

Solutions to Promote Commercialization of Research Results in Vietnamese Universities

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Abstract: Commercialization of research results plays an important role in the socio-economic development of a country based on science, technology and innovation. In Vietnam, promoting the commercialization of research results is concerned by the Party and the State, institutionalized under the Resolution, Law, Decree and guiding Circulars. However, in recent years, universities have recorded the limited number of research results commercialization and the low transaction value, which have not achieved the objectives as expected. The process of commercializing research results in universities encounters difficulties, including the limited quality of research results, the weak linkage between universities and enterprises, and the limited access to capital resources to develop inventions. This paper not only focuses on analyzing the situation of commercialization of research results in universities and colleges, we also propose solutions to promote commercialization of inventions, technical solutions formed from the universities, suitable to the conditions of Vietnam. In order to successfully commercialize research results in universities, it is necessary to consider various conditions: (i) Commercialization of research results in universities must derive from the needs of society; (ii) Commercialization of research results must be an urgent, self-motivated need of universities and individual scientists, the State only sponsors, supports, incentives, encourages and promotes commercialization activities through creating favorable legal corridors.

Keywords: University Research Results, Research Results Commercialization, Solutions to Promote Commercialization

1. An Overview of How to Commercialize Research Results at Universities

Commercialization is a complex process, going through various stages from conceptualization to successful marketing [2]. In fact, a good idea may not lead to success in commercialization and market acceptance. Commercialization of research results is a process of bringing research results into products / goods to market, accepted by the market. This process is associated with research and development and technology transfer activities; and requires the alignment and close cooperation among the government, ministries, industries, businesses, investors, financial institutions, universities to turn research results into

valuable products / goods, especially economic value.

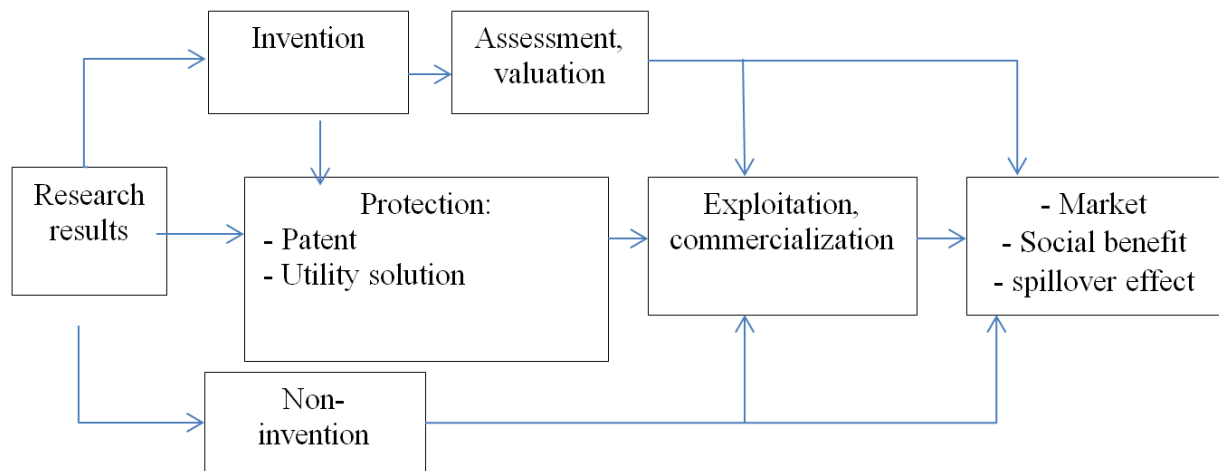
The term research results commercialization can be used interchangeably with commercialization of scientific research results, or commercialization of scientific and technological research results, or commercialization of scientific research and technology development results. In recent years, at the universities of Vietnam, research results are often associated with the results of the projects and most of them are state funded projects. According to National Agency of Science and Technology Information, research results include inventions, patents, technical solutions, technical know-how, business secrets, layout designs of semiconductor integrated circuits, industrial designs, trademarks, trade names, seedlings, computer programs, technical designs, scientific works and other subjects, including protected subjects and are not protected under the provisions of intellectual property law [6]. The research results are determined under the form

of a science and technology contract. The contracts could be state funded (partly or full funding) or allow to license the right to use state-owned facilities, instruments and techniques to perform scientific and technological tasks.

The process of commercialization of research has many different forms. For example: In some universities in the United States, the results of research are transferred and commercialized through Technology transfer offices (TTO) or technology licensing offices (TLO). The offices are located at universities or in production areas of the United States [1]. For universities and research institutions in the field of agriculture, through TLO network are located in the agricultural extension center in the key production areas of the states. These organizations join from the initial steps of commercialization process, right after the researchers and

universities announced their research results [12]. In the case of products that do not yet have commercial value but have potential in community service, they may be transferred non-exclusively through a document permitting the transfer; if the product is a patent that is formed through a sponsorship contract, the sponsoring business/investor will commercialize the research product. If the product is a patent that has not been business / investor funded but has the high potential to commercialize, the TTO will help to attract capital from venture capital funds, angel investors, innovative start-up businesses.

Commercialize research results in universities in this article, understood as the process of bringing research results of universities to the market, accepted by the market and taking place according to the following process (Figure 1):



Source: [8].

Figure 1. The process to bring research results to market.

An invention is a technical solution in the form of a product or a process to solve a specific problem by applying natural laws. The invention is protected in the form of patents if it meets the following conditions: being novel, involving an inventive step and Being susceptible of industrial application. Unless it is a common knowledge, an invention shall be protected by mode of grant of utility solution patent when it satisfies the following conditions: being novel; being susceptible of industrial application (Intellectual Property Law, 2009). Non-inventions include publications (articles, books, training materials,...); research cooperation; sharing equipment and information; consulting and training; forming startups, etc.

The research results are the product of intellectual activity. Therefore, they are assets and expected to be commercialized to firstly bring value back to the universities and the scientists, before creating the spread in society and promoting economic development. Research results often exist in the form of information, knowledge, patterns, so it is difficult to identify by human senses but only can be perceived through the process of self-awareness, transmission, exploitation and commercialization. Due to the nature of research results that are profitable, they can be exchanged, traded, transferred, contributed, licensed in the

market and follow the rule of supply and demand [9].

The evaluation of the potential of research and knowledge transfer results commercialization has been studied and proposed by European Commission experts (EC). Accordingly, the knowledge transfer and commercialization indexes are based on human research, cooperation and networks with the purpose to construct the general index of research results commercialization. The Association of Universities in the Netherlands has accepted the indicators of a group of specialists from EC. From 2013-2015, each university began implementing a process to construct the groups of related indicators and explain the ways to measure these indicators. Also at the level of organization, the industry-university office of the University of British Columbia has developed measurement methods, which also include the non-traditional effects of license activities, along with assessing the impact of licensing to measure and directly assess aspects related to the commercialization and knowledge transfers. Key indicators of knowledge transfer and commercialization in universities include: Indicators of investment and cooperation between universities / research areas and industry; Indicators of the potential for commercialization of knowledge, focusing on the published information store; Indicators on the use of public knowledge

of enterprises and other institutions; Indicators of other knowledge transfer channels, such as skilled labor migration and network setup (Compiled from [6]).

In Vietnam, most of research results formed through research funded by the state in the form of scientific and technological development tasks. Therefore, according to the current regulations, the ownership of these research results belongs to the state (if the state grants 70% or more of the total implementation budget), the university is the host and chairman and the implementing members are the authors. Therefore, in the process of commercializing research results, it is necessary to comply with the benefit distribution between the parties (Law on Science and Technology in 2013, Law on Technology Transfer in 2017 and Decrees and Circulars explaining, guiding the implementation of some articles of the Law). Scientific and technological tasks using the state budget include scientific and technological tasks at national, ministerial, provincial and institutional/ university levels are managed and controlled by authorities (Law on the Science and Technology, 2013). Scientific and technological tasks at the national, ministerial and provincial levels must comply with the order form. The ordered products are reflected through the contract, this is an important basis to conduct the evaluation and acceptance of ordered products after completing scientific and technological tasks.

For different types of scientific and technological tasks (national, ministerial, provincial, etc.), there are the different processes, procedures, evaluation contents and acceptance. However, it is generally based on the results of the advisory council for evaluation and acceptance. The council is composed of experts in the field of science and technology, related to the content and products that the task performs. The council is composed of the chairman of the council, the vice chairman of the council, the reviewers and the members. Although according to the type of science and technology tasks, the number of members participating in the council varies (usually between 5 and 9 members). However, the organization of the council to evaluate and accept the results of the scientific and technological tasks has certain advantages, such as assessed through two levels (university level Council – self assessment and provincial, national and Protocol levels - inspection); the contents of evaluation and acceptance have had specific forms and samples for assessment experts, which increases the features of objectivity, scientific, high consistency and minimizes the evaluation according to the feelings and experiences of experts. However, the evaluation and acceptance committees are established temporarily, after the evaluation and acceptance are completed, the council dissolves itself, so the obligations and responsibilities of the experts evaluate and test collection in the council is not yet clear and transparent. In particular, during the evaluation and acceptance process, members of the council may also be dominated by their own emotional relationships, or implicitly supporting each other, which has affected the results of the assessment and acceptance, affecting seriously to the quality of the results and the ability to commercialize research results.

2. Situation of Commercialization of Research Results in Vietnamese Universities

2.1. The Number of Research Results in Universities

According National Agency for Science and Technology Information, Vietnam currently has built database of research results, containing digitized summary and full text, published on the Vista network [7]. In particular, national leveled researches accounts for approximately 30%, ministerial with 34%, provincial with 31%, and university level with 5%. Most of the research results are concentrated in institutes / universities, science and technology organizations. It is estimated that every year about 1,400 research results are registered in the Department of Information Science and Technology, of which there are many tasks implemented 2-3 years. For example in 2018, the Department has about 1250 registration forms of task results of scientific and technological national level and the ministerial level tasks. In addition, local authorities in 2018 assigned 1,100 missions (agricultural science accounts for approximately 31%; 25% for technical and technological; 19% for social sciences, 8% for humanities science, 6% for natural science, 11% for medical science and medicine). The results of the studies are the product of scientific activities and technological development of science and technology missions, including the synthesis report of implementation results, the report summarizes the task performing results; annex summarizes survey data, surveys, maps, drawings, photos, multimedia documents; the software. They are registered and stored at the National Agency of Science and Technology Information. The database currently has over 23,500 bibliographic and summary descriptions, updated from about 1200-1500 tasks per year. The tasks after acceptance must be registered at the National Agency of Science and Technology Information. However, the registration of research results of many host organizations and the task manager is not really completed seriously on time and correct hand in process.

Regarding the publication of domestic science and technology:

From Vietnam's science and technology databases, gathered with the publications of 236 science and technology magazines (accounting for 70% of the total number of domestic science and technology journals), [5] showed that, until 12/2017, Vietnam had a total of over 240,000 scientific articles, averagely each year about 19,000 articles, in 2017 reached over 19,575 articles, the number of scientific articles published every year increased but not much (Table 1).

Table 1. Number of published domestic scientific and technological articles

Year	Annual number of articles	Rate increase (%)
2012	18777	
2013	18,710	3.5
2014	18,975	1.4
2015	19,234	1.3
2016	19,535	1.6
2017	19,575	0.2

Source: [7].

In the field of science and technology, Vietnam's scientific articles in 2017 focus mainly on social sciences and humanities, accounting for more than 70% of the total published scientific papers, science and technology

accounted for 12.4%, the lowest was natural science with only 4.5%, medicine and agriculture science, each of which accounted for nearly 6%, with more than 830 articles (Table 2).

Table 2. Number of domestic articles published by research areas.

Field	2015		2016		2017	
	Number	Ratio%	Number	Ratio%	Number	Ratio%
1. Natural science	1,538	8	856	4.38	874	4.46
2. Science and technology	4,039	21	2,930	15.00	2,435	12.44
3. Medical and pharmaceutical science	2,692	14	1,014	5.19	1,120	5.72
4. Agricultural science	1,251	6.5	860	4.40	1,129	5.77
5. Social science	7,694	40	11,238	57.53	11,267	57.56
6. Humanities science	2,020	10.5	2,637	13.50	2,750	14.05
Total	19,234		19,535		19,575	

Source: [7].

Regarding the international publication of science and technology:

According to Scopus database, the total number of S&T publications of Vietnam in the period of 2012 - 2017 is 27,453 items, with an annual increase of over 10%. In which, the field of physics, mathematics, chemistry, engineering has many published accounts to over 45%. Researchs in the field of agricultural science and health also has less published. In

ASEAN, Vietnam ranked fifth in total international publication in the period from 2012 - 2017, but was only half of the countries ranked 4 - Indonesia, 1/3 of 3rd country - Thailand and about 1 / 6 of the region's leading country - Malaysia. In 2018, the total published in ISI, Scopus journals of universities is 13,269 articles, there are 6,363 ISI articles and 6,933 Scopus (Table 3).

Table 3. Published in ISI journals, Scopus of Vietnamese Universities.

Year	ISI (number of articles)	Scopus (number of articles)	Leading University
2017	3,355	4,775	Ton Duc Thang (645 ISI articles and 728 Scopus)
2018	6,363	6,933	Ton Duc Thang (1,228 all the ISI and 1,468 Scopus)

Source: [7].

Regarding patent registration and technical solutions:

The data on registration applications and the number of industrial property protection certificates shows certain levels of national innovation, research and development capacity. Table 4 shows that in 5,382 applications for patent protection in Vietnam, there are 592 applications of Vietnamese people

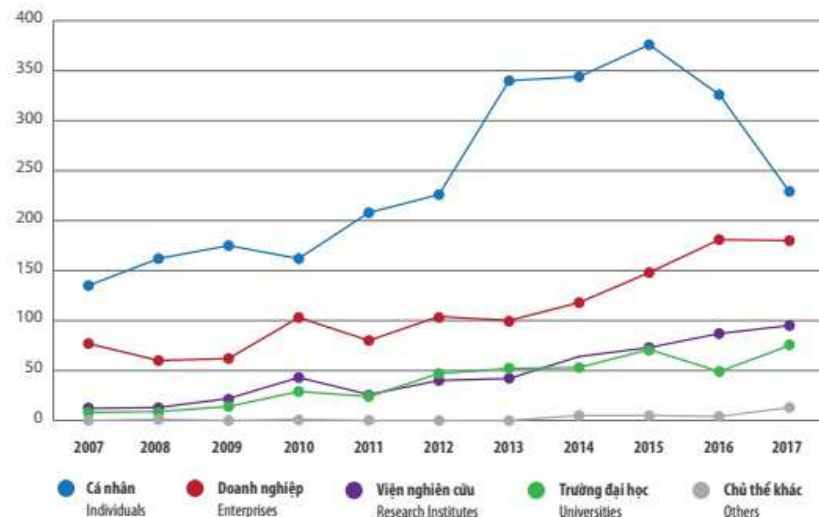
(11%). Thus, in nearly ten years, the number of patent applications of Vietnamese people has not increased much, maintaining in about 10% of the total applications for patent protection in Vietnam. The proportion of patents granted to Vietnamese people is still low, the highest is in 2017, which is only 6.2% of the total granted patents

Table 4. Number of applications and protection titles granted to the invention.

Year	Number of patent applications			Number of exclusive patents granted		
	Vietnamese	Foreigner	total	Vietnamese	Foreigner	total
2011	301	3,387	3,688	40	945	985
2012	382	3,577	3,959	45	980	1,025
two thousand and thirteen	443	3,726	4,169	59	1,203	1,262
2014	487	3,960	4,447	36	1,332	1,368
2015	583	4,450	5,033	63	1,325	1,388
2016	560	4,668	5,228	76	1,347	1,423
2017	592	4,790	5,382	109	1,636	1,745

Source: [4].

Although the number of applications and protection certificates granted to inventions is not much, the number of applications from universities in Vietnam has been negligible over the years. This shows that universities are not really interested in protecting intellectual property (Figure 2).



Source: [4].

Figure 2. The situation of patent registration at universities in Vietnam.

For a technical solutions, the number of applications of Vietnamese is higher than that of foreigners. However, the increase in the number of applications over the years is

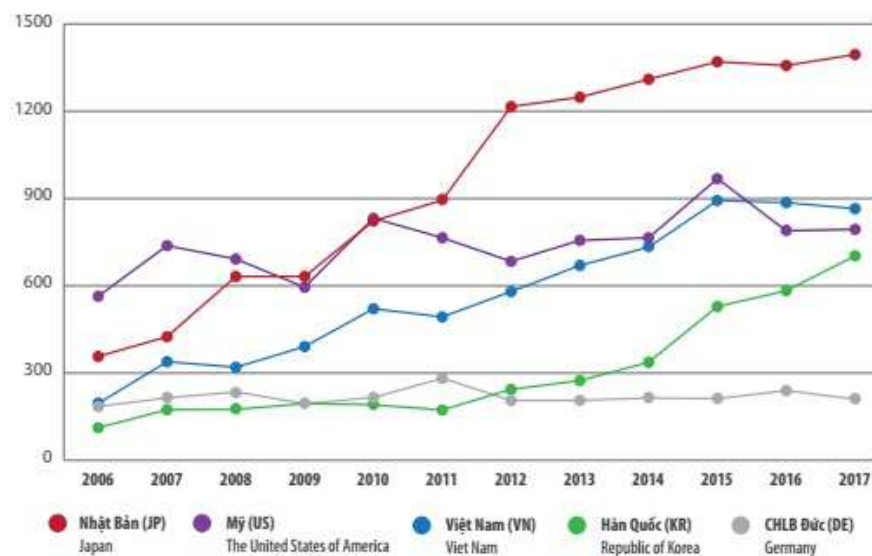
negligible, the recorded number for 2017 was even decreased, compared to 2016 (Table 5).

Table 5. Number of application and protection certificates granted for technical solutions

Year	Number of applications for registration of useful solutions submitted			Number of patents for useful solutions		
	Vietnamese	Foreigner	total	Vietnamese	Foreigner	total
2011	193	114	307	forty six	23	69
2012	198	100	298	59	28	eighty seven
two thousand and thirteen	227	104	331	74	33	107
2014	246	127	373	66	20	eighty six
2015	310	140	450	eighty six	thirty first	117
2016	326	152	478	114	24	138
2017	273	161	434	118	28	146

Source: [4].

Recognizing the potential market, many countries already have patent registration and technical solution applications in Vietnam (Figure 3).



Source: [4].

Figure 3. Registering patents and utility solutions of some countries in Vietnam.

2.2. The Difficulties in Research Results Commercialization at Universities in Vietnam

To date, there is no comprehensive study about commercialization activities of results at all levels are stored at National Department of Science and Technology Information. However, there are already many researchs about commercialization the research results with various approaches as below:

Nguyen Quang Tuan collected a list of 1035 national and ministerial-level projects that were accepted in 2005-2010 period and selected 300 applied research topics (this is a type of research that is capable of high commercialization) in four areas (Manufacturing machines, chemical technology and chemical industry; agriculture and forestry; fisheries), including many topics and projects hosted by universities [10]. Within 3 months from the time of sending the questionnaire, the research team regularly contacted by phone with the project leader / host agency, resulting in 39 written questionnaires. After that, the group continued to directly contact and receive responses by email with 68 more responses, bringing the total number of collected votes to 107 responses (the remaining 193 topics were not responded in any form). Survey results show that: Only 10/107 topics have created solutions, inventions and transferred directly into production. However, there are 6/10 managers, the host agency reposed that they "don't remember", or does not indicate the application business address; In the 4 topics, it shows the application address, there are 2/4 admitted they were not succesfully apply the results and the remaining 2 topics have not clearly defined economic efficiency when applied to production and business. Only 01/107 topics are commercialized in the form of a science and technology enterprise, but the research team has not yet evaluated the status of this enterprise.

Since 2013 to the end of 2018, there have been no further studies evaluating the ability to commercialize research results followed the approach of Nguyen Quang Tuan, which surveyed the accepted researchs stored at National Department of Science and Technology Information [11]. However, the Vietnam Center for Scientific and Technology Evaluation evaluated the effectiveness of KC.02 program through two periods, one from 2006-2010 and the another from 2011-2015 [3]. This is a program with the participation of many universities of natural science, technical and technological sectors. Objectives of the program: To acquire, apply and develop advanced technologies to produce raw materials and materials from Vietnamese minerals with great potential; Create and develop new technologies to produce materials for supporting industries; smart an d environmentally friendly materials; materials with special features to serve economic sectors and national security; create and support the development of a number of production lines of new materials industrial in industria scale, serving the economic sectors and national security. In which: 30% of the research results are eligible to become a

commercially capable products; 50% is accepted for registration of intellectual property protection, of which 20% of patents and utility solutions are recognized.

In fact, the process of commercializing research results at universities faces some of the following basic difficulties:

First, the quality of research results is limited. Currently, in general, universities mainly focus on traning, scientific research activities associated with production and business of enterprises are not paid high attention. According to the annual reports of the Department of Intellectual Property (2015-2018), there is only a few traded contracts, patern transfers, technical solutions was signed from the universities [4]. This shows that universities are not really interested in commercialization of research results, including commercialization of paterns. Moreover, the quality of inventions granted to universities is not high, most inventions only solve the single problems that arise in the production process, many paterns do not serve commercialization objectives that are primarily to meet the requirements of orders from funding agencies and projects.

Secondly, the linkage between universities and enterprises, with intermediaries in science and technology in commercialization of research results is still lacked and not tight. This linkage activity is understood as the establishment of coordination relationships between universities and businesses, stakeholders based on the principle of equality and mutual benefit. Thereby, the parties together enhance the benefits, especially economic benefits through the use of their resources in the commercialization of research results. The goal of the partnership is to work together to discuss and reach agreement on activities to bring research results into applications, turning research results into benefits, especially economic benefit. In fact, the link between universities and businesses and organizations involved in commercialization of research results is expressed in many different forms. According to the expression of the link, there are vertical links, cross links, mixed links. According to the structure of the affiliate organization, there is a direct link, links through intermediaries, informal links. In relation to the environment, there are closed links and open links.

Third, there are difficulties in capital to complete inventions, difficulties in assessing and valuing research results. In the process of commercialization of inventions, universities face many difficulties in capital, cannot mobilize capital for testing, perfect inventions, and bring inventions into technology to popularize in the market. Moreover, human resources in universities, although highly qualified but do not specialize and have no skills in commercialization. Besides, universities still have difficulties in accessing information sources to assess and evaluate inventions, it is difficult to choose the form of benefit sharing and in the invention of the patent. In fact, in order to commercialize the invention, the patent market needs to develop. However, in recent years, Vietnam's patent market has not really developed, the supply of paterns in universities is still very small, enterprises start up based on intellectual property is

not significant; intermediary organizations such as patent exchanges, consultancy, brokerage, transfer promotion, evaluation and valuation organizations are still limited in both quantity and quality, so they cannot show their roles. his role in commercialization.

In addition, activities to commercialize research findings in universities, which are products from the projects using the State budget, is limited, failing to meet the requirements of technological innovation and development goals economic and social development. Regulations on valuation of scientific research and technological and intellectual property development results using the state budget (Joint Circular No. 39/2014 / TTLT-BKHCHN-BTC); regulations on the order and procedures for the assignment of ownership rights and the right to use the results of scientific research and technological development using the state budget (Circular No. 15/2014 / TT-BKHCHN); regulations on conditions for establishment and operation of intermediary organizations of the science and technology market (Circular No. 16/2014 / TT-BKHCHN); regulations on the management and use of assets are formed through the implementation of scientific and technological tasks using state capital (Decree No. 70/2018 / ND-CP of the Government) have not yet created favorable conditions for commercialization of research results, not being implemented synchronously and scientifically.

3. Policy Solutions to Promote Commercialization of Research Results in Vietnamese Universities

In order to commercialize research results in universities, it is necessary to look at the following points of view: (i) Commercialization of research results in universities must derive from the needs of society, being consistent and expressed in the views and roadmap of the Communist Party of Vietnam, concretized in legal documents of the Government, ministries and branches from the central to local levels. Because today, the majority of research results in universities are formed through the use of state budgets. (ii) Commercialization of research results must be an urgent, self-motivated need of universities and individual scientists, the State only sponsors, supports, incentives, encourages and promotes commercialization activities through creating favorable legal corridors.

In fact, the commercialization of research results must be consistent with the characteristics of scientific research and technological development of the universities, in accordance with the mission of the university, and in line with the strategy / planning / programs / projects on education, economic, social, scientific and technological development in each period and closely linked with the development of the science and technology market. Therefore, in order to promote the commercialization of research results in universities in the future, we need:

Firstly, improving the quality of scientific research

activities, combining research activities with production and business practices of enterprises in the direction of enhancing research activities towards applications and goods from enterprises. In order to do well, it is necessary to nurture, maintain and encourage the development of strong organizations for scientific research and technology deployment. Along with that, to increase investment in material and technical foundations, equipment and laboratories, creating favorable conditions for research groups to strongly form and develop ideas towards social needs.

Second, strengthen the link between universities and businesses and stakeholders in the process of commercializing research results. The parties need to clearly identify the motivation, goals and associated policies. In which, clearly defined tasks, powers, responsibilities of parties in joint activities, especially coordination mechanism in commercialization of research results. On that basis, develop mechanisms of sharing benefits in the link, pointing out the relationship between the benefits of linking the three forms of association Basic: businesses and universities and research, the same effects benefit and bear the same risk; enterprises (as researchers using research results) order for university research universities; businesses and universities link by value chain, jointly research and commercialize research results. Next, the parties together strengthen and build their capacity and prestige, this is an important factor affecting the effectiveness of the association between universities and businesses.

Third, support the universities access to and use of capital, improving the quality of human resources through programs and schemes science and national technology -related activities to commercialize the results research. For example: Program to develop science and technology market (Decision 2075 / QD-TTg of the Prime Minister); National technology renovation program (Decision No. 677 / QD-TTg); Intellectual property development program (Decision No. 1062 / QD-TTg); High-tech program (Decision No. 2457 / QD-TTg); Program for searching and transferring foreign technology by 2020 (Decision No. 1069 / QD-TTg); high capacity of teachers and staff to research and innovate scientific research and technology transfer activities in higher education and vocational education institutions in the period of 2017-2025 (Decision 2469 / QD -TTg) Program to support the development of science and technology enterprises and public scientific and technological organizations to implement the mechanism of autonomy and self-responsibility (Decision No. 592 / QD-TTg of the Prime Minister) Government), etc.

In addition, it is necessary to support universities to establish intellectual property rights, support evaluation and evaluation of research results; support the order and procedures for the transfer of ownership and use of scientific research and technological development results using the state budget. Along with that is to support universities to establish intellectual property networks to advise scientists to determine whether their research results can register for

patents, technical solutions and good commercialization. To increase the supply of research results to the market, for topics and projects in the nature science and technological fields, especially state-level science and technology programs, in addition to the products such as articles, test products, it is necessary to add output products as registrations to apply for patents and utility solutions. Moreover, support is needed to form linkages through incentives, promotion and cooperation policies between research institutes, universities and businesses, especially startups and science and technology enterprises, contributing to the creation of value chains of innovative products through the commercialization of research results.

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