Introduction: The development of commercial biotechnology

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1 Introduction

The papers in this issue study the recent development of biotechnology in the USA, Canada and several emerging countries, namely India, Mexico and Turkey. A more methodological article analyses issues related to the collaboration between universities and private firms using an agent-based model. These papers are part of a series of studies on biotechnology conducted by Catherine Beaudry, Jorge Niosi, Susan E. Reid and Shyama V. Ramani [see, among others, those authored by Bas and Niosi (2007), Estades and Ramani (1998), Jolly and Ramani (1996), Niosi (2003, 2011), Niosi and Banik (2005), Niosi and Bas (2001), Niosi et al. (2012, 2013), Niosi and Queenton (2010), Niosi and Reid (2007), Ramani (2002), Ramani and De Looze (2002a, 2002b), Reid and Ramani (2012) and Schiffauerova and Beaudry (2011)].

Since the 1980s, the USA has taken the global lead in both the science and the commercial applications of biotechnology. Jorge Niosi has developed a database of some 120 biopharmaceutical drugs developed between 1980 and 2010. He shows that companies based in the USA have requested the FDA approval of some 80% of these drugs, the remaining 20% being the result of the R&D investment of European firms (based in Denmark, France, Great Britain and Switzerland). He believes such outcome is the consequence of the much larger public and private investment of the USA in biotechnology R&D, compared to those of other countries, particularly through the National Institutes of Health, but also through other federal and state funds, such as the Small Business Innovation Research Act, national and state tax credits for R&D, and others. In addition, the USA hosts the largest venture capital industry in the world, and the most productive university system. Biotechnology is far from being an inexpensive area of research, and it requires large and stable funding in order to produce results.

2 Papers on Canadian biotechnology

Catherine Beaudry aims at understanding whether collaboration, funding and government intervention have an impact on the patent behaviour of small and medium-sized Canadian biotechnology firms. For that purpose she uses both the biotechnology uses and

development surveys conducted by Statistics Canada between 1999 and 2005. She employs basic statistical methods including probit regression analysis. She finds that collaboration and contracting out have a positive impact on patenting. Angel and venture capital funding has a similar type of result. So do spin-offs, and size, but the patenting effect is reduced when firms move further into the commercialisation path. Public funding of DBF has a negative impact on patenting, thus supporting previous research on the subject.

Alliances are widely considered a necessary condition for the growth and success of DBF. Using two parallel samples of these biotechnology firms, one in Montreal, Canada and the other in Cambridge, MA, USA, Sophie Veilleux shows that the picture is slightly more complex. In fact, alliances may come at different stages in the development of new products by DBF. In Canada, due to the reduced angel and venture capital industries in this country, alliances arrive early in the life of the biotechnology firms. Under much more generous funding support, the US DBF prefer to postpone alliances until they arrive to the late stages of product development. In both cases, though, alliances are a second-best option. When adequately financed by other means, DBF prefer to wait as long as possible to organise alliances with pharmaceutical firms in order to extract the best possible deal, and increase and keep for themselves the value they have generated.

In several key papers, DBF are presented as displaying a longer life expectancy than new firms in other sectors. Using a unique database of Canadian biotechnology firms, Ayoub Moustakbal shows that this is true. Also, he finds that the disappearance of DBF takes place most often through mergers and acquisitions, and not by outright bankruptcy. In particular, DBF in human health are acquired more than firms active in any other type of application. In addition, companies supported by venture capital are more often acquired, when compared with those in agriculture, environment or in other types of application. He concludes that the disappearance of some 50% of the more than 1,000 DBF that have been created in Canada over the last three decades can not be considered a sign of failure, but one of a more difficult economic environment, for both the DBF and venture capital firms.

3 Other countries

The paper by Susan E. Reid, Jorge Niosi and Shyama V. Ramani explores and compares bionetworks and nano-networks in the context of India. The paper seeks to understand how information flow rates, country-level dispersion of networks and complexity of these generic technologies (based on a number of generic technologies) have an impact on technology diffusion rates. For that purpose they use patents. They find that biotechnology has been absorbed by Indian organisations much faster than nanotechnology: India got its 100th patent in biotechnology only ten years after the first one in 1995, while the same landmark in nanotechnology, starting in 1999, was not attained in 2007. Similar results appear when comparing PCT and EPO patents for both sets of technologies. The government of India has promoted biotechnology, particularly so in public institutions, while it has not promoted nanotechnology with a comparable vigour. In addition, fieldwork conducted in India by Reid and Ramani (2012) show various important holes in the innovation system, holes that make difficult the spread of information on these key technologies.

Dilek Cetindamar studies the slow adoption of biotechnology in the Turkish innovation system. She tries to understand the reasons for such a sluggish rhythm of adoption. She finds that the number of entrepreneurial biotech firms in Turkey is very small to generate synergies and spillovers, and even if the number of biotechnology articles is fairly substantial and keeps growing, the generation of commercial knowledge, as measured by the number of patents, is small. She argues that government incentives in support of biotechnology have been scanty in Turkey. Yet there is small but promising domestic market for biotechnology products, mainly in the areas of health, food and environment. The Turkish agricultural market is fairly closed due to the adoption of European regulations. The energy market is also fairly closed to biotechnology. Even the health products market is slow in adopting biopharmaceutical drugs for lack of regulation. In addition, biotechnology lacks legitimacy both among policymakers and general public. She concludes that biotechnology can only be largely adopted if governments devise a long-term strategy for that purpose.

In her analysis of the diffusion of biotechnology towards the Mexican industry, Julieta Flores-Amador shows the many institutional, managerial and scientific obstacles that such adoption face. Such obstacles include the lack of adequate public support for academic and industrial research, the lack of management expertise and the meagre support of venture capital to biotechnology start-ups. After establishing a database of the some 60 DBF active in Mexico, she conducts her study through in-depth interviews with company executives, policy makers and scientists in the main cluster of the Mexican capital. She concludes that, in order to absorb modern biotechnology, more public support is needed in developing countries.

Giorgio Triulzi, Andreas Pyka and Ramon Scholz analyse industry university relationships in biotechnology and pharmaceuticals using an agent-based simulation model. They find that universities tend to shift from more basic research activities to more applied ones due to their increasing collaboration with industry. Also, universities increase their financial resources as a consequence of these links, but their knowledge resources increase very little. Third, dedicated biotechnology firms increase their knowledge stock as they interact with universities. Finally, science policies aiming at consolidating basic research in universities may be needed to overcome the effects of industry-university relationships between pharmaceutical corporations and DBF.

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