Chapter 73
Is Collaboration Important at All Stages of the Biotechnology Product Development Process?

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ABSTRACT

Using the four Biotechnology Uses and Development surveys of Statistics Canada, the chapter examine the importance of collaborating with firms and public institutions at various stages of product development, from research and development to clinical trials and then on to production and commercialization. The models examine the propensity to have products at a particular stage of development using instrumental variables probit regressions. This chapter finds that while small firms do not benefit from collaborating with firms at the research and development stage, during the clinical trials and in the production phases, collaborating with firms has a strong positive effect. The factors that affect the R&D phase are R&D expenditures, an important IP strategy, revenues from contracts and to some extent contracting out some innovation activities. In later stages of the development process, the number of patents and the diversity of the biotechnology employment team play a more crucial role.

INTRODUCTION

Extensive literature exists on the impact of collaboration on innovation, generally measured by the number of patents or the number of products (Baum *et al*., 2000; Deeds &Hill, 1996; Faems *et al*. 2005; Rogers, 2004; Shan *et al*., 1994; Stuart, 2000). Innovation is treated as a relatively broad concept in the literature, from research and development (Esteve-Perez, et al. 2004; Hall, 1987) to new products and processes (Audretsch, 1991, Schoonhoven, et al. 1990) and patents (Banbury & Mitchell, 1995; Christensen, 1998).

In the case of biotechnology the product development process is considerably long and costly; the time elapsed between R&D, patents and products on the market can be as long as ten to fifteen years. Biotechnology is characterised by very risky R&D (Senker, 1998) that spreads over a long period of time where a large number of steps are necessary to bring a product to the market (Kellog & Charnes,

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2000). The literature is however relatively scarce on the biotechnology product development process let alone on the factors that affects the various stages.

Firms may develop new innovations entirely within the boundaries of the firm, but this is less and less the case as products and processes increase in complexity. Collaboration then acts as a complement to the internal innovation capabilities of the firm, hence contributing to adding to its capacity (Deeds & Rothaermel, 2003; Hagedoorn, 2002). Collaboration is thus essential to its innovative process and eventually to its survival (Deeds & Hill, 1996; Oliver, 2004; Powell *et al*., 1996).

Kortum and Lerner (2000) as well and Engel and Keilbach (2007) for instance, highlighted the importance of venture capital in the early stage of the product development process. Other studies are all in agreement concerning the incapacity of traditional debt financing to provide funding for the very risky early R&D phases (Czarnitzki & Kraft, 2009; Gompers & Lerner, 2001; Hall, 2002). Baum and Silverman (2004) found no impact of venture capital on a firm's propensity to patent, but noticed the importance of government funding in this regard.

Building on both the literature on innovation and on collaboration and alliances, this chapter aims to determine whether collaboration is required at each stage of the development process or whether other characteristics take over at some point along the innovation chain. The author is fortunate to have had access to Statistics Canada's four Biotechnology Uses and Development Surveys spanning the period 1999-2005. The data collected provides the classic innovation survey indicators in addition to specific strategy measures, and detailed data on the various product development phases.

Using instrumental variable probit regressions, the chapter investigates the influence of collaboration and other innovation factors on the biotechnology product development process in Canada. The results show that firms that collaborate with private organisations are more likely to currently have products in clinical trials and in production or on the market. No effect is found at the R&D stage. Similarly, firms that have a more diverse workforce dedicated to biotechnology have a higher propensity to have products in clinical trials and in production or on the market. In contrast, firms that contract out biotechnology activities are more likely to have products in R&D or in the clinical trials. The results clearly show that various factors affect different stages of the biotechnology product development process.

The remainder of the chapter is organised as follows: Section 2 presents the theoretical framework and the set of hypotheses to be tested. Section 3 describes the data and methodology that will be used to verify these hypotheses. Section 4 briefly presents the summary statistics that characterise the data. Section 5 analyses de regression results and finally, Section 6 concludes.

Theoretical Framework

Firms collaborate for a vast number of reasons (Gulati & Singh, 1998). The number of occurrences and frequency of collaboration has increased dramatically over the past 40 years (Hagedoorn & Shankenraad, 1990a, 1990b; Hagedoorn, 2002; Narula & Duysters, 2004; Perkmann & Walsh, 2007). The locus of innovation is no longer the firm itself, but the network within which it collaborates (Pisano et al., 1988). For instance, firms collaborate to overcome innovation barriers such as heavy regulatory or the short-termism of capital markets (Greis *et al.,* 1995). Firms also collaborate to survive (Lane & Lubatkin, 1998; Oliver, 2001). Baum *et al.* (2000) further showed that firms reduce their 'liability of newness' by entering into alliances with well-established firms.

Biotechnology knowledge being complex, expensive and dispersed in a number of entities, firms have no choice but to collaborate within a learning network community (Powell *et al*. 1996). Singh