Conference Proceedings

EFFECTIVENESS OF ALTERNATIVE MECHANISMS FOR FINANCIAL SUPPORT OF PROMISING TECHNOLOGIES

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DOI: 10.5937/EEE24064S
JEL: A10, I23
Review Scientific Paper

ABSTRACT

The main task of this article is to study the problem of the effectiveness of the main mechanisms of financial support for promising technologies and to determine the main ways of increasing their effectiveness. This work highlights three main mechanisms of financial support for promising technologies: funding of research by the corporate sector; direct state funding of promising research; funding of research thanks to grant support; and a comparative analysis of the mentioned support mechanisms is carried out. It is shown that the main disadvantages of research funding by the corporate sector, as a mechanism of financial support for the development of new promising technologies, are, firstly, the possibility of financial support exclusively for those scientific studies that have commercial potential; secondly, the presence of strict restrictions on the free dissemination of information on the results of research conducted by the research units of corporations. At the same time, direct state funding of promising research, which opens up the opportunity for funding research and further implementation of technologies that for one reason or another do not arouse interest in business, also has its own shortcomings. The main ones are: a limited list of research that can receive direct state funding (dictated, mainly, by the need to ensure the technological leadership of the country and its security); low efficiency in the use of financial resources allocated for research and the impossibility of using this mechanism to reveal the full potential of relevant technologies. Unlike the two previous mechanisms of financial support for promising technologies, research funding through grant support allows solving the problem of expanding the list of research that can receive the necessary financial support. However, this mechanism of financial support for promising technologies is characterized by a low level of efficiency in the distribution of funds and the efficiency of their use. It has been proven that ensuring proper support of most promising technologies requires the creation of favorable conditions for the most effective integrated application of all considered support mechanisms.

KEYWORDS

technologies, efficiency, transaction costs, bureaucratic procedures.

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INTRODUCTION

Support for new promising technologies is an objective necessity dictated by the following reasons. The first such reason is the inability of the scientific team to complete, without external financial support, the entire cycle of research, which is necessary to bring the new technology to a state where it can find its practical application. Another reason is the slow pace of implementation observed for certain categories of new technologies in the absence of external financial support. In a number of cases, these processes are conditioned by certain institutional barriers that can be eliminated thanks to the reform of the current formal rules (Abramov, 2023a, Abramov, 2023b). However, such measures can only weaken the mentioned problems, and the main reason for their appearance is the insufficient funding of relevant scientific research and the lack of sufficient financial resources and rapid deployment of relevant technologies. The latter gives special relevance to the determination of the effectiveness of the main mechanisms of support for promising technologies and the search for ways to increase the overall efficiency of the support system for promising technologies.

The interest shown in new technologies, both from the side of scientists and from the side of ordinary citizens, is quite understandable and justified. After all, nanotechnology (Roco, 2005, Bae, Lim, Shin et al., 2013, Roco, Harthorn, Guston, et al., 2011), quantum technology (Coenen, Grunwald, 2017), Digital transformation (Nadkarni, Prügl, 2021, Zhai, Yang, Gao et al., 2023; Danaefard, Kazemi, Karimi, 2024), artificial intelligence ,(D'Amato, 2024) and many other technologies promise to fundamentally change our daily lives in the near future. The researchers focus on issues such as: governing emerging technologies (Ghazinoory, Fatemi, Saghafi, et al., 2023, Schwarz-Plaschg, 2018, Beumer, 2019), emerging technologies and ethics (Gouvea, Linton, Montoya, et al, 2012), the role of society in the development of technologies (Schuijer, Broerse, Kupper, 2021, Hällström, 2008, Jansma, Dijkstra, de Jong, 2021), risk governance (Malakar, Lacey, Bertsch, 2022; Roco, Bainbridge, 2005), the connection of technologies with current social problems (Mooney, 2006) and other problems (Roco, Bainbridge, 2013). However, despite close attention to all aspects of the development and implementation of new promising technologies, the problem of the effectiveness of alternative mechanisms for financial support of promising technologies remains insufficiently researched.

The purpose of this article is to identify the main mechanisms of financial support for promising technologies and to determine the main ways of increasing their efficiency. Next, we will sequentially consider the following main mechanisms for supporting new promising technologies: funding of research by the corporate sector; direct state funding of promising research; research funding thanks to grant support.

FUNDING OF RESEARCH BY THE CORPORATE SECTOR

In today's world, an extremely large number of new technologies not only find their practical application thanks to the efforts of powerful corporations, but also originate in research units belonging to these corporations. This is due to the fact that in many industries, competitiveness is determined not only by the corporation's ability to recognize the potential of a new technology in time and implement it faster than its competitors, but also by the ability to effectively limit competitors' access to the corresponding technology by obtaining exclusive rights to its use. The latter is possible either by acquiring a patent or an exclusive license from an independent developer of a new technology, or by conducting independent research. Although corporations actively use both opportunities to secure exclusive rights to use promising technologies, conducting independent research has a number of indisputable advantages. Thus, conducting independent research in principle makes it impossible for competitors to buy a patent,

which is a common phenomenon in the case of purchasing technology from an independent developer. In addition, the presence of its own research unit not only narrows the range of possible areas of research on which the employees of this unit can work to those studies that, from the point of view of the management of corporations, are the most promising for practical use, but also increases the probability of creating such a variant of a new technology that best meets the needs of the corporation and the conditions in which it must work.

However, conducting independent research by a corporation as a way to increase competitiveness and ensure technological leadership has its drawbacks. So, it is quite obvious that the success of the research division of the corporation depends significantly on the professionalism of the employees of this division. On the other hand, during the creation of a research unit, the responsible managers of the corporation have only indirect tools for determining the professionalism of its future employees, which significantly increases the level of transaction costs of measurement that the corporation faces. The choice of prospective areas of research is also a significant problem. In contrast to the purchase of ready-made technology, the effectiveness of which in many cases is already proven, at the beginning of one's own research, the practical value of their future results is unknown. Accordingly, the wrong choice of research areas can result in significant financial losses for the corporation. However, the biggest disadvantage of this strategy is the risk of losses in the event that competitors manage to quickly cope with conducting all the necessary research and obtain a patent for a new technology.

Thus, powerful corporations are, on the one hand, directly interested in conducting cutting-edge research through their own research units, and, on the other hand, these corporations have enough financial resources to independently finance most such research. This creates favorable conditions for the support of a certain category of promising technologies thanks to the financing of relevant research mainly by the corporate sector.

The main advantages of this support mechanism for new promising technologies are:

- Firstly, the high efficiency of the use of financial resources allocated for the development and implementation of new technology;
- Secondly, a high percentage of the introduction of new technologies;
- Thirdly, high rates of research work.

The high efficiency of the use of financial resources allocated by the corporation for the development and implementation of new technology is due to purely practical considerations of the corporation's management. After all, the financing of scientific research by the corporation will be justified only if the expected profit from the implementation of the results of the scientific research work will exceed the costs of its implementation. Therefore, it is obvious that the corporation will finance only those research works that meet this requirement. If the corporation still decides to finance a certain research, then it will obviously try to do it with the lowest costs, because its future profit will depend on it. This also explains the high percentage of introduction of new technologies, because the corporation finances research precisely for the opportunity to be the first to use the corresponding technology. Only the emergence of a more competitive alternative technology can force a corporation to abandon the introduction of a new technology.

The high pace of scientific and research work carried out by the research divisions of corporations is due to the fact that in order for the corporation to be able to secure competitive advantages, it must not only conduct appropriate research with the lowest costs, but also complete it earlier than its competitors. After all, many competing corporations in the hope of securing competitive advantages conduct similar studies. And even if the winner in this race does not secure exclusive rights to use the resulting

technology, in most cases the first-to-market corporation can hope to win most of the contracts for the supply of the new product. As a result, corporations that complete their research later may not recoup the money spent on conducting their research.

The main, and most obvious, drawback of this mechanism for supporting new promising technologies is the extreme limitation of the range of research that can arouse interest on the part of corporations. As noted earlier, the main reason that motivates large corporations to create their own research units and finance relevant research is the desire to be the first to receive a new technology that will provide them with a competitive advantage. That is, the result of the research should be the creation of a fundamentally new or improved product that will be in demand among consumers, or the cost reduction of already existing goods, thanks to the improvement of production technology. Obtaining these results is the purpose for which corporations are willing to spend their financial resources.

The latter significantly limits the range of research that can be financed by the corporate sector. After all, any corporation will spend its financial resources only on those areas of research that, preferably, correspond to the field of activity of this corporation and, necessarily, are promising from the point of view of achieving the specified goal. The emergence of technologies that do not meet the specified requirements, thanks to financing by the corporate sector, can happen either as a side result of the main research, or as a result of a strategic miscalculation of the corporation's management, which overestimated the practical significance of the future results of certain studies.

Another significant drawback of this mechanism for supporting new promising technologies is the presence of significant restrictions on the free dissemination of information regarding the results of research funded by large corporations. Indeed, as stated earlier, the main purpose of a corporation conducting its own research is to secure a competitive advantage. Therefore, the corporation may not be interested in publishing the results of its research units, even in cases where, for one reason or another, it is not going to use them.

The consequences of such restrictions may be a slowdown in the pace of technology development. After all, in order to prevent the leakage of information, the staff of the laboratory belonging to this or that corporation is forced to manage only by their own forces without the help of other researchers. Moreover, restrictions on the publication of research results may affect the efficiency of the use of financial resources by the corporate sector. After all, a very common situation is when several laboratories belonging to different competing companies work in isolation on the same problem, not having the opportunity to exchange ideas and research results, and therefore being forced to go through all stages of research independently, often repeating the mistakes of their colleagues.

DIRECT STATE FUNDING OF PROMISING RESEARCH

Direct state funding is an equally powerful source of funding for scientific research and further implementation of new technologies into practice. It should be noted that the state can take part in the financing of scientific research and the further implementation of new technology in two fundamentally different ways: by participating in already existing funds or by creating separate state funds that should allocate grants for certain scientific research (indirect state funding). Or through the creation of certain state structures, which must both conduct relevant research and implement relevant projects (direct state funding). The first of the mentioned approaches to state support of promising technologies is fundamentally no different from the case of non-state funds financing certain areas of scientific research,

which will be discussed below. Therefore, we will focus exclusively on the second approach to state support for promising technologies — direct state financing.

The main and indisputable advantage of this mechanism for supporting promising technologies is the possibility of financing research and the further implementation of technologies that, for one reason or another, do not arouse interest in business. The latter can be caused both by the impossibility of practical application of the obtained preliminary research results and the extremely high level of costs associated with the implementation of the relevant projects. Thus, space or nuclear technologies were able to develop and find practical application only thanks to direct state financing of relevant projects under the control of specially created state structures. And only later, after these technologies were properly developed and demonstrated their commercial potential, big business joined their financing.

At the same time, the main advantage of direct state funding as a mechanism for supporting the development of promising technologies is closely related to its main drawback: the significant limitation of the list of potential areas of research that can receive funding from this source. After all, in the case of direct state funding, the choice of directions for research and relevant projects for implementation is dictated solely by the desire to demonstrate the country's technological leadership (space program at the initial stages of its development) or ensure its defense capability (nuclear program). In addition, the choice to implement this or that mega-project is the result of political decisions that are influenced not only by the desire to ensure the prestige of the country or its defense capability, but also by many other factors, including the desire of the pro-government political force to be re-elected in the upcoming elections. As a result, relevant political decisions regarding the selection of this or that megaproject for its further implementation will be compromised, which may negatively affect the ability to choose the most promising technologies even from such an extremely limited list.

Another characteristic shortcoming of direct state funding is the low efficiency of using financial resources allocated for research. Undoubtedly, as with any other mechanism for supporting promising technologies, in the case of direct state funding, the research program will be formed by scientists, and not only success in achieving the set goal will depend to a large extent on how optimally this program will be drawn up, but also and the efficiency of the use of financial resources. However, no less important factors that will determine, in this case, the efficiency of the use of financial resources are the procedure for agreeing the list of necessary equipment and the procedure for allocating financial resources for its purchase, existing rules for selecting possible suppliers of the agreed equipment and the procedure for holding tenders. And, unlike the previous mechanism, these issues will be resolved by authorized officials in accordance with the current (not always effective) formal rules and current public procurement policy. The latter can be the cause not only of slowing down, due to the need to go through unnecessary bureaucratic procedures, the pace of scientific and research works financed directly from the state budget, but also the cause of inefficient use of financial resources. After all, an official, even compared to a hired manager of a large corporation, is much less interested in achieving the set results, which can negatively affect both the terms of delivery of the necessary equipment and its quality, as well as the working conditions of the scientific team.

The last, but no less significant shortcoming of direct state funding is the impossibility of using this mechanism to reveal the full potential of relevant technologies. This is due to the fact that state bureaucratic structures are much less sensitive to the needs of end consumers and market requirements. Therefore, state officials will try first of all to ensure the accelerated development of those aspects of these technologies that correspond to the interests of the direct customers – the ruling political forces. The remaining aspects of the practical use of these technologies, if they will be implemented thanks to direct state funding, will be implemented much later. The opposite situation will be observed in the case of financing of these technologies by the corporate sector. Yes, the everyday, convenient and already

imperceptible advantages brought to us by the development of space technologies and the Internet were realized only after the commercialization of these technologies. However, despite this shortcoming, direct government funding allows relevant technologies to reach such a level of development when the prospects for their commercial use become obvious and the corporate sector is included in their financing.

Thus, it is necessary to recognize that direct state funding, as a mechanism for supporting promising technologies, will be effective only if favorable conditions are created in time for the start of commercialization of the corresponding technology and more active financing and implementation of further developments by the private sector. Direct state funding will allow support for those promising technologies in which the corporate sector is not interested in financing, or there are no corresponding financial opportunities. And at later stages, when the relevant technologies reach the necessary level of development, financing by the corporate sector will contribute to the fullest disclosure of the potential of these technologies. Only in this case will all the advantages of both support mechanisms for promising technologies be realized.

RESEARCH FUNDING THANKS TO GRANT SUPPORT

Overcoming the common problem of the previous two mechanisms for supporting promising technologies — a significant limitation of the list of potential areas of research that can be further developed thanks to these support mechanisms — is possible thanks to the wider use of such a mechanism as research funding by various state and non-state funds.

Today, state and non-state funds that support various scientific research with the help of grants are becoming an important source of funding for scientific research, and in some cases, for further practical use of their results. The main feature of the operation of most state and non-state funds, thanks to which it becomes possible to expand the list of possible areas of research, is that when making a decision on the allocation of a grant for financial support of one or another research, as a rule, the commercial value of the expected research results is not taken into account . Thanks to this, even those studies that do not arouse the interest of the corporate sector can receive funding. Of course, a significant part of non-governmental foundations specializes in supporting only those researches that correspond to its main purpose (for example, the fight against global warming, or the preservation of certain ecosystems). However, thanks to the large number of foundations, each of which specializes in its own research area, their support covers almost all possible areas of research. Because of this, the immediate topic of the research will have little effect on the overall probability of winning a grant to fund it.

The main drawback of this approach to supporting promising technologies is the efficiency of the use of financial resources allocated to finance relevant research. In general, two dimensions of this problem can be distinguished:

- efficiency of allocation of funds, and
- efficiency of their use.

The first dimension of the problem of the efficiency of the use of financial resources is that the limited financial resources belonging to one or another fund must be distributed among a certain number of studies. At the same time, it is obvious that, first of all, funding should be allocated to the most promising research, the results of which can be translated into new, more effective technologies. Accordingly, the level of efficiency of the distribution of funds will directly depend on the ability of the fund's representatives to accurately determine the prospects of those studies that can be financed by this fund.

However, the complexity of such an assessment can vary enormously between studies. Thus, the potential of some studies can be revealed even at the early initial stages of research. For example, if a certain group of researchers is working on a fundamentally new technology for accumulating and storing electricity, which is much more efficient than existing technologies, then, given the presence of an already fully formed and extremely capacious market for secondary chemical current sources, it is quite obvious that, in if successful, the relevant new technology will find wide application and have a positive impact on the economic development of society. As a rule, this is true for research that promises to translate into a new technology that meets the following criteria:

- firstly, a capacious market has already been formed for the corresponding technology;
- secondly, this technology is a more effective alternative to the already existing technology.

However, studies whose potential can be easily determined are an absolute minority. In addition, they attract the attention of relevant corporations interested in the fastest possible implementation of the future technology and/or obtaining exclusive rights to its use, and such research, as a rule, does not require funding from other sources. For the vast majority of studies, it is extremely difficult, or even impossible, to predict the prospects for the application of relevant technologies. The consequence of this may be the allocation of funds for conducting research, the results of which may be translated into technologies that will lose in their effectiveness to existing alternative technologies, or will not be able to find any practical application at all. The considered problem is undoubtedly an extremely difficult problem that has no solution, because it is connected with the fundamental impossibility of predicting the future. However, this problem is a universal problem that is common to almost all existing mechanisms for supporting promising technologies, and therefore cannot be considered a shortcoming of this mechanism for supporting promising technologies.

A much more specific problem is the problem of the effectiveness of the use of allocated funds. Although in the case of grants, the collective of researchers can dispose of allocated financial resources more freely than, for example, in the case of direct state funding, the functioning of the grant system is also associated with numerous bureaucratic procedures. However, in this case, the main difficulties arise at the stage of applying for a grant. After all, achieving success in receiving a grant largely depends on how correctly the application is prepared and the rest of the many requirements are met. Obviously, this leads to an increase in the level of transaction costs of bureaucratic procedures, with which scientists hoping to receive a grant to finance their own research have to deal. Evidence of the high level of these costs can be the emergence of such specialists as grant managers, whose main duty is precisely the formation of a package of documents for applying for a grant and further support of the received grant.

The specified features of the grant system will have negative consequences for the effectiveness of this mechanism for supporting promising technologies. Thus, some researchers will be forced to give up trying to get a grant altogether, especially those who have no previous experience in getting grants, because for them the probability of getting a grant will be minimal, or the level of transaction costs of bureaucratic procedures will exceed the amount of the grant. If the grant application is still submitted, in case of success, part of the allocated financial resources will go to pay the grant manager. Even if researchers do not use the services of a grant manager, they will still have to spend their time (which could be spent on research) going through the relevant bureaucratic procedures.

CONCLUSION

Thus, each of the mechanisms for supporting promising technologies that we have considered has significant limitations that significantly narrow the scope for their effective application. Such limitations are mainly caused by too narrow a range of problems, the research of which can be facilitated by a separate support mechanism, or by limited opportunities for funding research. Accordingly, none of these mechanisms can become a universal mechanism that would be able to provide support for any promising technology. Because of this, effective support of promising technologies becomes possible only if a comprehensive support system is used, which not only includes all the considered mechanisms for supporting promising technologies, but also creates the proper conditions for their most effective application. At the same time, to ensure the effectiveness of such a system, it must be taken into account that a significant part of technologies, in its development, goes through several stages, at each of which, the most effective will be its own mechanism for supporting promising technologies.

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