Innovative Strategies of American World-Class Research Universities

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Abstract

The article highlights the important role American research universities play in the US innovation system. It examines the types and specific features of university entrepreneurial activities. The necessity of implementing a transdisciplinary approach to research activity and new models of research alliances has been substantiated. The examples of successful cooperation between universities and business have been researched into.

Key words: research universities, university innovation strategy, entrepreneurial education, innovative competitiveness of universities, transdisciplinary approach to research.

In the highly competitive globalized economic environment, the key innovative countries make substantial investments in research and development of higher educational institutions, realizing the crucial role played by research universities in the economic growth of their countries due to training of experts and commercialization of knowledge and technologies. It is well known that research activity stimulates innovation development, resulting in creation of new jobs and increasing a country's living standards and competitiveness. Today, there are a number of studies of the role of innovation in accelerating countries' economic growth. For instance, Professor of Economics at Stanford University P. Klenov and Professor of Economics at the University of California, Berkeley, A. Clare have proved that over 90 per cent of changes in the growth of profit share per employee occur owing to innovations which change the way capital is used[4]. Similarly, professors of Stanford University R. Hall and C. Jones studied 127 countries and discovered that the innovation in the use of capital is 4.6 times more important for economic growth than the amount of such capital[5].

Innovations also allow the private sector of a country to benefit from new products, services and to enhance export activities. It should be noted that in the United States, export growth doubles employment compared to the employment increases

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from investment in the strictly domestic market[1]. Despite the substantial investments made in the corporate research and development, the private sector does not invest at the level required for the society, mostly because companies do not realize all advantages of innovations. According to the results of numerous studies, the level of the value received by society from corporate R&D and innovation is at least twice as higher as the approximate profit received by the company itself[2]. For example, J. Tewksbury, M. Krendall and W. Crane studied the profitability level of 20 well-known innovations and determined the average profitability factor for the private sector at a rate of 27 percent. However, the average level of profitability for society was determined as 99 percent[3]. According to Professor of Economics V. Nordhaus from Yale University, inventors receive only 4 percent of the total social benefits and profit earned by their innovations, while the rest of the benefits are received by other companies and the society as a whole[4].

The higher education system plays a key role in reducing the gap between the level of research activity in the private sector and the level which can be considered best for economic growth of countries. For the last twenty years, the role of higher educational institutions in the U.S. in creating innovations has grown as many companies closed or changed the focus of their research laboratories. As U.S. companies reoriented their research activities into projects with a short payback period, the significance of higher educational institutions in the national innovation system has increased.

Today, U.S. research universities perform 52 percent of all fundamental studies compared with 38 percent in 1960[5]. The research universities train 60 to 80 percent of PhD students in computer, information and communication, engineering and mathematical sciences and 78 to 95 percent of bachelors in the fields required by the American economy. In addition, many characteristics of research universities are coming increasingly to resemble the characteristics of the private sector. From 1991 to 2009, the number of patent awards from research universities increased from an average of 14 to 68, and the income from the licensing increased from an average of 1.9 million to 13 million U.S. dollars per university. The significant role of research universities is proven by the number of start-ups initiated as a result of the universities' research activity. This number grew from 212 start-ups in 1994 to 705 in 2012[6].

American universities' research activity has a significant positive effect on the country's economic growth, exerting considerable influence on the development of products and production processes in U.S. companies. E. Mansfield, a Professor of Economics at the University of Pennsylvania, determined that the profitability level for society from investments in universities' research should be at least 40 percent[7]. A study, conducted by the Scientific Coalition consisting of 50 leading U.S. research universities, has shown that the companies that cooperate with research universities achieve much better results in the market[8]. According to the results of a recent analysis conducted by the Stockholm Research Institute, companies which have research relations with research universities apply for more patents and receive more breakthrough and radical innovations than do companies without such relationships.

Research funded by the public sector supplements the research funded by the private sector but does not replace it. A study conducted by the Rand Corporation has shown that each additional dollar invested in a research funded by the government adds 27 cents of private investment to research activities[9]. A study conducted at Carnegie Mellon University has shown that public funding is vital for industrial research activities in some areas and has a significant effect on industrial research activity in the majority of industrial sectors[10].

The development and consolidation of key research universities in the U.S. has played a major role in their achieving leadership in the area of global innovations, in a survey report of the United States National Research Council «*Research Universities and*

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the Future of America»[1]. This survey emphasizes that in the process of economic growth and fulfilment of national goals, American research universities have become the main and arguably the most powerful economic assets of the nation. The Information Technology and Innovation Technology Foundation in its report «*25 Recommendations for the 2013 America Competes Act Reauthorization*» provide a number of recommendations for the support of research universities. Fourteen out of 25 recommendations address research universities' activities. The report states that universities contribute significantly to the country's innovation and economic development[2]. However, in 2011, U.S. government authorities (of certain states and the federal government) allocated only 0.28 percent of the GDP for research activity of higher educational institutions. As a result, the USA was ranked 24th among 39 countries for spending in this category. Furthermore, the USA is increasingly lagging behind other countries in terms of increasing such funding. The United States was ranked 18th in terms of making changes during the period from 2000 to 2011; and during the period from 2008 to 2011 the country was ranked 22nd in terms of making changes in research spending levels.

Despite the reduction of funding for economic development programs at the level of states by 40 percent since 2009, the funding of research activities during the period from 2010 to 2011 increased by 11.3% and was 1.4 billion U.S. dollars[3]. One-third of this amount was allocated for research activities of universities, and additional 3.8 billion U.S. dollars were allocated by authorities of states to universities for support of their academic research activity.

Governments of states support fundamental and applied research by universities, entrepreneurial initiatives, and the development of universities' clusters and partnerships with industry. The U.S. National Governors Association has emphasized the «growing expectations that universities will reduce the gap between research and commercialization as one of the main trends of economic development in 2013»[4].

In 2001, universities' innovation strategies were aimed primarily at enhancing faculty research activity and at the organization of partnerships with industry and the licensing of inventions. For the last 10 years, however, the conceptual approaches to student entrepreneurship development have been changed. It happened both by changing university curricula (basic and elective disciplines) and by changing the types of additional activity (accelerators, entrepreneurship centers, business competitions, etc.) conducted by universities. Entrepreneurial strategy has become a key component in almost all research universities and was supported by the US Department of Commerce in its recent report on commercialization of university technologies[5].

Going beyond basic types of university activity — creating new knowledge in the process of conducting fundamental and applied research and sharing it by publications and teaching — has also become an important element of universities' development. US research universities implement technological educational innovations when theoretical ideas and results of scientific research transform into products or processes which can be used by society and and following companies.

For the last 10 years, entrepreneurial education has included implementation of the following two processes: process one — the participation of graduates in educational entrepreneurial programs that accelerate the participation of students in the organization of start-ups. Process two — along with studying, students participate in forums, competitions for the presentation of business plans, the activity of business incubators, summer business schools, innovation clubs, etc. For instance, the University of Arizona demands that all first-year students have an introductory course in entrepreneurship. This course introduces first-year students to the concepts which help develop students' entrepreneurial skills. The University of Arizona offers a wide range of entrepreneurial courses including: social entrepreneurship, innovation environment and design, innovative legal clinic, digital media entrepreneurship and more. In addition to classroom courses, the university enables its students to participate in additional activities. The Edson Student Entrepreneur Initiative allows all students who have completed the entrepreneurial course at undergraduate or graduate level to participate in a competition by applying for a grant of 1,000 to 20,000 dollars

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in order to start their own business. The winners of the competition (20 people annually) receive office premises in the Edson accelerator located in the SkySong innovation center. For the past six years, 102 student enterprises and 19 companies have been created with the help of Arizona University's programs.

The entrepreneurship network program unites small business with student groups at the University of Arizona. While studying at the University, students can obtain entrepreneurial skills by working with professionals. The Innovation Advancement Program of the Sandra Day O'Connor College of Law finances the provision of legal and consulting services to students. The clinic gives student entrepreneurs recommendations for patent protection, licensing and defending their interests in court. The biodesign accelerator at the Biodesign Institute contributes to development of innovations by supporting new technologies at major stages of their development and by transferring them to the private sector as soon as they are ready.

The university's innovation strategy also prescribes the involvement of students in extracurricular activities. In 2010, the university created a program called «Venture Catalyst» as an international business and innovation center for technological innovation activity, cross-disciplinary collaboration and the development of world trade. The project's participants can live, work and recreate in a creative environment. The center enables students, teachers, outstanding entrepreneurs and the directors of companies to work together and communicate with one another. The companies created by students of the University of Arizona can receive the help of a mentor from the representatives of the venture fund available in the centre. This program is managed by the Assistant Vice President of the University responsible for innovations, entrepreneurship, and the Venture Catalyst initiative. The major programs of the Venture Catalyst include: the activity of the Firnes accelerator which fosters entrepreneurship with a competition that is open to all students of US universities and is based on creating enterprises where the primary value comes from intellectual property. The winners can place their companies in SkySong centre or the University of Arizona. The winning team receives $25,000 US, a chance to locate in a business accelerator, access to mentors, a fast licensing procedure, and access to shared premises.

Among the extracurricular activities is a networking event Techiepalooza, where lectures are delivered and discussions and intensive communication take place between more than 500 participants for seven hours. An accelerated school of start-ups is opened for teams of entrepreneurs. Built on the principles of Stanford University, it is conducted for nine weeks and each lesson is supported by practical training at enterprises lasting for 10-15 hours. The program «entrepreneurship hours» prescribes communication with an entrepreneur at a scheduled time. The entrepreneurs involved in the program are members of the «Venture Catalyst» program.

The program of extracurricular activities also provides a possibility to invite a manager with at least 15 years of experience to work with talented students in the early stages of business development. Such managers help the students solve problems during a term of six to 36 months. The experienced specialists hold such positions as Chief Executive Officer, Chief Financial Officer, Chief Expert for Technologies in their home companies.

The problem faced by each research university is how best to use limited resources for performing joint research with companies and organizations for the purpose to improve their competitiveness and innovative potential. To gain the greatest advantage, universities create partnerships on the basis of interdisciplinary and interorganizational programs and focus on research having the greatest potential for new discoveries and cooperation with local population. Such cooperation gives unique results which meet local needs best of all and by joint efforts can be turned into competitive advantages on a global scale. Professor M. Crow, the President of the University of Arizona in 2007, claims that this special feature is of major importance for new research universities and that it can be considered a competitive strategy of a research university as a commercial organization[1]. Such models are actively supported by the National Academy of Technical Sciences which recommends close cooperation with new and diverse partners, such as those included in regional clusters of innovation centers[2]. Clusters enable students to study and train with mentors and teachers, to study today's current issues, to train to work in teams, to develop important skills of communication and thinking and to gain hands-on experience in laboratories. Teachers are enabled by clusters to study and apply new interdisciplinary concepts and theories, to increase and improve knowledge of a certain discipline, as well as to benefit from common resources and unions of experts. Interdisciplinary research is more efficient if it is

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conducted within the clusters. In the report issued in 2004 by the Committee on Science, Engineering and Public Policy of the US National Academy of Sciences, interdisciplinary research is defined as a «method of research performed by teams or individuals which combine information, data, techniques, instruments, capabilities, concepts and/or theories from two or more disciplines or specialized fields of knowledge for better understanding or solving problems which cannot be solved within one discipline, industry or area of research practice[1].

In order to strengthen innovative competitiveness of universities, the American Academy of Arts and Sciences in its report «Unleashing America's Research & Innovation Enterprise» has set the following major objectives for higher educational institutions: 1) change interdisciplinary research into transdisciplinary research. 2) encourage synergistic interaction between universities, government and the private sector in the process of carrying out research[2]. Transdisciplinary research is becoming a priority for the development of world-class universities, since they encourage researchers from various areas of activity to work together in order to solve problems of humanity. Universities stimulate research in such a way that the research methods and experience obtained within a certain discipline are distributed to other disciplines in order to ensure conceptual and functional integration. In order to accelerate this process, the American Academy of Arts and Sciences recommends:

— to develop and promote the creation of substantial «knowledge networks» which would allow researchers from various disciplines to apply and focus efforts on solving common problems;

— to expand educational paradigms in order to model transdisciplinary approaches, i.e. to develop/support new and existing research programs of graduates and experienced researchers who integrate the concepts and technologies of both humanity and technical disciplines;

— to increase support of the common research infrastructure, especially where joint research in humanities and technical disciplines is conducted, including funding of the professional staff's activity for infrastructure management;

— to contribute to the policy of employment and career development of staff, which would support joint transdisciplinary research;

— to encourage conduct of transdisciplinary research, while reviewing and improving existing administrative regulations for the optimization of efficiency and dynamism of future inventions.

A successful example of implementing the transdisciplinary approach to research is the Integrated Program for Training Graduates and Researchers of the American Academy of Sciences, the participants of which are the departments of Biological, Computer, Engineering, Mathematical, Physical, Social Sciences, the Polar Research Office, and the International Engineering Research Office. This program was developed for solving problems faced by the United States in training PhDs, engineers and teachers with interdisciplinary education, who will become leaders in conducting global joint research that is beyond traditional disciplines. In order to conduct it, universities create interdependent ecosystems and stimulate fundamental and applied research, as inventions may appear during development in basic research laboratories. Universities, government and the private sector contribute to creation of an inclusive and adaptive environment which integrates and optimally applies unique objectives and best practices from various sectors, since the challenges faced by humanity become a catalyst of transdisciplinary research. It is no coincidence that, in order to respond to the challenges faced by humanity, the Bill and Melinda Gates Foundation and the Office of Science and Technology Policy of the White House recommend:

— to develop and implement new models of research alliances between universities and business;

— to create programs supported by tax incentives, to encourage business to support academic research;

— to develop programs to finance the research ideas proposed by universities and discussed with business consultants;

— to create programs and mechanisms to support cooperation at early stages of research with minimal discussion (or without any discussion) of intellectual property rights;

— to contribute to cooperation between business and universities at all stages of research by developing programs which teach students to work in two environments and enable exchanges for short terms;

— to create research alliances which enable researchers from companies to conduct research in university laboratories and vice versa;

— to establish new priorities for technology transfer between universities and business, while encouraging the exchange of knowledge, resources and people.

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The Bay Dole Act of 1980, which entitled universities to own intellectual property, helped revive the high-tech sector of the USA. The adoption of this Act resulted in creation of more than 7200 companies (in 2010 alone, despite the economic downturn, 600 new companies were created in the country) and more than 8800 new products. The university start-ups added 190 billion dollars to the gross domestic product and created more than 275,000 jobs for 9 years[1].

Though technology transfer offices play an important role at universities, they do not bring substantial financial benefits from licensing and patenting. In 2009, approximately 80 percent of 149 universities studied by the Association of University Technology Managers reported that the licensing revenue they received over 10 years was less than $10 million. The universities were receiving income from one or two licenses, rather than from a constant process of licensing inventions. Therefore today, universities' technology transfer offices are focusing on the mission of knowledge transfer rather than on receiving maximum financial income.

An example of a successful cooperation between a university and business is the Energetic Biotechnology Institute which joins British Petroleum and the University of California, Berkeley, Lawrence Berkeley National Laboratory and the University of Illinois. British Petroleum provides the Energetic Biotechnology Institute with a 10-year grant equalling $500 million for research in the field of energetic biosciences, focusing on the development of next generation biofuels, as well as on the use of biology in the energy sector. While cooperating with the University in the area where the company had a limited number of experts (e.g. biologists), British Petroleum created a new enterprise with the University without the need to open an additional department of the company. Research proposals are considered by the executive committee which consists of the university's representatives and the corporation's engineers, who evaluate the proposed research, taking into account all the corporation's needs. Only after that, the research proposal is presented for independent review. The intellectual property rights are distributed as follows: British Petroleum owns the rights to any research conducted by the company, while the university owns the rights to any research conducted by the university[2].

Thus, research strategies become the most important factor in development of US leading universities and influence the country's innovation development. The traditional functions of the university — to train experts, to create and pass knowledge — are supplemented by efficient cooperation with industry and business. Contemporary research universities have the greatest potential and range for solving problems of mankind by implementing interdisciplinary and transdisciplinary research models.

The US model has become increasingly popular in other nations as an effective method for quickly transitioning the innovations produced by fundamental university research into profitable products, and for linking private sector funding to specific research efforts at universities.

In Britain, university technology incubators have been shown to be an effective way to stimulate the growth of early-stage high growth technology companies[3]. In June 2013, the British government announced a set of public and private investments into university research projects worth 290 million British Pounds[4].

In Holland, the University of Twente was able to grow from a small regional university into a powerful research center over a 20 year period, largely through the development of connections with industry and the establishment of a business incubator and research park[5].

Incubators were identified as excellent tools for building linkages between the research orientations and capabilities of universities in Mexico in 1993 and have continued to develop[6]. The same conclusions were reached in Canada in 2005[7], and in 2011, research by Professor J. Malfroy showed positive effects on doctoral programs in Australia by joint university-industry research initiatives, although there were some negatives as well[8].

Conclusion. Clearly US-style linkages between industry and university research efforts and the establishment of university-based business incubators or accelerators offer significant advantages in the development of new innovations and the

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growth of innovation-driven national economies. The engagement of students at an early age in entrepreneurial training programs is beneficial as well. The steps that remain for the development of such an approach within Ukraine include both the identification of best practices on a global scale and the development of a set of policies and regulatory support that would allow both industry and universities to conduct research in this fashion.

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