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NATIONAL INNOVATION SYSTEM AND THE DEVELOPMENT OF SCIENTIFIC AND INNOVATION POLICY IN THE REPUBLIC OF ARMENIA

The paper deals with an overview of developments in S&T and innovation sectors in Armenia during the last decade. Adopted policy documents directed to promote innovation processes and development of national innovation system, and analysis of the government actions towards addressing the pressing challenge of reformation of S&T and innovation system in accordance with the requirements of the needs of economic development of the country are presented.

K e y w o r d s: innovation, innovation sectors in Armenia, innovation system, innovation policy.

ABSTRACT

The ongoing change means transition to knowledge based economy. There is a growing understanding that knowledge is at the core of economic development. This is also reflected in OECD publications referring to the knowledge based economy (OECD 1996; Foray and Lundvall 1996).

Much of the recent analytical works on the relationship between technological development, innovation, and economic performance has been focused on the concept of the «National Innovation System». Here, the emphasis is not just on the constituent actors within that system — firms, universities, government research laboratories, and so on, but more importantly on the relationships and linkages between them. National innovation system is «the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies» (Freeman, 1987). The study of national innovation systems directs attention to the linkages or web of interaction within the overall innovation system. An understanding of these systems can help policy makers to develop approaches for enhancing innovative performance in the knowledge-based economies of today.

Innovation being at the basis of economic development is instrumental for developing countries, and the process of innovation is still a challenging subject of research in economics, sociology and political sciences, and most efforts have concentrated on the understanding of the process in industrialized countries rather than in developing countries.

This paper deals with an overview of developments in S&T and innovation sectors in Armenia during the last decade, describes its background, current situation, adopted policy documents directed to promote innovation and develop national innovation system, and analyzes the government actions towards addressing the pressing challenge of reformation of S&T and innovation system in accordance with the requirements of the market economy and needs of economic development of the country. It also derives the policy implications that, to my mind, might have

positive effect on the efforts of the country towards building knowledge-based economy.

TOWARDS KNOWLEDGE BASED ECONOMY AND NATIONAL INNOVATION SYSTEM

The ongoing change means transition to Knowledge Society. There is not a unique standard model of knowledge based society or knowledge based economy. However, based on several evaluation studies the following factors seem to be fundamental: creativity and innovativeness; effective networking individuals and organizations; increasing intellectual capital; knowledge management; encouraging systematic lifelong learning; national innovation systems with special emphasis on well-targeted regional innovation policy; increasing investments in research and development.

There is a growing understanding that knowledge is at the core of economic development. This is also reflected in OECD-publications referring to the knowledge based economy (OECD 1996; Foray and Lundvall 1997).

Innovation and creativity are now valued as key to successful economic development, and knowledge society. The term innovation has been used since 1934 when American economist J. Schumpeter defined it as «Carrying out of new combinations, such as the introduction of a new good, the introduction of new methods of production, the opening of a new market, the opening of a new source of supply, or the reorganization of any industry» (J. Schumpeter 1934). Innovation is «The process by which new products or new methods of production are introduced, including all the steps from invention to development to pilot production to marketing to production» (J. Schumpeter 1934).

So, innovation can be defined as all the scientific, technological, organizational, financial, and commercial activities necessary to create, implement, and market new or improved products or processes (OECD 1997).

The effects of innovation are hard to measure. There is no single, simple dimensionality to innovation. There are, rather, many sorts of dimensions covering a variety of activities. We might think of innovation as a new product, but it may also be:

✦ a new process of production
✦ substitution of a cheaper material newly developed for a given task, in an essentially unaltered product
✦ reorganization of production, internal functions or distribution arrangements leading to increased efficiency, better support for a given product, or lower costs, or
✦ an improvement in instruments or methods of doing innovation (Stephen J. Kline and Nathan Rosenberg 1986).

Much of the recent analytical works on the relationship between technological development, innovation, and economic performance has focused on the concept of the «National Innovation System». Here, the emphasis is not just on the constituent actors within that system — firms, universities, government research laboratories, and so on, but more importantly on the relationships and linkages between them. Innovation System is the term used by scholars and policy makers to describe the emerging scientific and technological structures and processes that influence economic development (Freeman 1987; Lundvall 1992; Nelson 1993). According to innovation system theory, innovation and technology development are results of a complex set of relationships among actors in the system, which includes enterprises, universities and government research institutes.

The notion of a national innovation system was first described by Freeman in relation to Japan; he defined it as «the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies» (Freeman 1987). Later some other definitions of national innovation systems came in forth, among which the dominating ones are:

✦ the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state (Lundvall 1992);

+ a set of institutions whose interactions determine the innovative performance of national firms (Nelson 1993);
+ the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country (Patel and Pavitt 1994);
+ that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies (Metcalfe 1995).

The concept of national innovation system has since been developed by others and fleshed out with various empirical studies. It has come to prominence for several reasons. One is the growing economic importance of knowledge, with many economic activities becoming increasingly knowledge-intensive. A second and closely related reason is the widening range of institutions involved in knowledge generation.

The major success factors in national innovation systems are the political commitment to increase R&D funding together with the well functioning financial process of prioritizing the activities and focus areas. Every nation has, however, to find its own way. The profitability of additional investments is essentially dependent on how well the whole innovation system functions. A balance has to be found between basic research, applied research, product development, technology development, and training. The innovation system needs to be developed so as to improve its quality, efficiency and relevance. This, however, is not enough.

At the heart of the concept of the national innovation system is a belief that a better understanding of the linkages between the component actors in the system is the key to improved technological performance. For policy-makers, an understanding of the national innovation system can help to identify leverage points for enhancing innovative performance and overall competitiveness.

The policy implications of the national innovation system concept are far-reaching. As OECD has argued, it suggests a new rationale for government funding of research and technology based on correcting systemic failures — in other words, the lack of effective interactions between the actors in the system. It also points to the need for new types of policies to address those systemic failures, policies that develop, extend and strengthen the communication and the flows of information, and the networking, cooperation and linkages between the component organizations that make up the national innovation system.

GENERAL OVERVIEW OF S&T DEVELOPMENT IN ARMENIA

During the socialist period science has been one of the key branches of Economy. S&T in USSR enjoyed a significant state support. Continuous attempts to accelerate S&T progress or to introduce new military and civilian technologies required that the R&D system, especially in defense sector, be sustained on a large scale (Radosevic 2003).

Armenia was a part of that huge S&T system, having been developed into one of the leading scientific centers of the country starting from mid 1950s. By the end of 1980s Armenia possessed a ramified and actively operating system of research and technological institutions.

Collapse of the Soviet Union in early 1990s has led to disintegration of all previous ties, suspension of huge financial flows to S&T sector, and radical change in factors determining R&D supply and demand sides. Actually, the demand side nearly fully disappeared in Armenia at once, following emergence of political, economic and social problems on the entire territory of the former USSR, outbreak of ethnic conflicts in the region, and persisting blockade of transportation routes.

In the post soviet period the new independent Armenia has inherited well-developed sphere of

scientific, research and educational institutes, which were involving many fields of science and were coming forth within the institutes of the Academy, Ministeries and High Educational Systems. In soviet times the Academy of Sciences of Armenia had 25 instiutes, there were 3 all-union scientific research instiutes, 17 armenian branches, centers and departments of all-union scientific research institutes, about 30 institutes subordinated to the Armenian ministeries and other state bodies, 3 scientific research institutes functioning in the circles of science production unions. Besides, there were also 26 project institutes, 16 constuction bureaus, 5 science research laboratories, and 7 science reserch and normativ research stationaries. There were more than 10 higher education establishments, and institutes of professional developments. The network of scientific services was also rather developed: libraries, publishinghouses, printinghouses, etc..

Soviet Armenia, was considered to be a highly technological country, which had more than 30% of all Soviet electronics, and the significant part of military-industrial complex. It should be noted that in that system about the 75 % of the expenses of scientific R&D were done firstly for the satisfaction of the needs of military-industrial complex.

During transformation period the scientific potential of country was not saved and developed fully.

Currently the scientific potential and economic meaning of science are in deep discorrespondence. In that sense a more prospective investment and productive use of scientific potential in concrete programs of social economic development is significant. At the same time, in past Armenia was considered the «Silicon Valley» of USSR, where a number of productions of high technological industry have been centralized.

Nowadays a pressing challenge for Armenia is the reformation of its S&T and innovation system in accordance with the requirements of market economy. It is obvious that S&T can play a decisive role in assuring sustainable economic growth in our transitional country where significant R&D potential exists. Meanwhile, in Armenia no major reformation has been implemented in the field of S&T and innovation management system both on national and institutional levels since the collapse of the Soviet Union, which is one of the core reasons for inadequate innovation performance in the country.

INNOVATION PERFORMANCE: TRENDS AND OBJECTIVES

Science, technology and innovation (STI) policy was underestimated in overall economic policy and was neglected in Armenia during the first decade of transition. This might be reasoned by the absence of long-term economic development strategy where STI policy could be incorporated as integral part.

The economic growth in developed countries is basically provided thanks to the creation and usage of new knowledge and technologies. That's why the research and S&T activities in such countries deserve the unprecedented support of the state. The necessity of the coordination of S&T activities by the state is connected with the scientific «production» and peculiarities of the products (Ivanova). The cause is mostly the unpredictability of economic results of scientific research, when it is very difficult to wait for a profit even from the results with commercial prospective, in the existing conditions of IP protection system. But the market is not able to provide the necessary investments in science. That's why it is necessary for the state to coordinate the scientific sphere. Because of this, the main problem of state S&T and innovation policy must be the development and implementation of necessary steps for lessening the risks and other factors impeding innovation activities.

On the path to the development of innovation process there are a number of difficulties. For the successful implementation of innovation it is not enough just to have a good or even a genius idea. It is necessary to embody this idea practically into a concrete production, to bring it to the consumers to prove its advantages in comparison with the existing analogues, to save it from the

possible competitors and use of imitators. Thus the innovation process demands significant resources of organizational and personnel essence.

International benchmarking shows that sustainable economic growth can only be founded on technological development and the continuous increase of knowledge base, in which the Government support is necessary.

Yet in 2003 UNESCO organized a special parliamentary Round Table to tackle the issues of STI development. The key message of the seminar was to encourage parliaments to take a proactive role in developing science, technology and innovation policy for increasing the quality of life and human welfare (Fig. 1) (Markkula, 2008)

There are a number of key analytical lessons that can be learned from the national parliamentary experiences. These lessons can be sources of reflection and inspiration for such countries and regions of the world like Armenia.

It's known, that the main lever supporting R&D in country is the state budget.

In the industrially developed countries the volumes of science financing in the part of budget expenses in the last decades were sustainable high. Though, in Armenia the volumes of science financing factually make only about 1 % of expenditure part of the state budget. Budget financing of universities and state research organizations is being implemented via grants allocated to research projects. The grants are considered as one of the most productive ways of science financing.

The next important lever after the state budget, which is used in developed countries for the execution of state S&T policy, has an organizational essence. The use of the mechanisms of organizational essence allows providing cooperation (in the circles of legislation) between the state and private sectors involved in S&T sphere, which is so much lacking in the case of Armenia. In these conditions, the flows of financial means from the state budget to joint corporative structures, must be provided by a number of organizational mechanisms, which must be developed and implemented by the joint efforts of legislative and
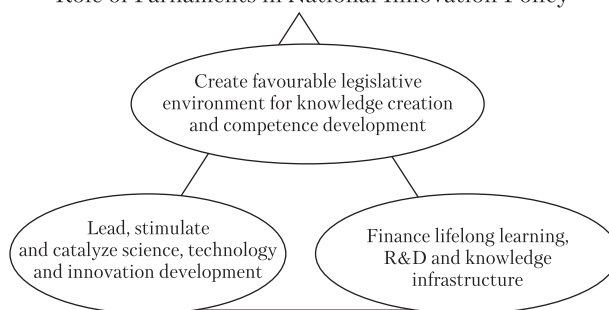
Role of Parliaments in National Innovation Policy

Fig. 1. Role of Parliaments in NIP

executive hands of authorities, and with the participation of corresponding ministries, departments and interested organizations.

In Armenia the financial sources for scientific activities are: a) the state budjet, b) means coming from agreements, c) foundations involving the allocation of international organizations and the investments of citizens, etc. d) grants, e) credits, f) means coming from scientific, publishing, consulting and other activities which are not forbidden by law e) means coming from the investment and realization of scientific results.

Only in 2011 some steps have been done to involve the private sector of economy into the funding of S&T activities, which gives an opportunity to change the inner structure of science funding. As it was already mentioned, till 2011 the only sources of science financing have been basicaly the State Budget and partially the international scientific grants. The part of the private sector of economy was neglegible. In 2011, for the first time, the funding of projects directed to the achievment of applicable results was implemented with the principle of cofinancing with the private sector. The size of cofinacing was defined as 15% and in the result 17 projects have been financed for the period of 2011—2012 yearly up to 30 million AMD with the total cost.

In Armenia the idea of government order in the sphere of science has formed recently in the form of state goal-oriented programs and basically has got another essence as it also serves mostly for the state scientific organizations. So, in Armenia the

research is being developed and implemented through three main financing mechanisms within the state budget: basic financing, thematic (project based) financing and goal-oriented project financing. The proportions among the financial volumes of these three types of funding are decided by the RA law about the State Budget.

Starting from the early 2000s an array of policy documents have been adopted in Armenia towards the regulation of S&T and innovation policy in the country. In December 2000, the Armenian Parliament adopted the Law on Scientific and Technological Activity aiming at regulating the interrelations between R&D performers, state bodies, and R&D outcome consumers, as well as outlining general principles of formation and implementation of state policy in the field of S&T.

In 2005 Government took the decision to approve an Action Plan 2005—2010 directed towards the creation and development of the innovation system in Armenia which was defining around 20 measures to be implemented in the period of 2005—2010.

In May 2006, the Law on the State Support to Innovation Activity was adopted (which was the first measure of the mentioned action plan 2005-2010), which defined the legal and economic bases of national innovation policy formation, and forms of state support of innovation activity.

To improve policy-making and better coordination in the field of S&T, the government took the decision in October 2007 to create the State Committee of Science and empower it to carry out integrated S&T policy in the country. This structure is responsible for development and implementation of research programs in the country.

Among the number of adopted policy documents supporting S&T and innovation system in Armenia are the Resolution on the Priorities of Science and Technology Development for 2010—2014 in the Republic of Armenia (adopted on May 2010), incorporating 6 areas, including information technologies, advanced technologies (biotechnology, nanotechnology), etc., the Concept of Innovation Activity in the Republic of Armenia (adopted on January 2005), aiming at formulation of general approaches and principles of the state policy directed towards consistent creation and development of a national innovation system, and its basic elements and infrastructure, capable for ensuring sustainable development of the country and increasing its competitiveness, and creating a favorable innovation environment for international economic co-operation, etc.

On July 2007 The Armenian Government adopted Conception on Improvements in Science, the primary objective of which was the creation of knowledge-based economy, and which sets several clear targets for action among which are increase in science funding, clarification of funding forms and mechanisms, enhancing productivity of funding, modernization and creation of new infrastructures, material and technical base, fostering commercialization of scientific results, etc.

On May 2010 The Strategy of Science Development was adopted in the Republic of Armenia. In this document the vision of the science development is formed like this: «In 2020 the Republic of Armenia is a country having science based economy, and which is competitive in European science technological territory with its fundamental and applied R&D level». The missions for this vision are:
+ formation of a system providing the stable development of science and advanced technologies,
+ modernization of the material-technical base of scientific sphere and the infrastructures,
+ provide stable growth of numbers of cadres, having high qualifications in the sphere of science and technology,
+ to provide immigration of young cadres in the sphere of science,
+ to provide productive state sponsorship for the fundamental scientific research,
+ to stimulate the implementation of research directed to the achievement of knowledge which can be used in the economy,
+ formation of a harmonic system providing the development of knowledge containing science, technologies, and innovation and stimulating

the involvement of the private sector in the science,

✦ to enlarge the international cooperation in the sphere of science and technologies (Strategy of Science Development in RA, 2010).

On June 2011 The Strategic Program and Action-Plan for the Development of the Sphere of Science in 2011—2015 was adopted, which involves the measures and the table for the targets defined in the strategy of science development.

Thus, these measures taken by the Armenian government can be considered as initial steps towards development of the legislative framework and improvement of the information support and institutional basis of the innovation system. The issues of effective management of innovative resources, modernization of S&T basis, introduction of incentives for innovative companies, and attraction of private investments still need to be addressed adequately.

But all these conceptual and legislative measures need to be supported by adequate concrete actions and programs directed towards forming the national innovation system. At the moment they have more of a declarative and fragmented character and are not supported by adequate financial commitments and tailored decisive actions consistent with general economic development trends. For instance the Action Plan measures have been implemented very slowly with considerable delay in timetable, and in 2006 only a small amount of funding (around 40,000 Euro) was allocated from the state budget for implementation of the planned activities, particularly, for the creation of Information and Analytical Centre and Permanent Exhibition of Innovative Projects at the Armenian Centre of S&T Information, and creation of the Research and Innovation Centre of Advanced Technologies and Integrated Information Network of Innovation Infrastructure at Yerevan Physics Institute.

In absolute values the budgetary expenditure on R&D has increased in Armenia during the recent years. The annual rate of growth in 2006 compared with the previous year was 18.7 %, and in 2007 it was 20 % compared to 2006 (in real terms), in 2011 it is 8.8 % compared to 2010.

In general, the program development, project coordination and outcome application mechanisms still need to be improved and adequately implemented according to the adopted policy documents. In Armenia, no indirect measures have been implemented to stimulate innovation in business sector, for instance, in the form of tax and customs benefits or exemptions. Existing regulations do not stimulate the creation of spin-off companies at academic institutes and universities. There is a need also to address intellectual property ownership issues, especially intellectual property created as a result of government financing.

Currently around 17 thousand people deal with scientific activities in Armenia, about 7.5 thousand scientists and scientific workers are involved in scientific programs which are beeing financed by the state budjet and the part of them have scientific degrees.

In 2008—2009 was created the system of independent scientific expertise, where 1200 scientist experts are involved from Armenia and abroad.

International cooperation is notably enlarged: a number of contracts have been signed since 2008 between State Committee of Science and Foundation of Fundamental Researches of Russian Federation, French National Center for Scientific Research, International Science and Technology Center, State Committee of Science and Technology of Belarus, Federal Ministry of Research and Education of Germany, etc...

Thus, the aforementioned arguments are generalized in a SWOT overview of innovation governance in Armenia, which is illustrated in Fig. 2.

On January, 2008 a mission to Armenia was conducted by UNESCO, aimed at the investigation of S&T and innovation system in Armenia. The outcome of the UNESCO mission based on the contract between UNESCO and Mr. M. Markkula was a report on the Science, Technology and Innovation Policy of the Republic of Armenia.

In the beginning of the mentioned report prof. Markkula states: «Armenia has excellent oppor-

Strengths	Weaknesses
• High economic growth rates (13.8% in 2007) registered during last decade, which create favorable conditions for stimulation of innovation activities • Adoption of several legal policy and strategic documents towards creation and development of innovation system • Creation of authorized body responsible for S&T policy-making and development (State Committee of Science) • Developed scientific system with advanced scientists and scientific organizations and institutes • Existence of big R&D potential	• Inadequate enforcement of adopted policy documents • Lack of the quantitative targets in the most of adopted policy documents directed to the promotion of innovation • Poor development of innovation support infrastructure • Insufficient level of R&D expenditure and negligible degree of share of private sector in it • Lack of the mechanisms of economic support: incentives for stimulation and growth of innovative and science-intensive organizations • Lack of the policy of supporting the innovation start-up companies • The Scientific institutes are technically old • The age of scientists is quite higher than average • Lack of modernization in processes and technologies • Market is not able to provide the necessary investments in science
Opportunities	Threats
• Growing ICT sector as possible engine and a good example of innovative activity in other sectors of Economy • Strong diaspora ready to bring new knowledge and investments in case of favorable conditions • Young specialists with high education, good skills and knowledge of different languages	• Adopted innovation policy documents are not based on strategic economic development priorities of the country • R&D system and infrastructure remain nearly unchanged and far from real economic and social needs of the country • Young scientists with high qualification leave for more developed (mostly EU countries and USA) countries

Fig. 2. SWOT overview of innovation in Armenia

tunities to become an important player in the global science, technology and innovation (STI) community — it is time to plan in detail and to implement well-targeted specific actions» (Markkula, 2008). Taking into account all issues that hinder to the development of STI policy in the country, around 15 recommendations suggest UNESCO for the Armenian case, which to me seem very important and essential for the formation of knowledge based economy in Armenia.

CONCLUSION

Thus, basing on the experience of economically developed countries, it can be concluded that living scientific systems alongside with their potential profitability, can be formed and survive only in the conditions of state support and right S&T policy. It involves the existence of officially formed realistic priorities, the volumes of state budget financing, and the investment of corre-

sponding structural-legal forms in the sphere of science and the creation of favorable legislative field. Summing up the trends and problems in the creation and development of the national innovation system in Armenia, it should be mentioned that one of the main goals of the state is to create a favorable and sustainable overall environment for innovation and investment in R&D-intensive activities. The government already had various initiatives to create a favorable legal environment for innovation and create the necessary constituents of a national innovation system, but the problem is that many adopted legal documents and measures are not adequately enforced. Most of the adopted strategic policy documents lack concrete quantitative targets — to be addressed within a certain time frame — and are not based on objective analysis of the current situation and weaknesses of the system. In general, the role of government is crucial in ensuring adequate S&T

and innovation policy as an integrated part of overall economic policy and long-term development strategy of the country.

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Аревік Хнкоян

НАЦІОНАЛЬНА ІННОВАЦІЙНА СИСТЕМА ТА РОЗВИТОК НАУКОВОЇ ТА ІННОВАЦІЙНОЇ ПОЛІТИКИ РЕСПУБЛІКИ ВІРМЕНІЯ

Розглянуто розвиток науково-технічного та інноваційного секторів економіки Вірменії за останнє десятиліття. Представлено державні документи, спрямовані на сприяння інноваціям і розвитку національної інноваційної системи, а також аналіз дій уряду на шляху вирішення нагальних проблем реформування науково-технічної та інноваційної систем Вірменії відповідно до вимог ринкової економіки і потреб економічного розвитку країни.

Ключові слова: інновації, інноваційний сектор у Вірменії, інноваційна система, інноваційна політика.

Аревик Хнкоян

НАЦИОНАЛЬНАЯ ИННОВАЦИОННАЯ СИСТЕМА И РАЗВИТИЕ НАУЧНОЙ И ИННОВАЦИОННОЙ ПОЛИТИКИ РЕСПУБЛИКИ АРМЕНИЯ

Рассмотрено развитие научно-технического и инновационного секторов экономики Армении за последнее десятилетие. Представлены государственные документы, направленные на поддержку инновациям и развитию национальной инновационной системы, а также анализ действий правительства на пути решения безотлагательных проблем реформирования научно-технической и инновационной систем Армении в соответствии с требованиями рыночной экономики и нужд экономического развития страны.

Ключевые слова: инновации, инновационный сектор в Армении, инновационная система, инновационная политика.