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Capability accumulation, innovation, and technology diffusion: Lessons from a Base of the Pyramid cluster

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ABSTRACT

Although research on industry clusters has made many valuable contributions, a dearth of empirical evidence and theoretical reflection about the characteristics of Base of the Pyramid (BOP) clusters has persisted. Consequently, the literature still lacks a framework that incorporates the context, challenges, and dynamics encountered in such clusters. Drawing from clusters, capability accumulation, and innovation literatures, we develop a theoretical framework that provides a more fine-grained understanding of the dynamics encountered in BOP clusters, the role of support organizations, the importance of capabilities accumulation in firms, and the challenges associated with technology development and diffusion within such settings. We use case study research method conducted in a traditional granite-mining cluster in Brazil, based on 154 interviews with key informants between 1999 and 2011. Our findings suggest that BOP clusters present different dynamics when compared to clusters elsewhere, because of the existence of idiosyncrasies such as additional barriers to technology diffusion, especially when coupled with a lack of coordination and misaligned policy approaches. We contribute to the literature by arguing that the process of technology diffusion in BOP clusters is hindered by these barriers, and that technology development without wide diffusion within BOP clusters can become a source of social exclusion and wealth concentration. Moreover, in large emerging economies, global pipelines are not necessarily the only path for BOP clusters to achieve competitive advantage and sustainable growth, as suggested in the clusters literature.

1. Introduction

Over the past two decades, capability accumulation in organizations has become an enduring research theme in the innovation literature. Business leaders and policy makers recognize that, to be competitive in the current business environments, knowledge and capabilities play significant roles in any industrial setting. Such capabilities often provide strategic and competitive advantage to firms, supply chains, and clusters.

Following this growing awareness of the importance of knowledge and capabilities, a robust body of literature is examining how firms learn and absorb external knowledge (e.g., Cohen and Levinthal, 1990; Caloghirou et al., 2004), how firms accumulate such knowledge (e.g., Bell and Albu, 1999; Figueiredo, 2002), how firms manage their knowledge (e.g., Hedlund, 1994; Coombs and Hull, 1998), how firms create new knowledge and innovate (e.g., Jensen et al., 2007; Silvestre and Dalcol, 2009), and what type of capabilities are needed to innovate (e.g., Galunic and Rodan, 1998; Zander and Kogut, 1995), among other streams.

Since Marshall's (1920) pioneering work, another body of literature on economies of agglomerations has been developed. Researchers argue that knowledge and capabilities are more easily acquired, and innovations are more efficiently developed and diffused within clusters (Porter, 2000; Basant, 2002). For example, Batheld et al. (2004) suggest that the existence of local buzz (i.e., high intensity communication of high quality and relevance) combined with a well-developed system of global pipelines (i.e., connections between the local cluster and the rest of the world) lead to more dynamic clusters in terms of knowledge creation, capability accumulation, and innovation. Consequently, geographical proximity tends to be perceived as a positive advantage for firms in terms of their performance (Porter, 1996; Maskell, 2001; Silvestre and Dalcol, 2007, 2009).

However, the processes associated with the way firms create knowledge, accumulate capabilities, and innovate can vary significantly when comparing developed and developing countries (Lall, 1992; Shin, 1996; Kim, 1998). These differences are especially acute when considering Base of the Pyramid (BOP) settings. This is because BOP regions, which are usually located in least-developed

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countries and rural areas of emerging economies, are idiosyncratic environments and should be analyzed as such (Prahalad, 2007; Kandachar and Halme, 2006; Anderson and Billou, 2007; Hall et al., 2011; Arora and Romijn, 2012). Studies suggest that such BOP idiosyncrasies are generated by factors such as the level of public presence (e.g., De Soto, 2000; Rivera-Santos et al., 2012), the role of institutions (Khanna and Palepu, 1997; Khanna et al., 2005), the level of industry coordination (Webb et al., 2010; Hall et al., 2012a, 2012b), and the intensity of inter-organizational interactions (Knorringa, 1994; Todtling and Tripl, 2005).

Although this prior research has made many valuable contributions, several important issues that require research attention remain understudied. The literature suggests that little empirical evidence and theoretical reflection can be found about the characteristics, challenges, and strategies that result in the firm success or failure in BOP contexts (Walsh et al., 2005; Landrum, 2007). In this paper, we draw from industry cluster, capability accumulation in organizations, and innovation literatures to build a theoretical framework and understand the challenges firms, support organizations, and policy makers face in BOP industry clusters.

As it is shown below, the theoretical contributions of this paper are threefold. First, we assert that BOP contexts present important idiosyncrasies and that the process of technology diffusion in BOP clusters is hindered by additional barriers to technology diffusion when compared to clusters elsewhere. Based on our fieldwork, we identified three main barriers to technology diffusion: entrepreneurial short-term mindset, high level of informality, and higher financial pressures faced by BOP entrepreneurs. These barriers are more salient and determinant at the BOP, respectively, due to the lack of business knowledge and training for entrepreneurs, strong presence of informal economy, and limited credit available for entrepreneurs, which consequently reduce the incentives for technology adoption. Second, we argue that technology adopted by one or a few firms without a broader diffusion strategy does not seem to be enough for a BOP cluster to develop itself. Although technology development is a critical step, without a broad diffusion, the technology can become a key mechanism exacerbating social exclusion and wealth concentration in BOP regions because privileged entrepreneurs will always be the ones with full access to the new technologies. Third, we argue that industry clusters in BOP regions of large emerging economies such as Brazil, India, and China, with significant domestic resources and consumer markets, are not necessarily required to build such dynamic global pipelines to prosper, as suggested, for example, by Batheld et al. (2004) and Maskell et al. (2006).

In the remainder of the paper, we discuss our theoretical framework through the lenses of clusters, capability accumulation, and innovation literatures, and explain how the issues associated with these streams may or may not apply to BOP settings. We detail the methodology and the research strategy employed in this study. We then illustrate the issues raised in this paper through an in-depth case study of the trajectory and challenges faced by a well-known BOP granite mining cluster in Brazil, Santo Antonio de Padua (henceforth Padua), followed by the discussion of the case, the implications of this study for theory, management, and policy, and a series of propositions. We then conclude by highlighting the theoretical contributions of this paper, as well as suggesting several opportunities for future research.

2. Capability accumulation, innovation, and technology diffusion

Recent literature on strategy and innovation has stressed the importance of capabilities for firms to achieve desirable and sustainable performance (Cohen and Levinthal, 1990; Caloghirou et al., 2004; Teece, 2007). According to Kim (1997), technological capabilities are referred to as the ability to utilize technological knowledge efficiently, create new technologies, and develop new products and processes. Technological capabilities can be classified as routine capabilities and innovative capabilities (Lall, 1987, 1992; Bell and Pavitt, 1992; Figueiredo, 2002; Silvestre and Dalcol, 2009). The first are associated with production and operational skills or abilities needed to use technology, knowledge, and organizational mechanisms, and the latter are related to innovation or the abilities for creating, modifying, or improving products and processes. Other studies also highlight the importance of organizational capabilities. For example, the dynamic capabilities approach has primarily addressed the role of organizational capabilities (Chandler, 1990; Teece and Pisano, 1994; Zander and Kogut, 1995), which involves the ability to utilize business-related and administrative knowledge, including the ability to learn and seek solutions creatively for managerial and technical problems.

The accumulation of organizational and technological capabilities by firms can be achieved through different learning processes. According to Silvestre and Dalcol (2008, 2009), firms are technologically immature, but they gradually learn over time, accumulating knowledge and capabilities so that they can evolve and become capable of performing new activities, innovating, and absorbing new capabilities. Firms use different ways of learning, such as learning from advances in science and technology and from inter-industry spillovers (Malerba, 1992). Firms can also accumulate knowledge through learning by doing (Arrow, 1962; Gilbert and Cordeyhayes, 1996), learning by using (Rosenberg, 1982; Carbonara, 2004), learning by interacting (Lundvall, 1992; Platt and Wilson, 1999), and learning by searching (Boulding, 1985; Johnson, 1992).

The literature seems to agree that organizational learning can occur at two levels: at the individual and at the organizational level (e.g., Kim, 1993; Kim, 1998). Individual learning occurs at the individual level when the knowledge is accumulated by each individual who is part of the organization (e.g., employees). Individual learning creates opportunities for organizational learning, and organizations can absorb that knowledge (i.e., learn) from individuals. This will happen only after that knowledge truly becomes embedded within the organizational routines (Attewell, 1992). However, organizational learning may not be the sum of its employees' learning (Hedberg, 1981) because the knowledge transfer from individuals to organizations is not an automatic process. Organizations actually require crafted strategies and deliberate efforts to embody individual knowledge into their routines (Hedberg, 1981; Shrivastava, 1983).

In the organizational learning literature, knowledge is often classified as explicit and tacit (Polanyi, 1966). Explicit knowledge is formal, codified, and transmittable while tacit knowledge is embodied in the individuals, and is difficult to be codified and communicated. Based on these two types of knowledge, organizational learning occurs mainly through the knowledge conversion modes proposed by Nonaka and Takeuchi (1995); that is, internalization, socialization, combination, and externalization.

Regarding clusters, Marshall (1920) argues that knowledge is "in the air" and that firms absorb such knowledge naturally and unconsciously, without any deliberated effort. We define clusters as a physical concentration of specialized firms operating in one or a few related industrial activities within a limited geographical area (Basant, 2002; Lorenzen, 2002). In regard to the 'Marshalian' metaphor, we acknowledge that specific knowledge, localized within clusters, can be absorbed more easily by firms located in these settings. However, we argue that learning will happen only if firms possess absorptive capacity and explicitly invest money, time, and effort so that they can identify, interpret, and transform