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SMEs inventive performance and profitability in the markets for technology

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ABSTRACT

This paper studies the inventive performance and profitability of small and medium sized firms (SMEs) that are "technology specialists" compared to the inventive performance and profitability of SMEs that are instead vertically-integrated. In this paper perspective, "technology specialists" are firms that specialize upstream in generating inventions and trade those inventions in disembodied form with other firms, usually through licensing agreements. Instead, vertically-integrated firms are those firms that both generate inventions and commercialize products incorporating those inventions. We argue that technology specialists achieve a higher inventive performance than vertically-integrated firms, since they can accumulate deeper and broader inventive experience, whilst keeping a more flexible organizational structure. These firms display a lower profitability though, due to the imperfections inherent in invention market transactions and the lower bargaining power caused by the lack of commercialization assets. The theoretical framework is tested through a cross-industry investigation on a sample of European SMEs. Implications for the viability of being a technology specialist as a strategy and for the development of markets for technology are discussed.

1. Introduction

Recent studies have established the increasing importance of markets for technology (e.g., Arora et al., 2001; Krammer, 2014; Ritala and Hurmelinna-Laukkanen, 2009; Veer and Jell, 2012; Wang et al., 2012)—hereafter, MFT—that is, markets where inventions are traded as "free standing" entity, disembodied from individuals, organizations and products (e.g., Arora et al., 2001). In these markets firms can exchange their inventions for a price, usually through a licensing agreement, which is a contract where the owner of an invention allows another party the right to use or modify it in exchange of compensation (WIPO, 2014). Previous research on MFT has mainly taken a policy perspective on this phenomenon, arguing that the development of these markets allows for an efficient division of innovative labor among small and large firms according to their comparative advantage—which is, respectively, doing research and generating inventions for small firms, and producing and marketing the final products that embody new inventions for large firms (Arora et al., 2001; Arrow, 1983; Holmstrom, 1989). This type of configuration is socially desirable, in principle, since every type of firm focuses on the activity it performs better (Firth and Narayanan, 1996; Li and Tang, 2010); hence, a higher overall value might be generated compared to a situation where all firms internalize both the research and final product commercialization activities (e.g., Arora and Ceccagnoli, 2006; Arora et al., 2001; Conceicao et al., 2012).

However, the firm-level implications of MFT in terms of firm inventive performance (i.e. the extent to which a firm is capable of generating valuable inventions) and profitability have been largely neglected. It is not clear whether small firms are better off exploiting their comparative advantage in inventing by becoming "technology specialists"—that is, specializing upstream in the inventive activities and then sell their inventions in the MFT—or whether they should vertically integrate—that is, commercialize their own inventions to final customers. In particular, on the side of *inventive performance*, previous research on MFT has largely neglected how the interdependence between upstream invention and downstream product commercialization activities affects the firm's capacity to generate high quality inventions; consequently we still lack an understanding of whether the inventive performance of technology specialists overcomes that of vertically-integrated small firms. At the same time, on the side of *profitability*, the literature on MFT has largely neglected to consider the ability of technology specialists to appropriate the economic returns of their inventions. Indeed, becoming a technology specialist and selling inventions to other firms

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require firms to incur the private costs related to search and negotiation in the MFT (e.g. Fosfuri, 2006). In addition, being a technology specialist also implies that a firm lacks downstream, complementary assets that have been demonstrated to be a relevant source of bargaining power (e.g., McGahan and Silverman, 2006; Teece, 1986). Accordingly, we still do not know the extent to which—at the firm level—the economic benefits of being a technology specialist overcome the costs.

This study fills in these gaps by investigating the following research question: how does the choice of being a technology specialist (as opposed to being a vertically-integrated firm) affect an SME's inventive performance *and* profitability? Addressing these issues is important because it allows for an understanding as to what extent being a technology specialist is a viable strategy for an SME. The rest of the paper is organized as follows. In Section 2 we present our theory and hypotheses and in Section 3 we describe the method that we used to test the hypotheses developed. In Section 4 we present the empirical results, while in Section 5 we discuss their implications to practice and theory. Finally, in Section 6, we present the conclusions from the study.

2. Technology specialists vs. vertically-integrated SMEs: implications on inventive performance and profitability

Building on the principles of specialization and division of labor (Smith, 1776 [1983]; Stigler, 1951; Young, 1928), literature on MFT has argued that small and large firms are naturally endowed with different capabilities in inventing and commercializing; hence, they can benefit from specializing in the activity in which they are relatively more efficient (e.g., Arora et al., 2001; Ceccagnoli and Jiang, 2013). In particular, we can represent the innovation value chain as the chain of activities from upstream research activities—i.e., research and inventions generation—to downstream activities—i.e., large-scale development of those inventions into products, manufacturing and marketing to the final customers. Large, established firms, due to their highly bureaucratic structure, have a comparative advantage in performing downstream activities, which typically involve a high degree of routinization and standardization (Allarakhia and Walsh, 2011; Holmstrom, 1989; Mangematin et al., 2011). Small firms, instead, have a comparative advantage in performing upstream research activities because, due to the low organizational distance between managers and researchers (e.g. Arrow, 1983; Marion et al., 2012), they are more likely to pursue risky but potentially extremely valuable technological trajectories (Arrow, 1983; Arora et al., 2001).

These arguments suggest that, at the system level, the division of value chain activities among firms on the basis of their comparative advantage leads to the generation of a higher value compared to a situation where every firm performs all these activities (i.e. invention, development and commercialization to final customers) internally. Hence, based on this argument, it would appear preferable—from a social welfare perspective—if SMEs specialized in upstream research activities, i.e. if they became "technology specialists" (Arora et al., 2001). However, existing research in this area provides only limited insight on whether operating as a technology specialist also brings a "private" advantage to SMEs, that is, whether technology specialists have a better performance compared to the vertically-integrated SMEs, i.e. those SMEs that internalize all value chain activities. More precisely, existing research on MFT has provided only limited consideration to the interdependence between upstream invention generation and downstream commercialization activities. Consequently, existing research has not investigated the extent to which this interdependence affects the inventive performance of small firms that are technology specialists, and only focus on the generation of inventions, vs. vertically-integrated small firms, which internalize both activities.

In addition, existing research on MFT has not investigated the extent to which SMEs' profitability is affected by the choice between upstream specialization vs. vertical integration. Becoming a technology specialist implies undertaking search and negotiation activities in the MFT; hence, it might require incurring additional costs that might reduce SME's profitability (e.g. Leiblein and Madsen, 2009). The extent to which these costs overcome the benefits of being a technology specialist has been overlooked by extant literature. Furthermore, a technology specialist lacks downstream complementary assets that a vertically-integrated firm instead possesses, with possible implications on its bargaining power and consequently on its profitability compared to a vertically-integrated SME (e.g. Fosfuri, 2006; Leiblein and Madsen, 2009). However, these implications have been neglected by extant studies. The goal of this paper is to fill this gap and compare the implications for an SME of being a technology specialist vs. being vertically-integrated, in terms of both their inventive performance *and* profitability. In doing so this paper contributes to improving our understanding on the performance of SMEs (Hoffman et al., 1998).

We argue that being a technology specialist (as opposed to being a vertically-integrated firm) has a positive impact on a small firm inventive performance for two reasons. The first reason relates to the deeper and broader inventive experience that technology specialists can accumulate (Leiblein and Madsen, 2009). Technology specialists devote all their efforts and resources to their inventive activity (Arora et al., 2001). This makes them more likely to enjoy faster accumulation of inventive experience in their technological fields compared to vertically-integrated small firms—which instead spread their resources and attention across upstream (i.e., invention) and downstream (i.e., commercialization) activities. While this argument holds for any firm (regardless of its size), it is even more salient for small firms, whose resource endowments are typically scarcer compared to those of larger firms (Teece, 1986). This implies that technology specialist SMEs tend to acquire a "deeper" inventive experience than vertically-integrated SMEs (Díez-Vial, 2009; Yelle, 1979).

At the same time, because technology specialists have the ultimate goal to sell or license their technologies to other firms (Bianchi et al., 2011; Veer and Jell, 2012), they have the incentive to generate inventions that target a greater variety of business applications and customer needs compared to vertically-integrated firms, whose research activity mainly serves in-house needs (Arora et al., 2001; Grant, 2002; Hicks and Hegde, 2005). This argument holds a fortiori for smaller vertically-integrated firms, which, due to their resource constraints, usually operate in a limited set of market niches. This implies that technology specialists tend to acquire a "broader" inventive experience than vertically-integrated firms and this effect is even stronger in the case of SMEs (Hicks and Hegde, 2005). Both a depth and breadth of inventive experience enable lessons learned from experience to accrue more steadily, thus generating better inventions (Katila and Ahuja, 2002).

The second reason why being a technology specialist (as opposed to being a vertically-integrated firm) has a positive impact on a small firm's inventive performance is related to the organizational structure typically characterizing technology specialists vs. vertically-integrated firms, which makes the former better positioned to generate valuable inventions. A vertically-integrated firm is likely to display tight interdependences between upstream organizational units—focused on research and on the generation of valuable inventions—and downstream units—commercializing those inventions embodied into products for final customers (Taylor and Helfat, 2009). These interdependences are likely to inhibit the generation of path-breaking inventions and rather favor path dependence at the expense of novelty (Powell, 1992; Taylor and Helfat, 2009). A very clear illustration for this mechanism is presented by Fosfuri and Roende (2009). Vertically-integrated companies are companies where an upstream R&D unit and a downstream manufacturing unit coexist. In principle the R&D unit may select the research trajectory to be pursued between multiple alternatives, which