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## APPROACH TO THE COMMERCIALIZATION OF UNIVERSITY'S RESEARCH ON THE BASES OF SPIN-OFF COMPANIES' CREATION

*Abstract. The article covers the theoretical approaches to the definition of the “academic spin-offs” concept, substantiates the need for the development of organizational forms of small innovative entrepreneurship in a university environment. A set of measures was developed aimed at increasing the entrepreneurial activity of universities and stimulating the processes of commercialization of research results. In order to stimulate the innovation activity of enterprises, it is necessary to create incentive schemes for this activity. In the article, a comparative analysis of existing models of financing of innovative activity is carried out in order to determine the possibility of their application for financing of innovative activity of industrial enterprises. Different models are used to finance innovative projects such as venture funding, business angel funds, crowdfunding. The article explores the areas of application of different financing models, opportunities and limitations of their use in innovative business. As a possible scheme for financing the innovative activity of an existing industrial enterprise, it is proposed to create spin-offs of companies that use the material, labour and other available resources of the parent company for the implementation of innovative projects. Under such a financing scheme, the parent company has opportunities to diversify its risk-sharing activities, to phase out the innovation project, and to increase its susceptibility to innovation. In turn, a spin-off enterprise can initially use material resources, management experience and ties of the parent company, simplify access to the necessary financial resources. To evaluate the effectiveness of spin-off company innovation, it is proposed to take advantage of the advantages and disadvantages of creating such companies, which compares the results of the enterprise achieved in practice, taking into account the launch of an innovative spin-off company, and theoretically possible in the implementation of ongoing activities without innovation.*

*Keywords: academic spin-offs, PEST-analysis, results of intellectual activity (RID), small innovative entrepreneurship.*

## ПІДХІД ДО КОМЕРЦІАЛІЗАЦІЇ ДОСЛІДЖЕНЬ УНІВЕРСИТЕТУ НА ОСНОВАХ СТВОРЕННЯ СПІН-КОМПАНІЙ

*Анотація. З метою активізації інноваційної діяльності підприємств необхідно створювати стимулюючі цю діяльність схеми фінансування. У статті проведено порівняльний аналіз існуючих моделей фінансування інноваційної діяльності з метою визначення можливості їх застосування для фінансування інноваційної діяльності промислових підприємств. Для фінансування інноваційних проектів використовуються різні моделі, такі як венчурне фінансування, кошти бізнес-ангелів, краудфандинг. У статті досліджуються сфери застосування різних моделей фінансування, можливості і обмеження їх використання в інноваційному бізнесі. В якості можливої схеми фінансування інноваційної діяльності чинного промислового підприємства пропонується створювати спін-офф компанії, що використовують матеріальні, трудові та інші доступні ресурси материнської компанії для реалізації інноваційних проектів. При такій схемі фінансування материнська компанія отримує можливості щодо диверсифікації діяльності з поділом ризиків, здійснення поетапного фінансування інноваційного проекту, підвищення сприйнятливості до інновацій. У свою чергу, спін-офф підприємство на початковому етапі своєї діяльності може користуватися матеріальними ресурсами, управлінським досвідом і зв'язками материнської компанії, спрощується доступ до необхідних фінансових ресурсів. Для оцінки ефективності інноваційної діяльності спін-офф компанії пропонується використовувати переваги і недоліки створення таких компаній, відповідно до яких проводиться порівняння результатів підприємства, досягнутих на практиці з урахуванням запуску інноваційної спін-офф компанії, і теоретично можливих при здійсненні поточної діяльності без впровадження інновацій. Якщо розглядати динаміку цього співвідношення протягом певного часового періоду, можливо виявити наявність або відсутність ефекту синергії при запуску нових спін-офф підприємств.*

*Ключові слова: спін-офф компанії, PEST-аналіз, результати інтелектуальної діяльності (РІД), комерціалізація, дослідження і розробки.*

**Formulation of the problem.** A specific feature of the institutional development of universities in the conditions of a post-industrial society is their

convergence with the real economy and, as a result, the realization (apart from the main social role of education providers) of the innovation-production

function. Creating the results of intellectual activity (RID), universities, as a rule, do not have their own production base and in most cases cannot independently organize the production of innovative products based on developments that confront universities with the problem of commercialization.

**Analysis of recent research and publications.** You can consider the various definitions of enterprises of this type used by researchers to show their heterogeneity. McQueen and Walmark define such enterprises as follows: to be considered a university's spinoff, three criteria must be met, namely: the founder or founders of a company must be from a university (faculty, staff or student), the company's activities must be based on technical ideas, generated at the university, the transfer from the university to the company should be direct in nature, and not occur due to additional hiring elsewhere [7]. Smilor, Gibson, and Dietrich believe that spinoff is a company founded by faculty, staff, or student who left the university to establish a company or founded a company while still at the university; and which is organized on the basis of a technology or technological idea developed within the university [8]. Weatherston describes an academic spinoff enterprise as a venture that is founded or commercially active thanks to an academic entrepreneur who played a key role in one or all of the following phases: planning, initial foundation, subsequent management [9]. Karayanis considers spinoff a new company organized by people who previously worked for a parent organization (university) based on a key technology originating in the parent organization and transferred to a new company [5]. Bellini considers academic spin-up enterprises as companies founded by teachers, researchers or students and graduates for the purpose of commercial use of research results in which they could be involved in a university, while the commercial use of scientific or technical knowledge is realized by university scientists (teachers or researchers), students, graduates [10]. Clofsten, Johns-Evans and others consider spinoff a new firm or organization formed to take advantage of university research [11]. Rappert and co-authors define university spinoff enterprises as firms whose products or services are developed from ideas based on technology or scientific and technical know-how generated at the university by faculty, staff or students who individually or jointly founded the company [12]. Clariss, Heirman and Degruiff believe that science and technology spin-enterprises are defined as new companies organized by the host institution (university, technical school, private or public research and development department (R & D) to transfer to industry and profit from invention, resulting from the R & D departments [13]. Steffensen, Rogers and Speckman define spinoff companies as new companies that are formed by former employees of the parent

organization, while IT transfer of key technology from the parent organization [14].

**Setting objectives.** The purpose of this article is to reveal the phenomenon of scientific and technological spin-business, the laws governing the functioning of scientific-technology spin-business, as an element of the national innovation system. Achieving this goal necessitated the solution of a number of analytical, scientific, and methodological tasks during the work, which predetermined the logic of their formulation and implementation – this, above all, the definition of conditions, prerequisites and motives for the emergence of scientific and technological spin-enterprises and their structure their activities.

**Presentation of the main research material.** The commercialization of RIA consists in introducing them into the economic (economic) turnover in order to recover the costs of creating and making a profit, which is the source of creating new results. The expediency of commercialization can be easily justified: if the RID is not recognized as an object of intellectual property rights and converted into intangible assets, the costs associated with their creation will have to be recognized as expenses of the current period and indirectly write off the cost of other products (services). Thus, instead of the source of development of the university, intellectual products can become, despite the enormous potential profitability, the yoke for the budget of the university.

In modern practice, there are three main forms of commercialization of university developments and technologies: 1) carrying out research and development (R & D) commissioned by industrial enterprises and companies; 2) licensing and assignment of patent rights; 3) the formation of small innovative enterprises with direct or indirect participation of the university [1].

The first two forms – custom R & D and licensing (assignment of patent rights) without the participation of the university in the capital of the company – guarantee a stable income and are simple enough to realize, but they are not the most promising from the point of view of the university's development, because in both situations ownership of the results of scientific and technical activities. Thus, according to the legislation currently in force in most post-Soviet countries, the exclusive intellectual property rights to the RIA, made to order, belong to the company-customer; the assignment of patent rights involves the complete alienation of intellectual property rights to the counterparty; the granting of a license leads to the loss of rights to use the RID by the university [3].

A promising model for the commercialization of university development, in which a university remains the owner of unique scientific developments created within its walls, is the creation of small innovative enterprises – in accordance with the world-wide terminology of spin-off or spin-out of companies (from

Table 1

*Advantages and disadvantages of a university development commercialization model based on the creation of a spin-off company*

Advantages	Disadvantages
Realization of the new strategy of the RID development team: transition from exclusively scientific and research work to the development of its own business based on intellectual property.	Complicated workflow procedure: the need to manage company shares, participate in strategic decision-making, etc., which entails additional managerial and financial costs.
The prospect of development of long-term cooperation ties in the field of technology transfer between the authors-developers of intellectual property and the university.	The need to search for large investments to establish a company.
No need to search for customers and licensees interested in purchasing an innovative product.	The complexity of the formation at the university of a development team competent enough to commercialize intellectual property through the creation of a spin-off company, and in some cases the need to attract external experts, which requires considerable effort and funds to pay for consulting and other services necessary for business development.
Securing the university of intellectual property rights to create innovative products.	High risk of a conflict of interest between the university and the developers of the RID.
The prospect of wide market coverage in the case of a successful spin-off project.	The difficulty of entering the market of a new spin-off company due to the presence of barriers associated with the monopolistic position of existing players in the market or cartel collusion of participants in the target market segment.
The possibility of participation in other (not only stipulated by a licensing agreement or an order for R & D) the company's revenues.	The threat of damage to the reputation of the university in case of unsuccessful implementation of the development.
The possibility of the gradual development and refinement of existing technologies in order to further increase their value.	The lack of royalties and lump-sum payments for the use of intellectual property by industrial enterprises, as a result of the refusal of licensing.

the English spin-off, spin- out – budding company). The close attention to the model is confirmed by the tendency to create special units in Russian and Ukrainian universities, as well as individual legal entities affiliated with universities, which provide comprehensive support to innovative projects. Such structures are innovation and technology centers, business incubators, technology transfer centers, collective use organizations, departments for the commercialization of intellectual property, etc.

The advantages and disadvantages of a spin-off company as a model for generating future income for a university are summarized in the table 1 below.

The results of identification (using the PEST analysis method) of the relevant groups of environmental factors that are determinants of the deactivation of the processes of intellectual property commercialization based on the creation of a small innovative enterprise are presented in Table 2.

The main difference and at the same time the advantage of a spin-off over a regular startup is that

the latter is created from scratch, and the spin-off is based on ready-made developments.

In other words, it is possible to add an innovative component to an existing company and become more competitive. Depending on the objectives of the project – this can be both the creation of a new business line and the commercialization of existing developments, – the following advantages of the spin-off model are distinguished:

The task for which the spin-off is created usually reflects the real problems and requirements of the market, which increases the chances of success.

It is possible to use the experience and experience of the parent company: promotion, distribution channels, communications, customers, etc.

The risk for the main business is minimal, while there are conditions for its growth due to the new dedicated direction.

Possible mistakes:

- Incorrect distribution of employees: for example, more experienced specialists remain

Table 2

*PEST-analysis of the spin-off company's environment*

<b>Factors "P" (political and legal environment)</b>	<b>Factors "E" (economic environment)</b>	<b>Factors "S" (sociocultural environment)</b>	<b>Factors "T" (technological environment)</b>
Imperfection of state innovation policy and strategic programs for the development of economic sectors	Insufficient and irrational distribution of state funding for innovative projects in areas	Mental stupor of officials and top officials of scientific and educational institutions and industrial enterprises, their unwillingness to realize the decisive role of intellectual property in the development of society	The complexity of the mechanism of functioning of technoparks
The inconsistency of the regulatory framework governing the legal relations in the field of intellectual property	Lack of budget financing of the innovation infrastructure of universities	The aging process in the social group of scientists (the average age of professors and doctors of science is 60-85 years on average).	Fragmentary and unsystematic nature of scientific and technical cooperation.
Imperfection of the institutional structure of intellectual property	Lack of funds from universities for the legal protection of research results	The problem of “brain drain”: the reorientation of a large part of talented domestic scientists to fulfill orders of foreign enterprises and research centers	Low level of material and technical base of universities, moral and physical deterioration of scientific equipment
The ineffectiveness of the judicial system in the protection of intellectual property rights of industry research institutes	Minor venture capital turnover	Low efficiency of the system of training of scientific personnel and, as a result, deterioration of the qualitative composition of university researchers	Degradation of industry research institutes
Lack of clear mechanisms in the legislation for the establishment of spin-off companies for universities.	Low share of foreign capital in innovative spin-off projects.	Lack of business competence among scientists.	Disproportion between engineering and humanities specialists (20:80)
The opacity of the legal scheme of technology transfer from universities and scientific organizations to industrial enterprises and companies	Lack of economic incentives for industrial enterprises to introduce innovative technologies	Inertial thinking of scientists, according to which there is a conviction that commercialization should not be carried out in universities applied research	Orientation of universities mainly to conduct fundamental rather than applied research
Impracticability in practice of tax preferences granted to innovative enterprises developing new technologies.	The status of universities as non-profit organizations	Loss of significant innovation potential and partnerships of domestic science as a result of the collapse of the USSR.	Formalism in research: work not on the bottom line, but on drawing up a report
Lack of tax incentives for enterprises introducing new technologies in their production	Lack of demand for innovative products in the domestic market	Immunity of the production sector to innovations Incorrect R & D	Initiation vector: from performing work to finding customers (and not vice versa)
The problem of effective customs privileges.	The problem of companies' spin-off entering the market.	The lack of initiative and the unwillingness of state employees to take risks, making management decisions in the field of innovation	Simplifying access to foreign technologies, which makes it possible to acquire new technology and that more often costs less than creating their own
Low efficiency of antitrust authorities' activity	Low material motivation of scientific workers	Borrowing and translating bureaucratic management standards from the past	Patent trolling and blocking promising developments by competitors

in the parent company, and employees who are not used to and cannot work independently develop the spin-off project.

- The parent company does not provide enough autonomy for the spin-off project, which subsequently hinders its development.

**Conclusions from the conducted research.** The solution of the problems discussed above will allow to successfully implement the results of university research in practice and provide the economy with new developments and technologies, thereby stimulating the flow of funds from material production to the scientific and educational sphere. The priority directions for initiating changes in this context in the coming years are the formation of university innovation infrastructure; training of qualified managers and scientists with knowledge and skills of effective commercialization of the results of educational and scientific activities, management of innovative companies and projects; establishing partnerships with leading foreign business schools and organizing joint programs in the field of innovative entrepreneurship.

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## НЕЙРОННІ МЕРЕЖІ У КЕРІВНИЦТВІ СКЛАДНИМИ ТЕХНІЧНИМИ СИСТЕМАМИ NEURAL NETWORKS IN THE MANAGEMENT OF COMPLEX TECHNICAL SYSTEMS

**Анотація.** Розглядаються методи використання нейронних мереж для вирішення задач керування динамічними об'єктами. Для кожного виду нейрокерування наводяться схеми з'єднання неймереж всередині системи керування та детально описуються процедури їх навчання. Аналізуються переваги і недоліки описаних методів.

**Ключові слова:** штучний інтелект, нейромережа, система керування, похибка, зворотній зв'язок, динамічний об'єкт, автоматичне керування, адаптивне керування.