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Divergent diffusion: Understanding the interaction between institutions, firms, networks and knowledge in the international adoption of technology

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ABSTRACT

Why do certain technologies diffuse globally while others spread only within certain areas of the world? I analyze the uneven process of international technology diffusion by focusing on how institutions moderate the impact of firm, network, and knowledge characteristics on the adoption of technology. The study shows that better economic institutions lower transformation costs; that similarities across social institutions minimize transmission costs; and that effective political institutions reduce transaction costs for technology diffusion. The impact of each institution-type on the diffusion process is based on the relative weight of the three different knowledge dimensions embedded in the technology. Complex technologies are most affected by economic institutions; tacit technologies are most dependent on social institutions; and systemic technologies are most influenced by political institutions.

1. Introduction

There is a growing literature on technology adoption that is focused on the process of how an innovation spreads from its source to the different adopters within a social system (Rogers, 1995; Strang & Soule, 1998). Numerous scholars have proclaimed the importance of rapid technology adoption in sustaining competitive advantage (Greve, 2009; Zhu, Kraemer, & Xu, 2006). Firms that adopt technology from foreign sources generate superior research capabilities and better financial performance, more than firms who obtain technology from domestic sources (Cohen & Levinthal, 1990; Kafouros & Forsans, 2012). The adoption of foreign technology accounts for more than 90 percent of national productivity growth (Keller, 2004) and is a major factor in the economic performance of countries (Rogers, 1995). The ability to absorb technologies internationally has become more important with the dramatic increase in the speed by which technology spreads: the pace of adoption of the automobile, the airplane and the fixed line telephone has been superseded by the relatively rapid spread of the radio and the television, which in turn have been outpaced by the diffusion of the personal computer, the mobile telephone and the Internet (Comin & Hobijn, 2004).

This hastening pace of technology diffusion appears remarkable until someone attempts to make a credit card payment, conduct an online purchase, buy a company's stock, or apply for a 10-year mortgage in many countries. While the latest mobile devices and electronic gadgets may be readily available throughout the world, other commercial technologies are not offered by firms in many countries despite the presence of sufficient market size or information technology infrastructure. The non-adoption of certain technologies – such as credit cards – reduces the productivity of other related technology investments – such as electronic commerce (Oxley & Yeung, 2001), and retards the capacity of domestic firms in absorbing technologies at the global frontier (Colombo & Mosconi, 1995; Hollenstein & Woerter, 2008). This uneven transmission of technologies magnifies the divergence in technological capabilities of firms across nations, despite the supposed globalization of more prominent technologies.

So what drives the uneven diffusion of technologies across firms in different countries? The broader international business literature has tangentially grappled with this research question. IB scholars have described the outcomes of such uneven technological adoption in terms of institutional voids (Khanna & Palepu, 1997); these studies talk about the underdevelopment of political and market institutions in emerging markets as an impediment to investments. Other scholars speak in terms of semi-globalization (Ghemawat, 2003, 2007) and regionalism (Arregle, Beamish, & Hébert, 2009; Rugman & Verbeke, 2004, 2007) which highlight how institutional differences across countries impede trade and investment flows. While these theories highlight the role of institutional differences as hindrances to global technological diffusion, they do not fully analyze the ways by which certain

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firms, technologies, or countries attain greater levels of technology integration than others.

At the same time, the literature on technology adoption has concentrated on analyzing the spread of technologies across countries or firms, without fully integrating the role of technology, firm, country and industry into the adoption process. This is because the literature is segmented into three separate research streams. First, there is scholarship on firm-level technology adoption that highlights the different firm- and network-specific characteristics – such as firm size (Davies, 1979; Gooderham, Nordhaug, & Ringdal, 1999), network position (Greve, 2009) and strategic orientation (Vilaseca-Requena, Torrent-Sellens, Meseguer-Artola, & Rodríguez-Ardura, 2007) – that facilitate technology adoption. Second, the literature on national-level technology adoption focuses primarily on the national characteristics that affect country-to-country technology diffusion, like the level of economic development (Comin & Hobijn, 2004), human capital endowments (Caselli & Coleman, 2001), and trade openness (Coe & Helpman, 1995; Comin & Hobijn, 2004; Eaton & Kortum, 2002; Keller, 2004). Third, research from the knowledge transfer literature looks at adoption from a micro-level and explains how the characteristics of the knowledge embedded in technology affects its diffusion across organizations (Garud & Nayyar, 1994; Kedia & Bhagat, 1988).

This paper makes two contributions to the international business literature. First, it integrates prior research from the three streams of technology adoption studies to analyze how the three different institution-types – economic, social and political – moderate the role of knowledge, firm and network characteristics in the technology adoption process. This integration draws from current IB theory which claims that the analyses of international processes require that studies incorporate the national-, industry- and firm-based aspects of firm behavior (Makino, Isobe, & Chan, 2004; Peng, Wang, & Jiang, 2008). The starting premise of the paper reflects the institutional view that international technology adoption is materially different from purely domestic adoption because differences in each country's institutions – regulations, norms, political structures, cultures and stages of economic development – modify the technology diffusion process (Erumban & de Jong, 2006). The paper suggests *how* differences in institutions modify the relative significance of the knowledge-, firm- and network-specific characteristics in each firm's decision to adopt a foreign technology. This multi-dimensional model provides a baseline for helping scholars understand which technologies will diffuse quickly and globally and which technologies will diffuse slowly and regionally.

Second, the paper advances academic research on international business by providing an underlying framework for supporting the IB theories that challenge the idea of unbridled globalization, such as regional strategy (Arregle et al., 2009; Rugman & Verbeke, 2004, 2007) or semi-globalization (Ghemawat, 2003, 2007). While these theories are supported by much empirical proof that firms are unable to fully globalize their operations because of the cultural, administrative and economic differences across countries, these theories fail to fully explain *why* certain firms or industries are more globalized than others. Through an integrated framework incorporating knowledge-, firm-, and institutional-level variables on explaining international technology flows, the model proposed in this paper provides some testable predictions to validate which technological phenomena are more affected by the constraints raised by regionalization and semi-globalization theory.

The rest of the paper is structured as follows. The next section briefly reviews the literature on firm-level technology adoption. The subsequent section summarizes the national-level adoption literature to highlight the role played by different institutions in this process. The following section draws from the knowledge transfer literature to show how the different determinants of knowledge transferability affect the relative importance of institutions. The concluding section provides a discussion on the managerial implications of this model and some directions for taking the literature forward.

The relationships enumerated in the paper are summarized in the illustrative model in Fig. 1. The figure summarizes how the pace of technology adoption is determined at three levels: at the knowledge-, institutional- and organizational-levels. Each of the arrows symbolizes one of the interactions between the different determinants of technology adoption that will be hypothesized in the subsequent discussions.

2. Firms, networks and technology adoption

There are two main sets of overarching theories that explain the processes that lead to technology adoption (Ansari, Fiss, & Zajac, 2010; Attewell, 1992). The first set of theories springs primarily from the economics literature, which assumes that firms are *rational* actors that efficiently scan the environment when deciding which innovations to adopt internally. The second set of theories incorporates more of a sociological perspective and highlights the influence of inter-firm *social* networks in propelling the spread of technology.

Under the rational frame of the technology adoption, the decision to adopt new technologies is determined by the costs and the expected returns to be generated by the investment (Attewell, 1992; Mansfield, 1968). When technology is first discovered, the novelty of the innovation makes it difficult for the firm to estimate its costs and benefits because its usage is surrounded by uncertainty and imperfect information (Jensen, 1982; Reinganum, 1983). Because profit estimates are uncertain at the onset, some firms are encouraged to wait and gather more information before deciding to adopt (Jensen, 1982; Oliva, 1991). Over time, the

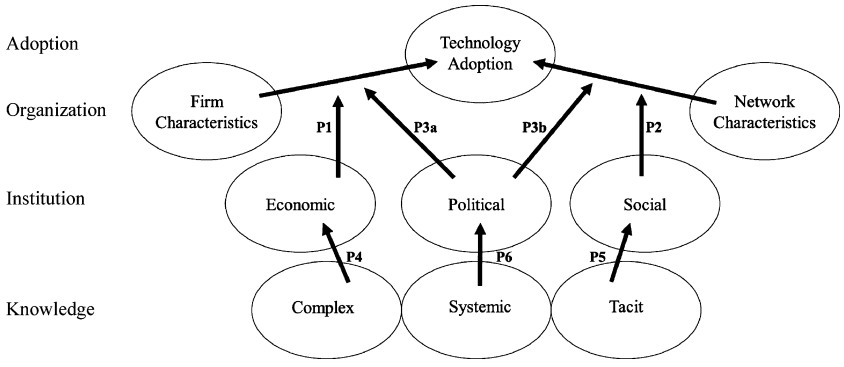

Fig. 1. Illustrative model of the determinants of technology adoption.