

# Schumpeter Revisited: Explaining the Emergence of the Biotech Industry

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## *Abstract*

This paper examines the emergence of the global biotechnology industry from the Schumpeterian perspective. Specifically, the changing importance of small versus large firms, as well as the shift from competition to cooperation within the biotechnology sector, is taken as typical manifestations of a process of ‘creative destruction’. Following an explanation of biotechnology from the neo-liberal economic view, an outline of Schumpeter’s views on technological change as a three-stage process involving invention, innovation and diffusion, the implications of such a conceptualization for long-term industrial evolution, are examined as the key explanation. It is therefore concluded that the biotechnology industry has thus far evolved in a manner mostly consistent with Schumpeterian views. Extrapolating into the future, a Schumpeterian framework suggests important challenges for an industry at that stage of maturity. The importance of technological discontinuities for the emergence of novel industrial sectors is illustrated by a case study of the biotechnology industry in the late 20th century.

**Keywords:** *Biotechnology, Schumpeterian perspective, multinational biotechnology companies, technology, creative destruction.*

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## **Schumpeter'e Yeniden Bakmak: Biyoteknoloji Endüstrisi Üzerine Bir Açıklama**

### **Öz**

Bu makale, küresel biyoteknoloji endüstrisinin ortaya çıkışını Schumpeterci bakış açısı ile değerlendirmektedir. Özellikle, büyük firmalara karşı küçük firmaların öneminin değişmesi ile biyoteknoloji sektöründe rekabetten işbirliğine sıçrama 'yaratıcı yıkıcılık' sürecinin tipik bir manifestosu olarak ele alınmaktadır. Neo-liberal ekonomik açıdan bioteknoloji incelendikten sonra Schumpeter'in teknolojik değişim yaklaşımının, icat (invention), yenilik (innovation) ve yayılma (diffusion)'yı içeren üç aşamalı sürecini izleyerek, böylesi bir kavramsallaştırmanın uzun dönem endüstriyel evrim (evolution) üzerindeki etkilerine bakılmıştır. Sonuç olarak biyoteknoloji endüstrisinin daha çok Schumpeter'in görüşlerine uygun bir davranış göstererek evrildiği gözlenmiştir. Geleceğe ilişkin olarak, Schumpeterci bir çerçeve olgunluk aşamasında bulunan bir endüstri için önemli değişiklikler önermektedir. Yükselen yeni endüstri sektörü için teknolojik kesintinin (discontinuities) önemi geç 20. yüzyılda biyoteknoloji endüstrisi vaka çalışması olarak gösterilmiştir.

**Anahtar kelimeler:** *Biyoteknoloji, Shumpeterci bakış açısı, çokuluslu biyoteknoloji firmaları, teknoloji, yaratıcı yıkıcılık.*

## 1. Introduction

The commercialization of biotechnology in the 1970s created a new economic space and provided an extraordinary standpoint to examine both small entrepreneurial firms and large companies in inter-firm R&D networks. According to Kenny,<sup>2</sup> Schumpeter provides a unique perspective for analyzing the manner of major questions by which capitalist enterprises extend their way into new areas of the natural world and in the process to create a new economic space. Can a Schumpeterian perspective be usefully applied to examine the emergence of new industries? Can the biotech industry in particular be a good example of ‘creative destruction’? What does technological change imply for market dominance in the sector? In order to respond to these questions the focus of the study is to analyze this new economic space from the Schumpeterian perspective and to provide a clearer view for biotech industry.

In section 2, biotechnology industry in neo-liberal economic view is explored. Development of new technologies like biotechnology is one strategy for overcoming some of the resulting problems of economic viability, especially in the realm of potential production and consumption. It is claimed that such development draws untapped resources, creates new commodities, open new markets and stimulates economic growth. The focus will be on both neo-liberalism, as the prevailing ideology of the global economy and the biotechnology, as the source of new commodities. This section will question neo-liberal economic view and its competence in explaining technological changes, specifically in the commercialization of biotechnology in the 1970s to create a new economic space. As this paper claims that neo-liberal economic view is not sufficient and satisfactory in explaining developments in biotechnology then, Schumpeter’s unique perspective for analyzing the new spaces is to be gradually introduced.

Section 3 concentrates on *Innovation, Invention and Diffusion* in the Schumpeterian tradition to build a logical argument around biotechnology. In the case of an economic impact of new inventions and innovations, Schumpeter pointed out that it is necessary to understand the *diffusion* process whereby new products, process and series are adopted and used by others in the economic system.

Then, section 4 discusses the pattern of small and large biotechnology companies to emphasize the importance of the small entrepreneurial

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<sup>2</sup> M. Kenney, “Biotechnology and the creation of a new economic space in Private Science, Biotechnology and the Rise of the Molecular Sciences”, (ed.) A. Thackrey, University of Pennsylvania Press, Philadelphia, 1995.

activity as a major generator of new innovations. In particular, a large company conducts innovation in large research laboratories and makes use of formal R&D activities; therefore it is essential for the innovative environment. At different stages in his career, Joseph Schumpeter embodied two very different views of the relationship between market structure and technological performance. At an early stage, Schumpeter stressed the important roles of the small entrepreneurial company for new innovations. In *The Theory of Economic Development* Schumpeter<sup>3</sup> pictured technological advance as the consequence of a never-ending cycle of entry by innovative small firms, commercial application of new products or processes, and displacement of incumbents. This model of innovative activity suggests that ease of entry will promote innovation and that small- and medium-sized enterprises (SMEs) will most often be the vehicles of technological advance. At later stage, in the *Capitalism, Socialism, and Democracy* Schumpeter<sup>4</sup> focused on larger firms and policy implications. In this study Schumpeter conceived of technological progress as emanating from the industrial research laboratories of large firms that enjoyed positions of static market power. He argued that such firms would use their economic profits to finance risky, large-scale R&D activity that would simultaneously leave society better off, in a dynamic sense, and allow the firms to maintain positions of static product-market dominance.<sup>5</sup>

‘As soon as we go into details and inquire into the individual items in which progress was most conspicuous, the trail leads not to the doors of those firms that work under conditions of comparatively free competition but precisely to the doors of the large concerns and a shocking suspicion dawns upon us that big business may have had more to do with creating that standard of life than with keeping it down’.

This second view suggests that the rate of technological advance will be greater where a few large firms dominate product markets. Such firms would be better able to finance investment in innovation, could take advantage of such economies of scale as might exist in the R&D process, and, because they typically produce a diversified range of products, would be more likely to find commercially viable applications for new technological

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<sup>3</sup> J. A. Schumpeter, *The Theory of Economic Development*, Oxford University Press, London, 1934.

<sup>4</sup> J. A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper and Row, New York, 1942.

<sup>5</sup> *Ibid.*, p. 82.

developments. To understand these views in the historical context, both small and large companies in biotechnology are assessed starting from the 1970s to today in Section 4.

Then, the process, in Schumpeterian terminology, is called as creative destruction, is examined in section 5. According to Schumpeter, capitalism was fast becoming the very victim of its own economic success by destroying its institutional framework and he named this process as creative destruction.

In that respect, it can be claimed that biotechnology exhibits a very good example for the process of creative destruction. Especially, for the pharmaceutical industry, modern biotechnology is a clear example of a set of new combinations with new technologies and state-of-the-art scientific understanding that creates a technological discontinuity. In the context of this technological discontinuity, innovations not only affect the introduction of new products and new processes but these technical innovations also come with new players.

In section 6, the future of Biotechnology Companies in Global World and International Political Economy is briefly looked at. Finally in section 7 the argument will be concluded with some policy implications.

## 2. Neo-Liberal Economic View and Biotechnology

Biotechnology, like microelectronics, indeed, is an element of the neo-liberal technological changes. Development of new technologies like biotechnology is one strategy for overcoming some of the resulting problems of economic viability, especially in the realm of potential production and consumption. Such development draws untapped resources, creates new commodities, and opens new markets. The resulting ‘growth’ tends to be in the form of primary accumulation of capital, increasing profits and greater financial power.<sup>6</sup>

According to Barry<sup>7</sup> “neo-liberalism as the prevailing ideology of the global economy, has two major aspects; *first*, it entails a worldwide ‘free market’ in which all economic considerations are ‘rationalized’ in terms of monetary loss or gain, and comparative advantage; *second* it relies on new

<sup>6</sup> L. Taylor and U. Pieper, “Reconciling Economic Reform and Sustainable Development: Social Consequences of Neo-Liberalism”, Office of Development Studies, *Discussion Paper Series*, No 2, United Nations Development Programme, New York, 1996.

<sup>7</sup> T. Barry, *Zapata's Revenge: Free Trade and the Farm Crises in Mexico*, Brown and Co., Boston, 1995.

technologies to create new markets by enhancing global financial transaction and capital transfer, with the least marginal loss". Based on these two aspects, the most important proposition of the neo-liberal view is economic growth. According to this view only economic growth assures and sustains capital accumulation through increasing actual production and the realm of potential production. Originally, such economic growth is always based on the difference between what human labour produces and what it actually receives in return, which is measured as profit. This model of economic growth must be organizationally and technologically dynamic. Its dynamism results in part from competition for labour and resources and in part from the need to manage social labour so as to remain variable.

Thus, even if neo-liberalism is the prevailing ideology of the global economy and as biotechnology can be accounted as a product of capitalist economy, particularly neo-liberalistic view, biotechnology also exhibits a very good example for Schumpeterian analytical view.

Schumpeter claimed that capitalism would not survive into the future because of its inevitable extra-economic consequences that were bound to undermine in turn its success, and he concluded that socialism would eventually replace capitalism in Western democracies. For Schumpeter, it was not the shortcomings or the instability of capitalism that produced the victory of socialism. Instead it was the superior performance of capitalism that paved the way for socialism. He saw the declining economic importance of the entrepreneur as one of the major forces in the transformation from capitalism to socialism. Schumpeter also claimed that by means of modern techniques and modern modes of organization the innovation process would become more and more automated. Innovations would no longer be connected with the efforts and the brilliance of a single person, who is called as entrepreneur and these innovation were increasingly to become the outcomes of the large organized teams. This would be done most effectively within the framework of large corporations. In fact, the entrepreneurs were, according to Schumpeter,<sup>8</sup> the backbone of the bourgeoisie, thus providing capitalism with its institutional and political basis. By destroying the entrepreneurs through its effectiveness, capitalism would also destroy its own political basis. In an economy that is increasingly dominated by giant corporations and devoid of entrepreneurs, the defense of capitalism has no constituency. Instead, capitalism will have to confront increasing hostility.

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<sup>8</sup> J. A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper and Row, New York, 1942.

So that, capitalism would kill itself by undermining its political base by its own efficiency as the forces of creative destruction would eventually kill capitalism itself. By using the proceeds from its monopoly power to finance new innovations, the large corporation could improve its monopoly position and in practice crowd out entrepreneurs and smaller firms.

In this context, it can be claimed that Schumpeter, despite some shortcomings, offers an analytical framework that is relevant to the modern biotechnology industry and accurately describes the discontinuity with the past. His analytical view can be employed for the biotechnology industry as technological discontinuity has occurred in existing pharmaceutical industry. To carry this analysis out to the future a couple of questions need to be answered. What can we do to understand possible challenges of biotechnology industry in the future? How can we extend our analytical view in biotechnology? Next section will offer a new perspective to have wider and more comprehensive view as an extension of Schumpeterian approach.

### **3. Innovations, Inventions and Diffusion in Schumpeterian Approach and Biotechnology**

Schumpeter<sup>9</sup> distinguished invention, innovation and diffusion in formulating his view on technological change and its economic effects mainly for small firms. In the case of *invention*, he thought that the ideas, which form the basis of the subsequent new technology, are formulated. Then, these ideas are used to produce and sell new or improved products, processes, and services; they are used to *innovate*.

Commonly innovations are thought as new inventions which will be further developed to new products but in Schumpeterian thought this interpretation is just one out of several cases of an innovation.<sup>10</sup>

Indeed, Schumpeter explained his approach by describing innovation in the context of ‘new combinations’ that replace existing products and markets. As suggested by Hagedoorn<sup>11</sup> Schumpeterian innovations meant in terms of new products or new quality of products, new methods of production or new sources of supply of raw materials. These technical innovations have to be distinguished from ‘market or organizational’ innovations which are new combinations in terms of new markets or new industry

<sup>9</sup> J. A. Schumpeter, *The Theory of Economic Development*, Oxford University Press, London, 1934.

<sup>10</sup> See Braunerhjelm and Svensson for a discussion of the asymmetry between invention and innovations.

<sup>11</sup> J. Hagedoorn, "Innovation and entrepreneurship: Schumpeter revisited", *Industrial and Corporate Change*, Vol. 5, Year 1996, pp. 883-896.

structure. Schumpeter<sup>12</sup> distinguished between five different matters of innovation: i) The introduction of a new good; ii) The introduction of a new method of production; iii) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before; iv) The conquest of a new source of supply of raw materials or half-manufactured goods; and v) The carrying out of the new organization of any industry, like the creation of a monopoly or the breaking up of a monopoly position. Schumpeter, also in his early works, emphasized the role of entrepreneur, who seized the new body of knowledge made available by the invention process and transforms it into commercial output.

Schumpeter<sup>13</sup> stressed the importance of the R&D activities for new commercially exploitable knowledge embodied, as corporations themselves grew in size and economic significance.<sup>14</sup> In order to analyze the economic impact of new inventions and innovations, Schumpeter pointed out the necessity to understand the *diffusion* process whereby new products, process and series are adopted and used by others in the economic system. Biotechnology is an excellent example of an industry with Schumpeterian competition because revolutionary changes in technology, innovation of new products and process have the potential to threaten the position of existing market-leaders and their product-market positions. In addition, it is also a sector that a large number of R&D alliances, in particular between large and small companies can be found side by side.<sup>15</sup> More interestingly, these new combinations with new technologies not only threatened the position of existing relations, but they also created a strong technological discontinuity with new players that restructure parts of the existing industry;<sup>16</sup> For instance, whereas the ‘traditional’ pharmaceutical industry and its innovations are largely based on organic chemistry, many new scientific

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<sup>12</sup> J. A. Schumpeter, *The Theory of Economic Development*, Oxford University Press, London, 1934.

<sup>13</sup> J. A. Schumpeter, "Capitalism", reprinted in R. W. Clemence (ed), *Essays of a J. A. Schumpeter*, Cambridge, Massachusetts: Adison-Wesley, pp. 184-205, 1946.

<sup>14</sup> R. Stokvis, "Knowledge and the Nature of capitalism: Some Schumpeterian Observations", *Discussion paper*, University of Amsterdam, The Netherlands, 2001; M. Fransman, "Biotechnology, Generation, Diffusion and Policy in Technology and Innovation in the International Economy", (ed.) C. Cooper, *United Nations University Institute for New Technology*, United Nations University Press, 1994.

<sup>15</sup> J. Hagedoorn and N. Roijakkers, "Small Entrepreneurial Firms and Large Companies in Inter-firm R&D Networks-The International Biotechnology Industry", *Discussion Paper*, MERIT, University of Maastricht, The Netherlands, 2000.

<sup>16</sup> W. W. Powell, "Interorganizational Collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, Year 1996, pp. 197-215; W. W. Powell, K. W. Koput and L. Smith-Doerr, "Interorganizational collaboration and the focus of innovation: networks of learning in biotechnology", *Administrative Science Quarterly*, Vol. 41, Year 1996, pp. 116-145.



and technical innovations in biotechnology, which are currently introduced, are largely based on immunology and molecular biology, including recombinant DNA technology. Furthermore, pharmaceutical industry has gradually become mature, but new technical innovations in biotechnology created a kind of discontinuity as Schumpeter explained in his idea for competition and the innovative role of both large companies and smaller entrepreneurial firms.

#### **4. The biotechnology industry in historical perspective: The changing importance of large and small companies**

In the Schumpeterian view, an entrepreneur is primarily an agent of change, who is searching for new opportunities and not necessarily a strictly rational, economically maximizing, a risk taking capitalist, as described in the 'classical' theories of entrepreneurship.<sup>17</sup> In his early work, Schumpeter<sup>18</sup> described small and independent entrepreneurial companies as major agents of change within new industries. For Schumpeter the small entrepreneurial companies are important because society needs them as a major generator of new innovations. These companies are innovators that successfully introduce new products and are largely financed by external sources, rather than by internal cash flows. In modern strategic management terminology, Schumpeterian small and innovative entrepreneurships are based on proactive strategies that capitalize on firm specific advantages and innovative capabilities, financed through back loans and venture capital.

In Schumpeterian argument, there is also an important role for large companies. In his work, Schumpeter<sup>19</sup> pictured large science based companies as dominant agents in the innovative environment, which innovations were developed in large research laboratories and R&D activities. For example, the long-term experiences of the large companies in the 1950s and 1960s mostly concentrated on the innovation process in the traditional pharmaceutical industry. Their dominance was derived from their superior ability to deliver incremental innovation, and its exploitation by way of expanding existing portfolios of pharmaceutical products.

**During 1970s**, basic science-type research stemming primarily from universities research led to major scientific and technological changes. Major

<sup>17</sup> E. Santarelli and E. Perciarelli, "The emergence of a vision: the development of Schumpeter's theory of entrepreneurship", *History of Political Economy*, Vol. 22, Year 1990, pp. 677-696; J. Hagedoorn, "Innovation and entrepreneurship: Schumpeter revisited", *Industrial and Corporate Change*, Vol. 5, Year 1996, pp. 883-896.

<sup>18</sup> J. A. Schumpeter, *The Theory of Economic Development*, Oxford University Press, London, 1934.

<sup>19</sup> J. A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper and Row, New York, 1942.

biotechnology emerged as a result of major scientific breakthroughs in the 1970s and created a new sector in the fields of recombinant DNA and hybridoma technology. This very new biotechnology sector owes its very existence to the new technological and commercial possibilities. Within biotechnology sector mainly two groups of firms coexist. The first group companies adopted a niche strategy and commercialize products as soon as they produce. On the other hand, the second group companies mostly focused on the creation of knowledge through intensive R&D activities and strongly connected with pharmaceutical companies'.<sup>20</sup> Nearly all of the small biotechnology companies at the time were part of the pharmaceutical industry.<sup>21</sup> The ensuing commercialization of biotechnology created what Schumpeter<sup>22</sup> termed as 'a new economic space'. As mentioned by Arora and Gambardella<sup>23</sup> these small new technology companies were frequently financed through venture capital or loans and equity participation of large companies. More importantly, new technology companies seem to be driven mainly by scientific discoveries and innovative performance not only by regular profit seeking incentives.<sup>24</sup> In fact, most of the small biotechnology companies were quite different from the traditional industries, their organizational settings and cultures. In particular, the academic culture, within these innovation-driven and loosely organized companies, with their informal, non-hierarchical structures, sets them apart from many other traditional pharmaceutical companies.<sup>25</sup>

<sup>20</sup> B. Coriat, F. Orsi and O. Weinstein, "Does Biotech Reflect a New Science Based Innovation Regime?", *Industry and Innovation*, Vol. 10, Year 2003, pp. 231-253.

<sup>21</sup> M. Kenney, "Biotechnology and the creation of a new economic space", in *Private Science, Biotechnology and the Rise of the Molecular Sciences*, (ed.) A. Thackrey, University of Pennsylvania Press, Philadelphia, 1995; W. W. Powell, "Interorganizational Collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, 1996, pp. 197-215.

<sup>22</sup> J. A. Schumpeter. *Business Cycles: A Theoretical Historical and Statistical Analysis of the Capitalist Process*, abridged by R. Fels, McGraw-Hill, New York, 1939.

<sup>23</sup> A. Arora and A. Gambardella, "Complementarity and external linkages: The strategies of the large firms in biotechnology", *Journal of Industrial Economics*, Vol. 38, Year 1990, pp. 361-379; S. R. Barley, J. Freeman and R. C. Hybels, "Strategic alliances in commercial biotechnology", (eds.) N. Nohria and R.G. Eccles, *Networks and organizations: Structure, Forms and Action*, Harvard Business School Press, Boston (MA), 1992, pp. 311-347; W.W. Powell, K. W. Koput and L. Smith-Doerr, "Interorganizational collaboration and the focus of innovation: networks of learning in biotechnology", *Administrative Science Quarterly*, Vol. 41, Year 1996, pp. 116-145.

<sup>24</sup> O. A. Lukerman and J. P. Liebeskind, "Three levels of networking for sourcing intellectual capital in biotechnology: implications for studying interorganizational networks1", *International Studies of Management and Organization*, Vol. 27, Year 1997, pp. 76-103.

<sup>25</sup> W. W. Powell, "Interorganizational collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, 1996, pp. 197-215; J. Hagedoorn and N. Roijakkers, "Small Entrepreneurial Firms and Large Companies in Inter-firm R&D Networks-The International Biotechnology Industry", *Discussion Paper*, MERIT, University of Maastricht, The Netherlands, 2000.

**During the 1980s**, new technology became more relevant to the pharmaceutical industry as established pharmaceutical companies have developed very distinctive and diversified strategies to deal with the emergence of molecular biotechnology.<sup>26</sup> That led to a certain degree of mutual dependence developed almost instantaneously between large pharmaceutical companies and a group of relatively small new biotechnology firms.<sup>27</sup> These small biotechnology companies, mostly from the USA, have developed a reputation for their R&D capabilities and applied laboratory research in advanced biotechnology at the scientific and technological frontier. Large pharmaceutical companies were always known for their vast body of engineering know-how necessary for scaling up from a laboratory setting to the actual manufacturing process of new pharmaceutical products. They have also had the resources to finance the extensive and costly clinical testing required as apart of the government regulatory process, enable them to deal with the costs of the formal stage of commercialization and the successful market introduction, distribution of safe and effective pharmaceutical products.

The obvious complementarities between both groups of companies during the early period of modern biotechnology in the 1980s facilitated a mutual dependence. Both groups of companies started to collaborate on various projects, when large pharmaceutical companies provided financial support and regulatory know-how to small entrepreneurial biotechnology companies in return for access to the research skills of these small biotechnology companies.<sup>28</sup> For instance, the increasing number of new products based on pharmaceutical-biotechnology collaboration between small entrepreneurial firms and large companies also provided the first group with access to new markets and distribution facilities.<sup>29</sup>

<sup>26</sup> L. Orsenigo, *The Emergence of Biotechnology, Institutions and Markets in Industrial Innovation*, Pinter Publishers, London, 1989; L. Orsenigo, F. Pammoli and M. Riccaboni, "Technological Change and Network Dynamics: Lessons from the Pharmaceutical", *Research Policy*, No. 30, 2001, pp. 485-508.

<sup>27</sup> A. Arora and A. Gambardella, "Complementarily and external linkages: The strategies of the large firms in biotechnology", *Journal of Industrial Economics*, Vol. 38, Year 1990, pp. 361-379; W. W. Powell, "Interorganizational collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, 1996, pp. 197-215; F. Malerba, "Sectoral Systems of Innovation: A Framework for Linking Innovation to the Knowledge Base, Structure and Dynamics of Sectors", *Economics of Innovation and New technology*, Vol. 14, No. 1-2, Year 2005, pp. 63-82.

<sup>28</sup> A. Arora and A. Gambardella, "Complementarily and external linkages: The strategies of the large firms in biotechnology", *Journal of Industrial Economics*, Vol. 38, Year 1990, pp. 361-379; S. R. Barley, J. Freeman and R. C. Hybels, "Strategic alliances in commercial biotechnology", (ed.) N. Nohria and R.G. Eccles, *Networks and Organizations: Structure, Forms and Action*, Harvard Business School Press, Boston (MA), 1992, pp. 311-347; W. Shan, G. Walker and B. Kogut, "Interfirm cooperation and startup innovation in the biotechnology industry", *Strategic Management Journal*, Vol. 15, Year 1994, pp. 387-394.

<sup>29</sup> J. Hagedoorn and N. Roijakkers, "Small Entrepreneurial Firms and Large Companies in inter-firm R&D networks-The International Biotechnology Industry", *Discussion Paper*, MERIT, University of Maastricht, The Netherlands, 2000.

**During the 1990s**, the mutual dependence of large pharmaceutical companies and small entrepreneurial biotechnology firms has gradually changed. In the biotechnology industry, sector specific technological developments together with the high cost of R&D, and the dependence on a substantial stock of knowledge have led to a situation where large pharmaceutical companies were no longer the main provider of innovation.<sup>30</sup> In biotech small firms two different patterns have emerged; a more science-based pattern and a more application-oriented one.<sup>31</sup> The split between the two types of activities seems to have consolidated over the years, with some companies becoming research companies because of their strong focus on basic research, and with some companies becoming specialized application-oriented because of their research contracts on behalf of large established pharmaceutical companies or patent licensing.<sup>32</sup> At the end of the period, large firms exceed the intensity found for small firms. The changing role of the large pharmaceutical companies is also found to support the Schumpeterian tradition for the period 1993-1995. In Schumpeterian view patent protection is essential to promote innovation, although this does not guarantee a pension is perpetual, and increases forever, the common heritage of knowledge.<sup>33</sup> So that, companies should be able to keep their production processes secret, have their trademarks protected from infringement, and obtain patents.

**From the late 1990s to 2000s**, major companies became deeply involved in agro-biotechnology. The reason for this was that they have been severely disturbed by the rejection of genetically modified (GM) food and a sharp reduction in their profit levels. They have developed **new life sciences** companies, with divisions specializing in agriculture, pharmaceuticals and the nutrition fields. Those companies also developed strategies involving **mergers** and **de-mergers** and opened a period of uncertainty in terms of industrial evolution and created new opportunities for agro-biotechnology. For these agro-biotechnology companies, the development of integrated

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<sup>30</sup> A. Arora and A. Gambardella, "Complementarily and external linkages: The strategies of the large firms in biotechnology", *Journal of Industrial Economics*, Vol. 38, Year 1990, pp. 361-379; J. A. Cantwell and A. Bachman, "Changing Pattern in Technological Leadership-evidence from Pharmaceutical Industry", *International Journal of Innovation Management*, Vol. 21, Year 1998, pp. 45-77.

<sup>31</sup> F. Malerba and L. Orsenigo, "Technology Regimes and Firm Behaviour", *Industrial and Corporate Change*, Vol. 2, Year 1993, pp. 45-71.

<sup>32</sup> B. Coriat, F. Orsi and O. Weinstein, "Does Biotech Reflect a New Science Based Innovation Regime?", *Industry and Innovation*, Vol. 10, Year 2003, pp. 231-253.

<sup>33</sup> B. Bronwyn and R.M. Ziedonis, "The patent paradox revisited: an empirical study of patenting in the US semiconductor industry", *Rand Journal Of Economics*, Vol. 32, 2001, pp. 1001-128.

approaches linking seeds, plant protection products and biotechnology in a synergistic way was an important stage not only on the research side, but also to develop new products and enhance their stock market value in the global market. From the Schumpeterian perspective, this new structure widened the gap between pharmaceuticals and biotechnology, in consistency with his views on industrial discontinuity theorem and creative destruction.

### **5. Schumpeter's Creative Destruction in Biotechnology Industry**

Schumpeter<sup>34</sup> defined small entrepreneurs as firms, which innovate using internal capabilities and race for the patents to create an industry structure of intense competition. Schumpeter<sup>35</sup> portrayed large companies as firms, which collaborate through on-going relationships with alliance partners with mutual, but possible different strategic interest. In that respect, obtaining access to knowledge through relationships produce competitive advantage for firms and this is the hearth of the capitalism.

In addition, Schumpeter<sup>36</sup> described capitalism as an 'evolutionary process' and the dynamics of this process come from the competition between entrepreneurs (small firms) and the large firms. Schumpeter argued that stationary capitalism is impossible and a contradiction in terms. Schumpeter claimed that for the central figure on the capitalist stage, the entrepreneur, is concerned not with the administration of existing industrial plant and equipment but with the incessant creation of new plant and equipment, embodying new technologies that revolutionize existing industrial structures.<sup>37</sup>

By marrying capitalism with the business cycle, Schumpeter<sup>38</sup> identified a pattern behavior of cyclical ups and downs coinciding with the entrepreneurial introduction of innovations and their gradual assimilation in which way entrepreneurial profits were undermined and the benefits of new technology passed over to the consumers in the form of reduced prices. Hence, the economy alternated between phases in which there were first positive profits due to monopolistic advantages and then zero profits with competition among many equals. Schumpeter argued that capitalism

<sup>34</sup> J. A. Schumpeter, *The Theory of Economic Development*, Oxford University Press, London, 1934.

<sup>35</sup> J. A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper and Row, New York, 1942.

<sup>36</sup> Ibid.

<sup>37</sup> J. A. Schumpeter, "Capitalism", reprinted in R. W. Clemence (ed.), *Essays of a J. A. Schumpeter*, Cambridge, Massachusetts: Adison-Wesley, 1946, p. 193.

<sup>38</sup> J. A. Schumpeter, *Business Cycles: A Theoretical Historical and Statistical Analysis of the Capitalist Process*, Abridged by R. Fels, McGraw-Hill, New York, 1939.

would not survive into the future because of its inevitable economic consequences that were bound to undermine in turn its success. In other words, capitalism was fast becoming the very victim of its own economic success by destroying its institutional framework, which bases on competition, growth and great improvements in life throughout technological changes. This process, in Schumpeterian terminology, is called as *creative destruction*.<sup>39</sup> Schumpeter viewed capitalism as a “form or method of economic change”,<sup>40</sup> which is often summarized as never-ending process of “creative destruction”. Creative destruction refers to the economic processes by old systems; technology is destroyed by the new ones.

Our lives have plenty of examples of such creative destruction. When specific production lines loose their regional production ground, such as with shipbuilding, coal mining, or textile industries in Europe or North-America new fields of economic activities emerge simultaneously, such as e.g. tourism or leisure industries, microelectronic related industries or biotechnology driven production.

High technology industries face extraordinary rates of change in terms of technology and business conditions. The external environmental influences (such as social, ethical and religious considerations) create massive impact on the biotechnological industry and these are more complex than in most industries. Biotechnology including stem cell research, genetic engineering such as cloning, genetically modified organisms and genetically modified foods have major economic impacts at both national and international level.

Many of the new biotechnology firms have actually not yet begun to make profits however, biotechnology has already begun to have some important economic effects. In *stem cell field*, A Singaporean firm ES Cell saw a rapid increase in the demand for their product. Another Singaporean company CordLife was initially setup as the first private cord-blood bank in Singapore, but later it was expanded to become the leading stem cell biotechnology company in Asia. *Genetically engineered products* are beginning to have an impact in the area of animal and human vaccines.<sup>41</sup> In July

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<sup>39</sup> Creative destruction is not originally coined by Schumpeter but by Werner Sombart who introduced the topic (R. Prendergast, “Schumpeter, Hegel and the vision of development”, *CambridgeJournal of Economics*, Vol. 30, No. 2, Year 2006, p. 501)

<sup>40</sup> J. A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper and Row, New York, 1942, p. 82.

<sup>41</sup> D. Hine and J. Kapeleris, *Innovation and Entrepreneurship in Biotechnology, An International Perspective; Concepts, Theories and Cases*. Edward Elgar: UK, 2006.

1986, the U.S. Food and Drug Administration approved the first genetically engineered vaccine for human use: a hepatitis B vaccine. Then, one pharmaceutical company Merck, Sharpe and Dohme developed a genetically engineered version of the conventional hepatitis B vaccine in search of an estimated market of \$300 million. In *medical sciences*, Bioscot is marketing a diagnostic kit that allows fish farmers to detect a dangerous fish virus that can rapidly kill the entire stock of fish. *Single-cell proteins* are a further area where great potential was foreseen as a way of producing sustenance for both humans and animals, and where significant investment was undertaken by large corporations, such as ICI.

According to Sinai<sup>42</sup> developing a Genetically Modified Organisms costs \$200-400m to the US multinationals and takes 7 to 10 years to develop. Therefore, it is vital for the MNCs to expect a return on this massive investment by imposing pressures on governments to protect their property rights and to regulate the market to block the market for new entries.

By and large, the Schumpeterian perspective on the creation of profits is shared by small innovative companies and by the more internationally integrated multinational companies (hereafter MNCs), who particularly in sectors at the leading edge of innovation. In particular, the relationship between MNCs and the creation of monopoly profits exhibit a very interesting pattern in biotechnology case and can only be understood in the context of the increasingly homogenous neo-liberal global economy.

Biotechnology exhibits a little different pattern and trend from all other high tech industries. Although, contrary to Shumpeter's prediction, capitalism still survives in today's world, in particular, modern biotechnology is a clear example of a set of new combinations with new technologies that create a technological discontinuity in existing pharmaceutical industry. In the context of this technological discontinuity, it is true that innovations not only affect the introduction of new products and new processes but these technical innovations also led new frontiers into the market.<sup>43</sup>

Nevertheless, as can be seen from Figure 1 up-front payments in the US and Europe shows a declining trend between the periods of 2006 and

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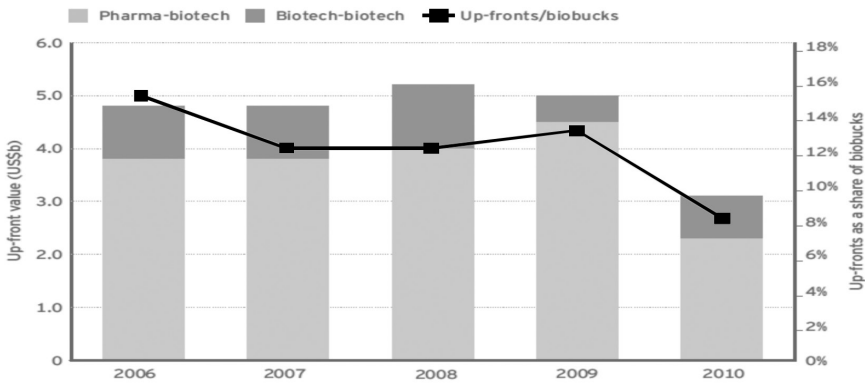
<sup>42</sup> A. Sinai, "New Monsanto and GMO Propaganda: Seeds of Irreversible Change", *Le Monde Diplomatique*, 2001.

<sup>43</sup> W. W. Powell, "Interorganizational collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, 1996, pp. 197-215; W. W. Powell, K. W. Koput and L. Smith-Doerr, "Interorganizational collaboration and the focus of innovation: networks of learning in biotechnology", *Administrative Science Quarterly*, Vol. 41, Year 1996, pp. 116-145.

2010, and demonstrates that there is a widening gap between the high total values and the cash actually flowing in to fund biotech innovation among pharma-biotech, biotech-biotech and up-fronts (bio bucks<sup>44</sup>). In five years time licensees have become more risk-conscious, with up-front license fees and other payments declining sharply, especially for earlier-stage technologies. This trend also reflects a challenging financing environment.

Decline in up-front payments from 2006 to 2010 also confirms that Schumpeter’s prediction is right on creative destruction which refers to old technology is destroyed by the new technology within capitalism. As a solutions, according to investors in the US and Europe, profitable biotech MNCs can at least in the short-run maximize shareholder value by selling to revenue-hungry pharmaceutical companies rather than by pursuing high-risk R&D in order to survive.<sup>45</sup>

**Figure 1: US and European Up-Front payments**



Source: Ernst & Young, *Beyond Borders; Global Biotechnology Report 211*, UK.

The biotechnology industry has thus far evolved in a manner mostly consistent with Schumpeterian views. Extrapolating into the future, a Schumpeterian framework suggests important challenges for an industry at that stage of maturity. The importance of technological discontinuities for the emergence of novel industrial sectors is illustrated by a case study of the biotechnology industry in the late 20<sup>th</sup> century and by declining in pharmaceutical industry.

<sup>44</sup> It is a special term for companies to trumped the total potential value of alliances in their press releases.

<sup>45</sup> Ernst & Young, *Beyond Borders; Global Biotechnology Report 2011*, UK.



## 6. Future of Biotechnology Companies in Global World, Institutional Economy and International Political Economy

In order to address the biotechnology industry better we can introduce the international political economy perspective and institutionalism perspective for biotechnology from the Schumpeterian view.

Schumpeter's position is quite close to an institutionalism perspective, which tries to embed historical, regional, and, in that sense, cultural specifics in order to get a clear sense of empirical material, which differs internationally and historically.<sup>46</sup>

According to Hine and Kapeleris<sup>47</sup> due to constant development and implementation of new science and new technology, through publications and patents, most areas of biotechnology operate in a climate of near constant change. However, even in this change climate there come opportunities for ground breaking innovations which will create even more dramatic change fluctuations. For example, in biotechnology some of these important developments can be accounted as recombinant DNA, and then there are PCR, the completion of the mapping of the human genome, and cloning Dolly the sheep. In biotechnology the institutional framework serves to support the diffusion of innovation throughout the industry, through knowledge sharing, licensing deals, publications and the purchase of new technology through public funding. The height of the fluctuations is a function of the extent of support or hindrance of the institutional framework surrounding the innovation. A supportive institutional environment could still be regarded as the creative destruction phase of industry development.

It will be appropriate to consider that the international political economy perspective can offer a supportive view by recognizing the possible links of the biotechnological sector to a regional, national and international economic system through institutionalism.<sup>48</sup> To do that, as Powell suggested, we should stress on the biotechnology industry by focusing upon four primary structural elements of the industry: knowledge, production,

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<sup>46</sup> P. G. Michaelidis and J. G. Milios, show the different roots between Historical School and Schumpeterian thought in more detail.

<sup>47</sup> D. Hine and J. Kapeleris, *Innovation and Entrepreneurship in Biotechnology, An International Perspective; Concepts, Theories and Cases*, Edward Elgar: UK, 2006.

<sup>48</sup> W. W. Powell, "Interorganizational collaboration in the biotechnology industry", *Journal of Institutional and Theoretical Economics*, 152, 1996, pp. 197-215.

finance and security, and three secondary considerations; biosafety, public opinion, choice of intellectual property. Without analyzing these elements and considerations, our analytical approach towards biotechnology industry to deal with its shortcomings and opportunities will be uncompleted.

When we take into consideration the interaction between different governance levels in this market, the evaluation and capacity of those actors to shape the development of the market will be able to guide us to make better decisions. This is known as structural power and unlike the more realists driven rational power, it is the capacity of an actor/set of actors to shape and influence the development of that market sector. This can be achieved with the combinations of finance, knowledge, security and production as key factors underpinning the development of this structural power are examined in the biotechnology sector.<sup>49</sup>

## 7. Conclusion

Reading Schumpeter is an appropriate tool finding a way back and to shed light on contemporary questions and problems. Schumpeter find a revival of his theoretical thought in recent times where lessons provided through the current economic crisis show the relevance of seemingly external influences. Creative destruction has to be seen in context with innovation and entrepreneurship for which Schumpeter is especially so well known. In the perception of Schumpeter the process of industrial change occupies the basic place.

From the Schumpeterian view it is also true that decreasing investor funds (and confidence), rationalization, problems of intellectual property and healthcare policies, increasing degree of monopolization biotechnology as a result of merger policies and structural economic difficulties are rapidly maturing the biotechnology industry.<sup>50</sup> Because biotechnology is extremely capital intensive and needs huge investment in R&D, there is a strong tendency towards monopolization. This, in return, gives big MNCs a reason to perceive agricultural problems as genetic deficiencies of organisms and treat nature as a commodity. This can also be seen as a good sign of creative destruction of capitalism.

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<sup>49</sup> Ibid.

<sup>50</sup> W. W. Powell, K. W. Koput and L. Smith-Doerr, "Interorganizational collaboration and the focus of innovation: networks of learning in biotechnology", *Administrative Science Quarterly*, Vol. 41, Year 1996, pp. 116-145.

Even though Schumpeter had clearly underestimated the potential innovation sources of capitalism, this is a fact that competition in capitalism is ultimately linked to company strategies which are permanently competing for new ways of innovation, subsequently, competing for the need of new technologies within industries in order to survive. So it is rational to claim that Schumpeterian approach explains biotechnology industries better than neo-liberal economic approach.

The term of Schumpeter's creative destruction is a contradictory expression, which seeks to highlight the fact that competition and inherent processes towards monopolistic and oligopolistic competition are only one part of the overall economic game. Until now, the economic and political domination of the agricultural development agenda by MNCs has thrived at the expense of the interests of consumers, farm workers, small family farms, wildlife and environment. The trends towards a reductionist view of nature and agriculture set in motion by contemporary biotechnology must be reversed by a more holistic approach to agriculture. Power relations should determine the future of biotechnology-based research, and there is no reason why farmers and the public in general, could not influence the direction of biotechnology along sustainability goals. National and international public organizations will carefully monitor and control the provision of applied non-proprietary knowledge to the private sector so as to protect that such knowledge will continue in the public domain for the benefit of rural societies. Publicly controlled regulatory regimes must be developed and employed for assessing and monitoring the environmental and social risks of biotechnological products.<sup>51</sup>

It can be concluded that the biotechnology industry has thus far evolved in a manner mostly consistent with Schumpeterian views. Extrapolating into the future, a Schumpeterian framework suggests important challenges for an industry at that stage of maturity. The importance of technological discontinuities for the emergence of novel industrial sectors is illustrated by a case study of the biotechnology industry in the late 20<sup>th</sup> century.

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<sup>51</sup> D. J. Webber, *Biotechnology: Assessing Social Impacts and Policy Implications*, Greenwood Press, Westport, CT, 1990.

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