

Pohulak-Żołędowska E., *Common resources in open innovation model as the competition driving agents*, „Ekonomia i Prawo. Economics and Law”, Polzakiewicz B., Boehlke J. (ed.), Vol. 13, No. 4/2014, pp. 559-572. DOI: <http://dx.doi.org/10.12775/EiP.2014.040>.

ELŻBIETA POHULAK-ŻOŁĘDOWSKA*

COMMON RESOURCES IN OPEN INNOVATION MODEL AS THE COMPETITION DRIVING AGENTS

SUMMARY

The hereby article is addressed to the problem of innovation in new, Academia rooted industries. The traditional models of innovation seem to fail, whilst R&D activity of companies is more and more risky, and expensive. An example of pharmaceutical industry is given here. Pharmaceutical (and especially biopharmaceutical) industry widely adopts the open innovation model in order to increase innovation. Opening of the innovation process is a novelty in these industries, as the secrecy and inward research activity have been the key features of Big Pharma's success.

Creation of common knowledge platform that enables the communication between researches makes the innovation environment more collaborative but also competitive. Common, open information platform lowers the cost of innovation and also, thanks to the researchers' collaborative behavior, helps to face the big challenges of contemporary societies. The collaboration on the research phase does not exclude the competition. Those are companies that compete, as the prize is profit. Commonly built resources only facilitate the competition process.

Keywords: closed innovation, open innovation, R&D, the commons

JEL Classification: O31, I23, L21

* Elżbieta Pohulak-Żołędowska, Wrocław University of Economics, Faculty of Economics, Management and Tourism, Department of Microeconomics, ul. Nowowiejska 3, 58-500 Jelenia Góra, phone: +48 757 538 252, e-mail: elzbieta.pohulak-zoledowska@ue.wroc.pl.

INTRODUCTION

Innovation became a key word to translate the economic growth of modern economies. The environment for contemporary innovations is so called knowledge-based economy, which- in its meaning, is equal to the 'new economy' – the economy of information and – most of all – economy of communication. These features shape the new conditions for innovation and innovative activity of firms.

Nowadays 'the hunger' for breakthrough innovation results in identifying new directions of economic development – so called the 'new growth areas'. Those are industries that originate in university laboratories, development of which is crucial for citizens' future welfare. An example here can be chemical industry from the XX century, or biotechnology and nanotechnology at present. The expensive and uncertain effect of the laboratory discovery, and trials of transforming it into the innovation, caused the trials of lowering the discovery's cost by changing the shape of the innovation model. The result of these changes is the open innovation model.

The development of innovative products needs competition as a main condition of success. Competition between inventors, scientists, companies. Innovative products develop more effectively in an innovative environment of open-minded, socially networked creators, not restricted by firm's secrecy policy.

The open innovation model is a model that is most relevant for the 'new industries' and new innovation-making process. The change is seen particularly in the flattening of the industry structures (where outsourcing, in-, and outlicensing are new production model's features). It is noteworthy that opening of the innovation process can cause more competition within the new industries. Opening of innovation process changes the landscape of biopharmaceutical as well as the software industries. In pharmaceutical industry opening of the innovation process was related with the crisis in so called 'Big Pharma' model. For software industries the open source movement is the open innovation equivalent.

The goal of the article is an analysis of the open innovation model in order to demonstrate the potential of the 'open' philosophy in innovating with respect to the new, risky, but promising areas of science and industry, as pharmaceutical industry.

The critical review of literature method was used in the hereby article.

1. CONTEMPORARY PROBLEMS OF INNOVATION—INTENSIVE INDUSTRIES

Contemporary economies slow down. One might find the guilt in the economic crisis, but such an explanation looks a bit naive. The general slow-down can be associated with multiple factors, like exhaustion of existing production methods, lack of innovation, descending productivity of R&D, etc. The remedy for this state of affairs can be the long-awaited big change – a breakthrough innovation – a driver of further economic development. The hunger of innovation results in intensive search for high profit areas of economic activity. High profit is usually determined by high risk decisions and – consequently – high cost of economic activity. Areas targeted as potentially valuable for further generations are health, environmental or communication technologies, biotechnology¹.

The specificity of above mentioned areas of interest is that those are strongly science-based activities, in the early stage dominated by basic research (predominantly publicly funded in the form of research conducted in Academia or in publicly funded laboratories). The potential importance for citizens' welfare and general economic development seems to ensure the success of mentioned disciplines. The development of ICT, biotechnology and pharmaceutical industry seems to be a proof here.

The success of new industry disciplines is strongly dependent on the basic research. Enterprises that participate in the innovation creation, incur high costs of the research activity, high risk of invention unprofitability, but also, the temptation of monopoly profits – if the invention becomes innovation. The main problem on this stage of economic activity is the lack of capital. Basic research conducted within the firm's boundaries is a costly process of unpredictable results. It means that nowadays innovation became a more complex and costly process, and the example of pharmaceutical (or biopharmaceutical) industry shows a great evidence here². The development of a new drug costs more than 900 million USD, and takes approximately 13 years³. In the past 60 years, the pharmaceutical industry has delivered over 1,220 new

¹ OECD, *Technology and Industry Scoreboard 2011*, http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2011_sti_scoreboard-2011-en (20.05.2013).

² While pharmaceutical industry can be more calculable thanks to generic and 'me-too' drugs, the biopharmaceutical industry is an example of innovation itself as it focuses on NME-new molecular entities – innovative, never-before discovered compounds.

³ M. Muralitharan et al., *Open Innovation: Next Frontier In Global Biopharma Industry*, „Asia-Pacific Biotech News”, Vol. 14, No. 4/2010, p. 19-22.

drugs that have played an important part in improving public health and extending life expectancy by an average of 2 months each year. But the R&D model that has powered that success, however, is showing signs of fatigue: costs are skyrocketing, breakthrough innovation is ebbing, competition is intense and sales growth is flattening⁴.

Traditionally, the pharmaceutical industry's core innovation model has been the 'blockbuster' approach of furtively developing a product⁵. It's been mostly hidden from competitors at closed innovation model. As the literature shows, most of the existing blockbusters have matured and the cost of developing new drugs is extremely high. In light of the high value-driven product development environment, the hard-coded blockbuster strategy has become completely futile with increasing probabilities of failure⁶. The consequence of such a state of affair was the search for efficiency in economies of scale (through mergers and acquisitions⁷) or just search for the capital support from the venture funds⁸.

Undoubtedly economies of scale in the innovative, high risk, high cost industries are not the remedy for the dwindling R&D productivity⁹. As the data show both in Europe and USA number of new chemical or biological entities (innovative compounds that have been approved as drug compounds) decreases with the increase of R&D investment¹⁰. That can be a proof that

⁴ B. Munoz., *Lessons From 60 Years of Pharmaceutical Innovation*, „Nature Review Drug Discovery”, Vol. 8, No. 12/2009, p. 959-68.

⁵ Blockbuster is an extremely popular drug that generates annual sales of at least 1 billion USD for the company that creates it. Blockbuster drugs are commonly used to treat common medical problems, can be a major factor in a pharmaceutical company's success.

⁶ M. Herper, *How Much Does Pharmaceutical Innovation Cost? A Look At 100 Companies*, <http://www.forbes.com/sites/matthewherper/2013/08/11/the-cost-of-inventing-a-new-drug-98-companies-ranked/> (20.05.2013).

⁷ It is noteworthy that 1950-1990 mergers and acquisitions were caused by the belief that 'scaling-up' would facilitate the technological and commercial exploitation of life science capabilities. Last two decades' M&A have different explanation. The factors that have generally driven consolidation have tended to be negative; that is they are a defensive response to internal weakness, such as innovation deficit and managerial concerns about R&D efficiency and productivity.

⁸ The lack of initial capital in the life science industries has attracted the venture capital which financed the emerging biotech industry, and which is mostly responsible for the 'biotech boom' of the 1980's and 1990's.

⁹ See also: Research and Development in the Pharmaceutical Industry, *The Congress of the United States – Congressional Budget Office*, No. 2589/2006, p. 40, <http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/76xx/doc7615/10-02-drugr-d.pdf> (20.05.2013).

¹⁰ S. Gavura, *What does a new drug cost? Part II: The productivity problem*, <http://www.science-basedmedicine.org/what-does-a-new-drug-cost-part-ii-the-productivity-problem/> (20.05.2013).

the present model of innovation in the high-risk, high-cost, innovative industry sector is no longer valid. It is also noteworthy that we are running out of market space for the 'blockbuster' drugs. The 'niche' drugs that are created to cure uncommon diseases, do not bring that much return and surely do not cost less than the 'blockbusters'. That is why the closed innovation model is no longer efficient here and needs a remedy for the problems with innovation.

2. OPEN AND CLOSED INNOVATION MODELS

The literature shows plenty models of innovation. In 1912 Schumpeter identified, the first time in history, conditions for innovations¹¹. From that time many innovation models evolved. From the linear model of innovation, through the 'chain-linked model of innovation' to the newest attitude of innovation model which are networked innovation model or open innovation¹². More complex systematics of innovation models can be found in the literature¹³. The progress in conceptualizing innovation has been described by Roy Rothwell in the shape of five generations of innovation models¹⁴.

For the need of the hereby article it is noteworthy to reduce the whole variety of innovation models into two – closed and open innovation models. The 'high-risk, high-cost' nature of examined industries reduces the search of the most appropriate innovation model to those. As the business practice shows, the new industries focusing on so called 'new growth areas' (like pharmaceutical, biotechnological or software industry) adopt different innovation models, generally differing in the attitude to the opening and networking of innovation process.

¹¹ J. Schumpeter, *Teorie rozwoju gospodarczego*, PWN, Warszawa 1960, p. 88-150.

¹² S.J. Kline, N. Rosenberg, *An overview of innovation*, [in:] R. Landau, N. Rosenberg (eds), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, Washington, National Academy Press, Washington 1986, p. 275-305.

¹³ J. Tidd, J. Bessant, K. Pavitt, *Managing Innovation: Integrating technological, market and organizational change*, Third edition, Wiley, 2005.

¹⁴ J. Tidd, *A Review of Innovation Models*, Tanaka Business School, Imperial College London 2006, http://www.emotools.com/media/upload/files/innovation_models.pdf (20.05.2013).

2.1. MODEL OF CLOSED INNOVATION

The underlying assumption of the Closed Innovation model says that “successful innovation requires control”¹⁵. It is a logic that is strongly internally focused, since it is not guaranteed that others’ technologies or ideas are available and of sufficient quality. This self-reliance is rooted in the following – admittedly slightly overstated – implicit rules of closed Innovation¹⁶:

- A firm should hire the best and smartest people.
- Profiting from innovative efforts requires a firm to discover, develop, and market everything itself.
- Being first to market requires that research discoveries originate within the own firm.
- Being first to market also ensures that the firm will win the competition.
- Leading the industry in R&D investments results in coming up with the best and most ideas and eventually in winning the competition.
- Restrictive IP management must prevent other firms from profiting from the firm’s ideas and technologies.

According to above assumptions, closed innovation model implies the extreme autonomy of the firm, beginning with idea generation, development and production, to marketing, distribution, service, and financing. This implies that innovation projects can only enter the innovation process at the very beginning, are developed using only internal resources and competencies, and finally can only exit the process by getting commercialized via the firm’s own distribution channels. The ideas or technologies rejected or projects cancelled are stored and collected in internal databases, used only by firm’s own innovation teams. Thus, the traditional funnel analogy is appropriate here. AT&T’s Bell Laboratories stands as an exemplar of this model, with many notable research achievements, but a notoriously inwardly focused culture¹⁷. The “closed innovation modes” can be imaged as the “innovation funnel” (see picture 1).

The closed innovation model is relevant for the blockbuster drug discovery model, where the company’s research activity is a secrecy because of the blockbuster drug development. Inwardly organized R&D process guarantees high returns on R&D investment (because of large population of potential

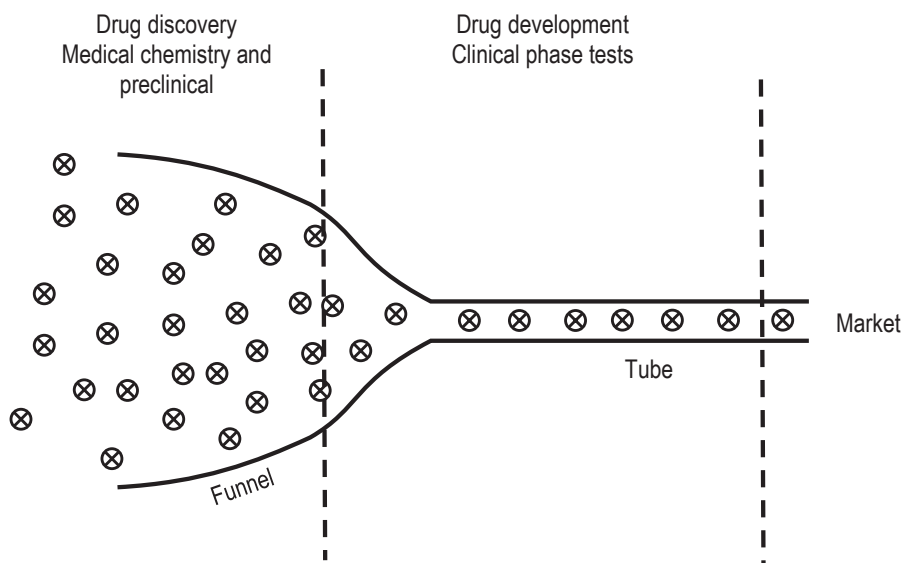
¹⁵ H.W. Chesbrough, *Open innovation: the new imperative for creating and profiting from technology*, Harvard Business School Press, Boston 2003.

¹⁶ Ph. Herzog, *Open and Closed Innovation. Different Cultures for Different Strategies*, Gabler Verlag, Heidelberg 2011.

¹⁷ H. Chesbrough, W. Vanhaverbeke, J. West (ed.), *Open Innovation Researching a New Paradigm*, Oxford University Press, Oxford 2006.

consumers), and can be represented by the Big Pharma. The ‘niche’ drugs development under conditions of closed innovation model is therefore too costly. And that can be the reason of Big Pharma’s R&D productivity and innovation crisis.

Picture 1. Closed Model of Innovation



Source: H. Chesbrough H., *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, [in:] Chesbrough H., Vanhaverbeke W., West J. (ed.), *Open Innovation Researching a New Paradigm*, Oxford University Press, Oxford 2006, p. 3.

2.2. OPEN INNOVATION MODEL

‘Open’ conception has often been used in order to clarify ambiguities in the new goods development process. There are at least three terms directly related to the concept of openness. First one is ‘open source’ concept. It refers to the idea of software development in global partner production process¹⁸. Second one is ‘open development’ associated with more general activities of development process. David M. Waguespack and Lee Fleming indicate a key concept here, which exposes the developed project to the external entity comments and criticism. This solution is helpful, because it gives

¹⁸ See S. Czetwertyński, *Produkcja partnerska w internecie jako przykład globalnej dezintegracji procesu produkcji*, „*Ekonomia i Prawo*”, Vol. XI, No. 4/2012, p. 47-60; Y. Benkler, H. Nissenbaum, *Commons-based Peer Production and Virtue*, „*The Journal of Political Philosophy*”, Vol. 14, No. 4/2006, p. 394-419.

the opportunity to improve problematic issue or reveal unknown mistakes¹⁹. The third term – ‘open innovation’ is for sure the most comprehensive approach to the discussed matters. Henry Chesbrough defines open innovation as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation”²⁰. In this context open innovation is something opposite to the vertical integration model. Internal research and development that traditionally lead to internally developed products, is replaced by the business model that utilizes internal and (even more important) external ideas to create new and unique value. In a certain sense open innovation constitutes an open system that resembles open network of creators working on chosen issue.

Open innovation model is framed in opposition to closed innovation one. It brakes the traditional paradigm of internal innovation²¹. It is noteworthy that some of the rules and theories constituting the open innovation paradigm were well known before Chesbrough’s findings²². However it was Chesbrough that compiled a holistic approach to innovation management describing internal and external sources of innovation as an opportunity to receive measurable benefits.

Open innovation model implies that valuable inventions do not need to come from the company itself and release of those ideas into the market does not need to be achieved by the company’s own doings. Firms rather can, and should, use outer ideas and technologies as well as outer paths to market in order to advance their innovation projects²³.

The graphical illustration of the open innovation phenomena is the open innovation funnel (see picture 2). Open Innovation therefore applies to all three phases of the innovation process (front end of innovation, idea realization and development, and commercialization). During the front end of innovation, firms externally search for problem solutions. In the idea realization and development phase, firms may license external IP or acquire external innovations, which may have already been commercialized, but now offer new opportunities. Furthermore, firms may also license their technology to others

¹⁹ D.M. Waguespack., L. Fleming, *Scanning the Commons? Evidence on the Benefits to Start-ups Participating in Open Standards Development*, „Management Science”, Vol. 55, No. 2/2009, p. 214.

²⁰ H. Chesbrough., *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, [in:] Chesbrough H., Vanhaverbeke W., West J. (ed.), *Open Innovation Researching a New Paradigm*, Oxford University Press, Oxford 2006, p. 1.

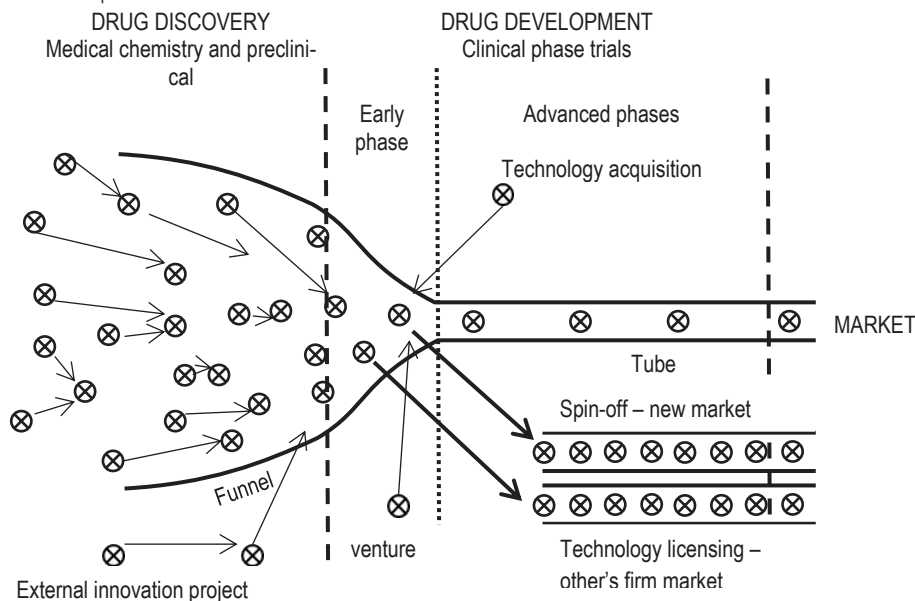
²¹ See H.W. Chesbrough, *Open innovation: the new imperative...*, *op. cit.*, p. 21-62, 93-112.

²² Ph. Herzog., *op. cit.*, p. 2.

²³ H. W. Chesbrough, *Open innovation: the new imperative...*, *op. cit.*

to generate additional sales. During the commercialization phase, firms may spin-out technologies that have already been commercialized via the firms' own distribution channels²⁴.

Picture 2. Open Innovation Model



Source: Hedner T., Change in the Pharmaceutical Industry. Aspects on Innovation, Entrepreneurship, Openness, and Decision Making, Linköping Studies in Science and Technology, Dissertations, No. 1393 p. 24.

In open innovation model projects can be launched from either internal or external technology sources, and new technology can enter into the process at various stages. In addition, projects can go to market in many ways as well, such as through outlicensing or a spin-off venture company – in addition to going to market through the company's own marketing and sales channels. The model is 'open' because there are many ways for ideas to flow into the process, and many ways for it to flow out to the market. IBM, Intel, and lately pharmaceutical companies all exemplify aspects of this open innovation model.

The inner part of the funnel contains internal innovation projects. Walls of funnel stand for company's boundaries. Outside the funnel there are external innovation projects on different stage of development. It is noteworthy that only at the end of the funnel product is fully IPR protected. The wide

²⁴ *Ibidem*, p 3.

parts of the funnel show different shades of openness in the drug discovery and development process. The molecules that leave funnel in the middle of it, are innovations that, for some reason, leave the boundaries of the firm (as spin-offs, out-licensing) and find a new tube of development in different firms.

In general, this approach to innovation makes the boundary between the firm and its environment more porous, turning the former solid boundary into a semi-permeable membrane. In contrast to the closed innovation model, the launch of an innovation project can be triggered by either internal or external idea and technology sources. Those ideas and technologies can enter the innovation process at any time by various means, such as technology in-licensing or venture investments. Besides going to market by using the firm's own distribution channels, innovation projects can be commercialized in many other ways as well, such as through spinoff ventures or out-licensing. As such, Open Innovation therefore applies to all three phases of the innovation process (front end of innovation, idea realization and development, and commercialization). Open Innovation, however, is more than just using external ideas and technologies. It is a change in the way to use, manage, employ, and also generate intellectual property. Open Innovation is a holistic approach to innovation management as "systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels"²⁵.

The new challenges for pharmaceutical industry caused the adoption of open innovation model. The end of dominant role of blockbuster drugs in companies' portfolios and the search for productivity and savings in 'niche' drugs R&D process are achievable in the business model based on common information (or knowledge) resources that benefit both from public and private.

3. OPEN INNOVATION – COMMON RESOURCES AND COMPETITION

The presented open and closed innovation models show different attitudes to creating innovation. A new, open innovation process allows the industry to use the common resource of information²⁶.

²⁵ Ph. Herzog, *op. cit.*, p. 22.

²⁶ Common resources of information constitute the first step of the opening process in each area of interest. The open platform of transferring information, ideas and opinions is one

Building the common base of knowledge is not an easy process, because the most critical information is often protected by privacy concerns. It's all locked up in insurance companies, academic and research centres, and government health agencies, and it is very difficult to get, because there is no conduit by which this information consistently reaches the research community²⁷. What research scientists want, is information on health outcomes, mortality, health conditions of patients, and their behaviour in the context of the disease. Scientists also want information from gene banks or tissue banks from those patients for whom a history is known. At present even a wider scope of information is more and more often the subject of the collaborative 'openness' in the pharmaceutical industry research sector.

The substance of common resources in scientific activity is information. The information can be of three types. First type of info comes from Academia. Information of this type is embodied in publications which represent the university research results. This type of research is mainly the basic research. It is connected with a traditional profile of university's activity.

The second information stream comes from collaborative projects. In those partnerships public actors (universities, research institutes) meet private ones (pharmaceutical companies) in order to discover new areas of knowledge, solve problems of 'stuck', potentially innovative projects, and stimulate new growth areas by public finance support²⁸.

The third knowledge inflow source is a result of different agreements between specific business players²⁹. This last type constitutes the body between open and closed concept. It is noteworthy that results of such relations are more in the type of a "club good" than of a public domain. Still the openness in this issue appears in diffusion of knowledge between competing firms. Ex-

of key factors influencing scientific progress. Only the dialog between various actors can provide a new, sometimes extraordinary or even surprising discovery. The advantage of 'openness' over 'closeness' is the fresh, outsider look on the problem, often breaking stereotypes, accelerating the positive change.

²⁷ R. F. Waldron, *Open Innovation in Pharma – Defining Dialogue*, <http://www.pharmexec.com/pharmexec/article/articleDetail.jsp?id=788391&pageID=1&sk=&date=> (20.05.2013).

²⁸ M. Allarakhia, *Novartis Institutes for Biomedical Research*, @CanBiotech Inc., 2011, p. 6.

²⁹ An example here can be: NIBR, NIH Roadmap Initiative in USA and its European counterpart – EU-OPENSREEN and many initiatives. See also: Novartis Repository <http://oak.novartis.com>; C.P Austin, L.S. Brady, T.R. Insel, F.S Collins, *NIH Molecular Libraries Initiative*, „Science”, Vol. 306, No. 5699/2004, p. 1138-1139; A. Roy A. et al., *Open Access High Throughput Drug Discovery in the Public Domain: A Mount Everest in the Making*, Vol. 11, No. 7/2010, p. 764-778.

ample of these are: licensing, joint R&D agreements, corporate venture capital, joint ventures and acquisitions³⁰.

Opening of the innovation process in pharmaceutical industry was caused by its diminishing innovativeness. Growing costs of R&D process, decline in profits, the change of the business model – all these changes seem to negate the force of closed innovation model in Big Pharma. The remedy for these ‘illnesses’ may be opening of the innovation process. Such an approach has many advantages. First – allows to use common information resources. Different sources of information allow to achieve a complex set of information on investigated problem. The information comes from public and private sources. Public sources of information are universities and public research institutes or laboratories. Thanks to the publicly funded, industry dedicated research this source of information is an extraordinary important one. Public funds devoted to the industry-dedicated research (of high-risk, high-cost nature) can significantly reduce costs and uncertainty of the innovative firm. And the fact of creating the common knowledge platform, with the open access and no secrecy, speeds up innovation creation. Thanks to the commons in pharmaceutical industry companies compete and collaborate. Collaboration is possible on the research level, because of the commons used in order to create an innovative compound. Competition concerns the same stage of the drug discovery – companies compete in compound’s development, because only the first one can possess the exclusive rights to the promising marketable compound.

CONCLUSIONS

The “open” idea in the context of innovation process is not a new one, but adapts well to new challenges of contemporary economies. The ‘hunger’ of innovation makes enterprises involve in more and more risky activities. The success of software industry, the emergence of Internet, Linux example are the evidence of successful stories.

The most important part of the open innovation model is creation of the open knowledge platform that is the base for the pre-discovery research (especially in biopharmaceutical industry). This model of innovation changes the environment of new drug creation. Formerly in the closed innovation model companies competed with each other from the very beginning of the drug

³⁰ A. Roy, R.P. McDonald, R. Chaguturu, *Recent Trends in Collaborative, Open Source Drug Discovery*, „The Open Conference Proceedings Journal”, Vol. 2, No. 1/2011, p. 130-136.

discovery process. All R&D process was conducted in the profound secrecy, because failure to observe secrecy resulted in market exclusion and the loss of monopoly profits.

Open innovation implies a wide scope of collaboration on the pre-discovery level. It is a very important step towards lowering costs of innovation and increasing competition. Using of the commons that emerged on the basis of both public and private funds does not mean the loss of monopoly profit. The pre-discovery phase of new drug development is a costly one, but it determines further innovations. And the company that discovers the marketable compound – wins. Moreover open innovation allows companies to work on ‘niche’ drugs which do not sell as much as ‘blockbusters’ and bring smaller profits.

BIBLIOGRAPHY

- Allarakhia M., *Novartis Institutes for Biomedical Research*, @CanBiotech Inc., 2011.
- Austin C.P, Brady L.S., Insel T.R., Collins F.S., *NIH Molecular Libraries Initiative*, „Science”, Vol. 306, No. 5699/2004, <http://dx.doi.org/10.1126/science.1105511>.
- Benkler Y., Nissenbaum H., *Commons-based Peer Production and Virtue*, „The Journal of Political Philosophy”, Vol. 14, No. 4/2006, <http://dx.doi.org/10.1111/j.1467-9760.2006.00235.x>.
- Chesbrough H., *Open Innovation. The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston 2003.
- Chesbrough H., *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, [in:] Chesbrough H., Vanhaverbeke W., West J. (ed.), *Open Innovation Researching a New Paradigm*, Oxford University Press, Oxford 2006.
- Chesbrough H., Vanhaverbeke W., West J., *Open Innovation Researching a New Paradigm*, Oxford University Press, Oxford 2006.
- Czetwertyński S., *Produkcja partnerska w internecie jako przykład globalnej dezintegracji procesu produkcji*, „Ekonomia i Prawo”, Vol. XI, No. 4/2012, <http://dx.doi.org/10.12775/eip.2012.032>.
- Gavura S., *What does a new drug cost? Part II: The productivity problem*, <http://www.sciencebasedmedicine.org/what-does-a-new-drug-cost-part-ii-the-productivity-problem/> (20.05.2013).
- Herper M., *How Much Does Pharmaceutical Innovation Cost? A Look At 100 Companies*, <http://www.forbes.com/sites/matthewherper/2013/08/11/the-cost-of-inventing-a-new-drug-98-companies-ranked/> (20.05.2013).
- Herzog Ph., *Open and Closed Innovation. Different Cultures for Different Strategies*, Gabler Verlag, Heidelberg 2011.

- Kline S.J., Rosenberg N., *An overview of innovation*, [in:] R. Landau, N. Rosenberg (eds), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, Washington, National Academy Press, Washington 1986.
- Munoz B., *Lessons From 60 Years of Pharmaceutical Innovation*, „Nature Review Drug Discovery”, Vol. 8, No. 12/2009, <http://dx.doi.org/10.1038/nrd2961>.
- Muralitharan M. et al., *Open Innovation: Next Frontier In Global Biopharma Industry*, „Asia-Pacific Biotech News”, Vol. 14, No. 4/2010.
- OECD, *Technology and Industry Scoreboard 2011*, http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2011_sti_scoreboard-2011-en (20.05.2013).
- Research and Development in the Pharmaceutical Industry, *The Congress of the United States – Congressional Budget Office*, No. 2589/2006, <http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/76xx/doc7615/10-02-drug-d.pdf> (20.05.2013).
- Roy A. et al., *Open Access High Throughput Drug Discovery in the Public Domain: A Mount Everest in the Making*, Vol. 11, No. 7/2010, <http://dx.doi.org/10.2174/138920110792927757>.
- Roy A., McDonald R.P., Chaguturu R., *Recent Trends in Collaborative, Open Source Drug Discovery*, „The Open Conference Proceedings Journal”, Vol. 2, No. 1/2011, <http://dx.doi.org/10.2174/2210289201102010130>.
- Schumpeter J., *Teorie rozwoju gospodarczego*, PWN, Warszawa 1960.
- Tidd J., *A Review of Innovation Models*, Tanaka Business School, Imperial College, London 2006, http://www.emotools.com/media/upload/files/innovation_models.pdf (20.05.2013).
- Tidd J., Bessant, J., Pavitt, K., *Managing Innovation: Integrating technological, market and organizational change*, Third edition, Wiley, 2005.
- Waguespack D.M., Fleming L., *Scanning the Commons? Evidence on the Benefits to Startups Participating in Open Standards Development*, „Management Science”, Vol. 55, No. 2/2009, <http://dx.doi.org/10.1287/mnsc.1080.0944>.
- Waldron R.F., *Open Innovation in Pharma – Defining Dialogue*, <http://www.pharmexec.com/pharmexec/article/articleDetail.jsp?id=788391&pageID=1&sk=&date=> (20.05.2013).