variations in technology policies and their affects assumes special significance not only for new industry creation, but also when making location choices as multinational firms internationalize their R&D activities (Patel and Pavitt, 1991; Pavitt and Patel, 1999; Penner-Hahn and Shaver, 2005).

A large number of studies have recognized knowledge resources as a vital component of firms' innovatory and competitive advantage (Winter, 1987; Kogut and Zander, 1992; Zander and Kogut, 1995). By adopting an institutional perspective to explain technology policy variations and the associated impacts on knowledge-building, this study draws on the established wisdom that national innovation systems are embedded in a long history of interactions between the political and economic elites creating distinctive national systems of property rights, contractual relationships and governance systems adopted by resident firms (Fligstein, 2001; Guillen, 2001; Vitols, 2001; Casper, 2001; Casper and Matraves, 2003).

Based on simple indicators, the study evaluates the relevance of social and political institutions – reflected in the levels of statism and corporatism – for understanding the central tendencies pertaining to the key macro indicators of national technology policies. Next, to establish the salience of this institutional typology in the context of a specific industry, the study uses a case-based inductive approach to compare fuel cell technology policies in the U.S., France, Norway and Japan, in four key areas—the allocation of public resources, collaboration involving public and private actors, extent of foreign participation and technological diversity in the national innovation system. The variation in technology policies revealed by this analysis maps closely to the core institutional characteristics of countries reflected in their degrees of statism and corporatism. Finally, drawing on this comparative analysis of fuel cell technology policies that are embedded in distinctive national institutions, the study proposes firm-level implications for knowledge-building.

2. Cross-national variations in innovatory approaches: an institutional perspective

An appreciation of the macro institutional influences on the development and commercialization of emergent technologies has led to a large number of studies on how national institutions have either supported or constrained innovation in specific industries

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(Van de Ven and Garud, 1989; Porter, 1990; Dobbin, 1994; Murtha and Lenway, 1994; Mezias and Kuperman, 2001; Garud et al., 2002; Garud and Karnoe, 2003; Edquist, 2004; Murmann, 2004).

National institutions are important because they shape the technology policies, and the resultant opportunities and capabilities of firms engaged in technological development (Fligstein, 1991; Dobbin, 1994; Murtha and Lenway, 1994; Bartholomew, 1997; Lundvall, 1998; Mowery and Nelson, 1999; Soskice, 1999; Malerba, 2002; Casper and Whitely, 2004). Viewed from an institutional perspective, innovation is as much a social and political activity as it is a technical and rational process (Van de Ven, 2004). Thus, the emergence of new technologies is situated in a collective enterprise involving firms, government organizations, universities and consumer groups, such that firms not only engage in economic activity but are also involved in social relationships (Swaminathan and Wade, 2001).

Consistent with these findings, the Organization of Economic Cooperation and Development (OECD) in its recent report comparing innovation policies across industrialized countries noted that variations in industrial performance can be attributed in large measure to two factors—the role of government and the nature of cooperation among firms and non-firm actors (OECD, 2007). In a related study, Spencer et al. (2005) developed a theoretical framework suggesting that cross-national variations in the role of government and the nature of cooperation among societal actors can be usefully explained by juxtaposing two constructs – the levels of statism and corporatism – that characterize the socio-political institutional context of industrialized countries. They argued that national institutions characterized by a high level of corporatism (e.g. Japan and Germany) are usually more equitable in terms of distribution of technological and financial resources. In addition, corporatism results in extensive collaboration and high degree of welfare orientation that often pressures private firms to share social burdens (Schmitter, 1974). Whereas collective requirements and duties are stressed under corporatist systems,[1] individualism in interests and choices are more prominent in less corporatist or pluralist systems (Cawson, 1985). In less corporatist systems of society of which the U.S. and U.K. are cited as primary exemplars[2] (Hicks and Kenworthy, 1998), multiple and widely dispersed interests create competition but can also lead to cleavages and conflicts over policy preferences (Jankowski, 1989; Crouch and Streeck, 1997; Whitley, 2000; Royo, 2002).

Similarly, the level of statism characterizes the role of government in setting national technology policies and priorities[3] (Spencer et al., 2005). Highly statist models observed in Japan and France, for example, feature an imagery of central administration and planning of society or what Dyson (1980) called "integrated models of public power". The state in this model is the primary locus of social rationality, and politics are grounded in an objective search for national interests (Dyson, 1980; Badie and Birnbaum, 1983). In contrast, more societal or liberal systems found in Norway and the U.S., for example, locate authority in society at large, with government acting as an instrument and expression of society with less independent legitimation and standing (Skocpol, 1985; Katzenstein, 1978). The level of statism impacts the competitive landscape because policies instituted by government have implications for property rights allocated between public and private actors and the governance of transactions (Dyson, 1980; Hart, 1992; Murtha and Lenway, 1994).

The motivation for using the statist and corporatist dimensions of the national institutional environment in the present study is based on their utility for explaining both innovation and collaboration. The state, represented by the government, plays an important role in the development of new technological breakthroughs such as fuel cell technologies that are likely to impact the national and global economies. Further, new technologies such as fuel cells require extensive knowledge-building to allow for the transition to a hydrogen-based economy that is expected to make existing energy technologies obsolete in a variety of applications. Such an effort requires knowledge transfer through participation and involvement of a variety of firm and non-firm actors that are involved with producing and using fuel cell technologies. The nature of collaboration, therefore, can play a crucial role for addressing issues concerning technological hurdles and social acceptance that are perceived as deterrents to the successful diffusion of fuel cell technologies. The corporatist dimension helps better understand the proclivity of society to engage with different actors that constitute it and the social drivers for such engagement.

The relevance of these socio-political constructs in understanding the antecedents of the distinctive innovatory approaches is corroborated by an examination of relevant indicators of national technology policies across industrialized countries. Based on a 2-way analysis of variance, Tables 1 and 2 illustrate how the key indicators of national innovation systems obtained from the Science Technology and Industry Scoreboard (OECD, 2007) across 21 industrialized countries vary significantly across groups of countries according to their levels of corporatism and statism. Countries associated with each polity[4] (or system of rules that incorporate the characteristics of the state and civil society) are based on their core institutional structures, so that the existence and efficacy of statism and corporatism may be regarded as a matter of degree, and countries may vary in their proximity to the ideal type (Jepperson, 2002; Williamson, 1989).

2.1. Investment sources

Analysis of the data presented in Tables 1 and 2 shows that the percentage of government investment in civilian R&D tends to vary significantly across levels of corporatism. Less corporatist or pluralist countries like the U.S. and France, for instance, where multiple interest groups compete for resources, receive less government investment in civilian R&D. Higher government investment in more corporatist countries like Japan and Norway, for instance, likely results from a more unified collective bargaining apparatus. When considering the role of venture capital, the data suggests that this type of private investment is considerably smaller in countries characterized by strong states such as France and Japan compared to the U.S. and Norway, where the state plays a more facilitative role. Consequently, the data suggests that higher levels of corporatism and lower levels of statism embodied in the social-corporatist environment of Norway, for example, generates

[1] Corporatist theory can be applied to the macro, meso and micro levels of analysis (Cawson, 1985). In some countries like Germany, corporatism manifests itself at the macro level through extensive industry-level coordination. In Japan, the concepts of meso-level or group-level coordination such as the keiretsu are also in evidence. Micro-level corporatism may be observed when a monopoly exists and/or large or powerful firms can directly negotiate investment strategies with the state as in France (Chesnais, 1993). Our analysis, however, pertains primarily to macro- and meso-level corporatism.

[2] Hicks and Kenworthy (1998) and Kenworth (2003) provide a more detailed explanation of the measures used to develop corporatism scores based on the extent to which interest groups collaborate in society.

[3] Previous works categorized countries as statist or societal based on their composite scores on a number of dimensions such as the size of bureaucracy (Nettl, 1968), amalgamation of the political and administrative functions of government (Badie and Birnbaum, 1983), involvement of the government in industrial planning, investments, and banking practices, and business and government relations (Wright, 1988).

[4] Examples of countries corresponding to high and low levels of statism and corporatism are provided in Table 5.