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Diversity in patterns of industry evolution: How an intrapreneurial regime contributed to the emergence of the service robot industry

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ABSTRACT

How do new industries emerge? This paper aims to answer this question by analyzing the key actors in this process. We focus on the new industry of service robot. By using data of Japanese patent applications, we analyze the role of new firms and of collaborations. We find that the emergence of the industry is mainly triggered by established large firms, rather than by new firms. We further show that collaborations are at the core of new industry formation, but that they possess distinct properties. As the emergence of this new industry matches to the characteristics of Japan's institutional and knowledge regime we essentially argue that the notion of regimes with fewer start-ups being inefficient is erroneous. Our main conclusion is that industry emergence in intrapreneurial regimes seems to be distinctive from entrepreneurial regimes.

1. Introduction

Many authors have advanced the idea that new firms and linkages to them are at the core of new industry formation (Arora and Gambardella, 1990; Dushnitsky and Lenox, 2005; Giarratana, 2004). It is claimed that new firms and collaborations with them are not the sole, but at least the most critical locus of innovative activities (Aoki and Takizawa, 2002; Arora and Gambardella, 1990). Hence, innovation systems shall be designed in a way that new firms are enabled to evolve, exit or survive (Audretsch and Thurik, 2001). In this view, countries with low levels of entrepreneurship have an inherent inability to create new industries. And indeed, numerous works have called for change in order to create an institutional set-up which is supportive for new firms, characterized by turbulences, a massive number of new entrants and a reduced role for large firms (Anchordoguy, 2000; Aoki, 2000; Syed and Lee, 2010). It is common within this view to associate new industries with a paradigmatic shift toward 'entrepreneurial regimes' in which a turbulent process ensues with many new entrants and a reduced role for incumbents (Audretsch and Thurik, 2001).

The case presented in this paper, the service robot industry, is, however, an industry that emerged within an economic system, the Japanese one, which is characterized by a relatively high degree of stability and a dominant role of large established firms. Together with the entrepreneurship literature, we argue that indeed, new knowledge is at the core of new industry emergence. However, in contrast to approaches that focus on knowledge creation by new firms, we argue that there is a variety of patterns in which new industries may emerge, and that large established firms may play a key role in this process. This insight is, per se, not new; in particular, works in management and organization studies have elaborated innovative strategies of large firms and their contribution to new industry formation (Chang, 1995; Gort and Klepper, 1982; Rosenbloom and Cusumano, 1987; Tripsas, 1997). However, this alternate path to new industry creation has, in the last 20 years, almost been forgotten, with only few exceptions (Lazonick, 2010; Lazonick and Tulum, 2011; Lehrer, 2000; Parker, 2011). In so far, Japan's success in the service robot industry fits into its

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long-established pattern of corporate intrapreneurship and industry creation (for example videocassette recorders (VCRs), Rosenbloom and Cusumano, 1987), and is closely related to the "refined business model", as Lazonick (2009, 2010) has called it, which has outperformed the United States for a long time. In line with these works, this paper suggests a view on industry emergence that takes into account the variety of industry emergence patterns. We argue that new industries, depending on their knowledge properties, tend to match to different institutional regimes. As we will demonstrate, the service robot industry is an industry that is characterized by cumulative knowledge stocks, which show a good match to Japan's long established path with more cumulative, integral innovations, and a dominant role of large established firms.

We are certainly not the first who argue that the stable nature of knowledge regimes and institutional regimes does not per se become a barrier to industrial dynamics. A rich literature on the resources of systems' adaptability has been developed (Amable, 2004; Streeck and Thelen, 2005). Specifically related to industrial dynamics, the literature on technological regimes stresses that these differently affect innovation (Audretsch, 1995; Malerba, 2007; Nelson and Winter, 1982). Lehrer (2000) has linked evolutionary (to which Japan would belong) and revolutionary regimes (to which the United States would belong) to different capabilities of firms. In addition, proponents of the comparative capitalism approach argue that the so-called coordinated economies possess an inherent ability to give birth to new industries, namely by specializing on new industries' subsectors that match to the established innovation system (Casper, 2003; Casper and Kettler, 2001; Casper and Whitley, 2004). Lazonick (2009, 2010) has shown that large firms play an important role in new industries also in U.S. We are building upon and attempting to reconcile these prior works.

Meanwhile, we go beyond the prior literature in a number of ways. First, we show that established large firms do also play a substantial role in a recently emerged new industry. New firms do exist in this new industry but, compared to the role of established large firms, their role is minor. Second, we choose the service robot industry a core segment within the robot industry. Service robots are robots that perform tasks for humans or equipment excluding industrial automation application. Usually, a certain degree of autonomy, ranging from partial to full autonomy, is required (IFR, 2013, p. 39). As a segment of the robot industry, it is characterized by high levels of cumulativeness (Harhoff et al., 2011). While being aware that the service robot industry is only one case, we question the implicit assumption that new industries are necessarily radical-destructive in nature, and thus, in general in need of an entrepreneurial regime which allows for fast competence creation and destruction. Finally, we enrich the prior literature through the case of an industry that evolved in Japan – because, and not despite its specific institutional regime. It is less institutional change but the activation of given capabilities that cause the emergence of the new industry. In contrast to Germany (Casper, 2003; Casper and Whitley, 2004; Herrmann, 2008), Japan has not been subjected to this level of detailed analysis yet and we hope our research contributes to fill the gap.

The analysis of the service robot industry is based on a patent data analysis. We use 15,043 patents that have been applied between 1993 and 2004 in the field of robot technologies in Japan. With this data, we are able to identify the key actors in the sector, to distinguish between existing and new knowledge within the robot industry and to identify collaborations. Further, we carried out a total of 21 interviews with firms, research institutes, business associations, ministries and public institutes between spring 2006 and autumn 2012, and used sectoral reports of ministries and industrial associations in order to gather additional information and to obtain background information on micro-levels of industry emergence (for example JARA, 2001; JPO, 2006; see Appendix A).

2. Regimes and the emergence of new industries

2.1. Key factors for the emergence of industries: institutional and knowledge regimes

Modern economies are characterized by the emergence, development and decline of industries (Malerba and Orsenigo, 1995). New industries are emerging industries in an early stage and are constituted by new markets and new knowledge (Malerba, 2007).

While empirical research on new industry emergence is scarce, there are some indications that, perhaps surprising, the expected growth rate and the fixed costs do not significantly deter the start-up of new firms (Audretsch, 1995, p. 62; Geroski and Schwalbach, 1991; Siegfried and Evans, 1992). Therefore, we do not consider these two factors. However, research has shown that knowledge regimes and institutional regimes are relevant; in case of the latter in particular the quality of cooperation, for example in terms of producer–user interactions (Audretsch, 1995; Lundvall, 1985). The following theory section and the empirical section will therefore discuss only these factors.

2.1.1. Institutional regimes: entrepreneurial and intrapreneurial regimes

In this section, we distinguish between two different institutional regimes: entrepreneurial and intrapreneurial regimes. As institutional regimes shape behavior and hereby the outcome (Ostrom, 2005), different outcomes are produced, depending on the specific institutional regime. In particular, the institutional set-up of the liberal market economy type (Hall and Soskice, 2001) resembles very much the entrepreneurial regime (Audretsch and Thurik, 2001) in which the main actors are individual entrepreneurs who enter the market via new firms, often linked to larger firms via R&D and innovation networks, and supported by an institutional set-up allowing for vivid market entries and exits and growth (Dushnitsky and Lenox, 2005; Powell et al., 1996). Arora and Gambardella (1990) find that small firms provide complementary knowledge assets to large firms which imply both a key role for large as well as for new firms. In a similar vein, Malerba (2007, p. 692) states that "the relevance of collaborations in innovation and R&D networks is due from the broad recognition that R&D and innovation are highly affected by the interaction of heterogeneous actors with different knowledge, competences and specialization".[1] Lazonick (2009, pp. 26–32) shows that the leading firms in the U.S. ICT sector have been founded since the beginning of the industry in the 1950/1960s. To put it differently, the U.S. ICT sector is made up out of new firms that have been founded during the process of industry emergence, and not out of existing firms that have diversified into the ICT sector (see also Lazonick, 2008). Hence, innovation is distributed across a wider population of firms, and new firms and turbulences in the industrial organization are more characteristic.

Only few papers have questioned the assumption that systems that are built around new firms outperform others in economic terms. Lazonick (2009, 2010) has convincingly argued that the "New Economy Business Model" with its dynamic entries and exits (which we call in this paper the entrepreneurial regime) has been

[1] The relevance of collaborations has been recognized by resource based theories (Gilsing et al., 2008), game theory/transaction-cost based theories (Williamson, 1985) and evolutionary economics (Malerba, 2007). At the same time, the advantages of heterogeneity are not unlimited: a too high degree of heterogeneity reduces the firms' absorptive capacity. Gilsing et al. (2008) have proven an inverse U-shape of the effects of heterogeneity on new knowledge creation.