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Ana Popa

Research, Development and Innovation in the Republic of Moldova

problems and options

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This study is developed as a part of the project *"Economic Transformation: Development of Innovation and Entrepreneurial Skills"* implemented by the Expert-Grup Analytical Center from Moldova and the CzechINVENT Technology Agency with the support of the East East: Partnership Beyond Borders Program of the Soros Foundation-Moldova and Open Society Fund – Prague, being co-funded by the Ministry of Foreign Affairs of the Czech Republic.

About the project

The project "Economic Transformation: Development of Innovation and Entrepreneurial Skills" is a further development of the collaboration between the Czech and Moldovan partners established during last years, the CzechINVENT being open to sharing the Czech experience and knowledge gained over last decade concerning the infrastructure, science & technology parks and business incubators development. It is obvious that the success of technologic development, innovation and research and development activities could contribute to promotion and implementation of reforms that largely depend on Moldova's domestic policies and local support, therefore it is hoped that the developed initiative will stimulate the interest of regional actors in defining these policies and extending their support to other actors. The experience and knowledge received from the Czech Republic will contribute to empowering the project beneficiaries – Moldovan experts, local authorities, NGOs from the field of local economic development – to become promoters of new approach on reforms and will enable authorities to be more consequent and coherent in implementation of necessary transformations. The study developed within this initiative refers to the current institutional set-up existing in the Republic of Moldova that is not favouring yet a rapid advance of the innovation and building of the entrepreneurial capacities within society, therefore needs considerable improvement and reconsideration.

The Moldovan partner expresses its appreciation for all assistance provided by the Czech counterpart during the implementation of this project, with special thanks from the author of the study for the suggestions and comments received from the Czech experts. At the same time, the project partners are grateful to the East East: Partnership Beyond Borders Program of the Open Society Foundation-London for granting support for this initiative that made it happened.

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Acronyms used in the paper

AGEPI	State Agency on Intellectual Property of the Republic of Moldova
AITT	Agency for Innovation and Technological Transfer
ASM	Academy of Science of Moldova
GDP	Gross Domestic Product
R&D	Research and Development
RDI	Research, Development and Innovation
VAT	Value Added Tax

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Executive Summary

This paper analyses the state of the R&D sector in Moldova, the way it encourages research activity in public and private institutions and the outputs of the system using international comparisons. The main objective of the study was to identify the weaknesses of the system in order to propose viable solutions for the reformation of R&D sector so that it can contribute the establishment of an economy based on competitiveness and innovation. The main findings are:

- Moldova inherited from the Soviet Union a very centralized R&D system where the research activity is mainly concentrated in the Academy of Science and its institutions. During two decades there were no major changes. Currently, the ASM is responsible for the formulation of R&D policy and priorities and also manages the financing of R&D activities and the president of ASM is an ex-officio member of the Government.
- Other stakeholders have very limited contribution to the R&D process. Universities and private sector almost do not participate in the research process due to barriers in getting public funds (rigid requirements for accreditation of research institutions, almost impossible to be met by private companies and provision that only institutional members of ASM can be beneficiaries of projects financed entirely from budgetary resources) and poor incentives provided for the collaboration of public and private sector (especially universities and business sector).
- Current system encourages more basic research and not applied research that is usually market-oriented and mostly conducted in private companies or in collaboration with them. As a result the applicability of many inventions is re-

duced. Despite high patent registration activity in Moldova, few of the patents are extended after a five year period (this being a proxy for the utilization of the registered invention). There should be a clear delimitation of basic and applied research. Academy of Science of Moldova should be responsible for the basic research, while applied research should be managed by joint councils composed by members of relevant ministries (education, economy, industry), universities and private sector. National R&D policy should be in line with the general economic and industrial policy in the country and financing priorities in applied research should follow strictly the development priorities.

- Stimulation of R&D activity by additional incentives is necessary order to get the sector a new development impulse. There are already some benefits for institutions and companies that conduct R&D activities, (VAT exemption at the import of goods and services for research purposes and income tax exemptions before 2008), but these were not very efficient to stimulate private investments. In case of reintroduction of corporate income tax in Moldova investments in R&D should be 100% tax deductible. Also, this should be accompanied by the stimulation of universities and R&D institutions to collaborate with the industry and sell the results of R&D to them
- Moldova invest more than other countries with the similar level of development in R&D as share of GDP, however the achieved results are lower than in many of these countries. The World Economic Forum score for innovation places Moldova on the second bottom place among the transition countries.
- Poor performance of the R&D sector is determined by limited involvement of private sector in the process, the quality of research staff in the public research institutions, poor management and inefficient and non-transparent use of the available public finances.
- Low availability of scientists and engineers and the unsatisfactory quality of researchers is an outcome of the badly-reformed educational system. The educational system,

especially tertiary and post-graduate education, need urgent reforms in order to provide valuable human resources capable to be engaged in research activity. Facilitation of collaboration between national and international universities, including the establishment of branches of foreign universities in Moldova should be a priority. Also, international R&D collaboration should be facilitated by adapting the legislation for international cooperation in R&D activities (joint financed projects), bilateral cooperation between research organizations, including an increase in international mobility of researchers involved in R&D.

Introduction

Already for few years Moldovan Government aims to change its economic growth model and to become an economy based on competitiveness and innovation. Despite the declarative goal, the Research, Development and Innovation (RDI) system in Moldova seems to be static, with a very slow transition from the soviet R&D model to a more advanced model, used in most developed countries.

The scope of this paper is to identify the efficiency of the Moldovan R&D system - organization, financing and achieved results - in order to assess the real possibilities and necessary actions to be undertaken for Moldova becoming an economy based on innovation. For a better illustration, international comparisons are used when possible with the following countries in transition (countries with similar level of development, but also countries that registered significant progress during the last decade and achieved remarkable outputs in the R&D): Armenia, Azerbaijan, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia, Tajikistan and Ukraine.

The paper is structured in three chapters as follows:

- **Chapter 1 - Research, Development and Innovation Sector in Moldova: Current Situation** - looks at the R&D framework in the Republic of Moldova. It analyses the organization of the R&D process: formulation of innovation policy, financing of R&D, involvement of different stakeholders (Academy of Science, Ministries, Universities, private sector). It also looks at the quality of research institutions that determine the system outputs.

- **Chapter 2 - Main outputs of R&D activity** – looks at the outputs of the R&D activity: innovations, scientific results (published articles and citations), procurement and use of new technology and when possible correlates it with the level of spending on R&D. Another important issue addressed in this part is the collaboration between different research institutions that generally determines the level of output in research activity and applicability of the outputs.
- **Chapter 3 - Problems and Options for Moldovan R&D Sector** – identifies main problems of the R&D sector in Moldova that cause low R&D activity and outputs and does not stimulate private investment in R&D. It ends with few solutions for the restructuring R&D system based on the experience of European countries.

Research, Development and Innovation Sector in Moldova: Current Situation

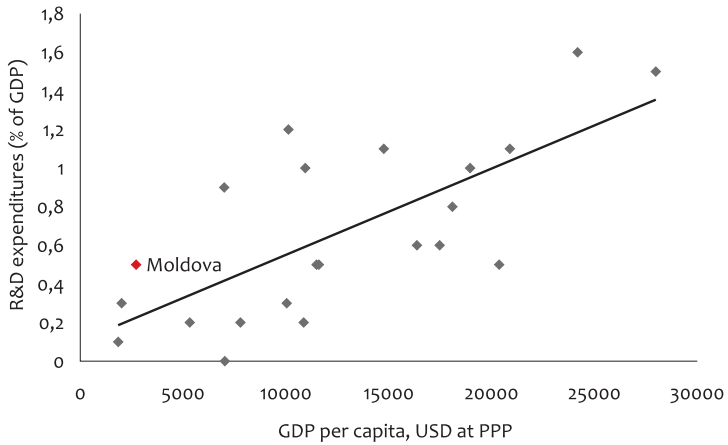
Moldova inherited from the Soviet Union a very centralized system of research and development (R&D), where the research activity was almost entirely financed from public money spent mainly to carry out state orders. The main and single institution that managed R&D activities in this system was the Academy of Science. After 20 years of transition not many changes occurred. The Code on Science and Innovation, enacted in 2004, gives the Academy of Science of Moldova (ASM) the whole authority in carrying out the state policy in science and innovation field that should be in line with the state's economic, financial and technical-scientific policies[1]. Also, the president of ASM is ex-officio member of the Government[2], an unique case in Europe.

The Government delegates the competences to ASM through a four years partnership agreement between the two stakeholders, defining the development and strategic directions strategy in science and innovation area and the amount of public resources for R&D activities according to the budgetary law. While in other countries this is the task of joint councils composed by ministers from relevant ministries (Education, Industry, Economy), Academy of Science, universities and representatives of business sector, in Moldova the system is still very centralized, ASM being the main stakeholder.

During the last few years Moldova spent on R&D around 0.5% of GDP. Although the level may seem low, being much under the European target of 3% of GDP[3] (both public and private expenditures), Moldova spends relatively more than countries with the same level of development (Chart 1).

[1] Code on Science and Innovation no. 259 from 15.07.2004, art. 55.
[2] Code on Science and Innovation no. 259 from 15.07.2004, art. 82
[3] Target set in the Treaty of Lisbon.

Chart 1. Correlation between public expenditures on R&D and level of GDP per capita in some countries, 2007



Note: Countries included for comparison: Belarus, Bosnia and Herzegovina, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Montenegro, Poland Romania, Russia, Serbia, Slovak Republic, Slovenia, Tajikistan, Ukraine
Source: World Development Indicators, WB, World Economic Outlook, IMF.

However, a deeper analysis of expenditures shows lower effective spending on actual R&D activities. ASM manages a secondary school and a university, which is an unusual practice for such institution. This is very costly and not necessarily legitimate as the sector of R&D should be open to any innovative idea and not bound itself to train a limited amount of researchers in the areas the state is able to provide training. In 2010, the spending on these two educational institutions accounted for 4% of total R&D expenditures. If administrative costs, trainings of scientific staff and capital investments are excluded, only 70% of R&D expenditures were oriented directly to basic or applied research in 2010 (33% to 67% respectively), evolving from around 50% in 2007.

Capital investments are very important in the research process if these imply the acquisition of new equipment and technologies that consequently may increase the returns of investments. But these expenditures accounted for less than a half of capital investments in the sector in 2010 (Table 1); the largest share was used for construction, renovation and maintenance

of buildings (for research, administrative and educational purposes). Although sometimes very important, these types of investments have a much lower return and obviously limit the available resources for other current investments. They accounted for 18% of total R&D expenditures in 2007 and reduced to 7.9% in 2010.

Table 1. Structure of R&D public expenditures, %

	2008	2009	2010
Total expenditure (thou MDL)	393764.5	390077.6	353372.1
Education	1.7	3.7	4.0
Research activity (current expenditure)	57.9	59.7	70.0
Research activity (other capital expenditure except construction)	11.5	13.1	4.3
Training of scientific staff	4.6	5.9	4.8
Administration expenditures	3.0	3.0	2.9
Other current expenditures	5.6	6.7	6.1
Capital investment in construction	13.6	7.8	7.9
Other capital expenditures	2.1	0.2	0.0

Source: Budgetary Laws for 2008, 2009, 2010

The high share of expenditures for the remuneration of the ASM and its institutions' staff (which is exaggerated in number) was addressed in one of the audit reports of the Courts of Accounts that concludes that the remuneration does not take into account scientific results and projects' outputs and in 2008 few ASM' institutions benefited from non-regulated overpayments of salaries[1].

Another important feature of the efficiency of R&D expenditures is their dependence on the implementing institution. The motivation and financial possibilities for innovation vary between private and public institutions. While private sector is more market oriented, often interested in increasing productivity and reduction of production costs and looking for higher applicability of these innovations, the financial possibilities of private sector may be relatively low. International experience indicates over more intense basic research being conducted in public institu-

[1] Courts of Accounts Decision no. 48 from 29.10.2009 regarding the Audit Report on the utilization of the financial resources allocated for science development in 2008 to ASM

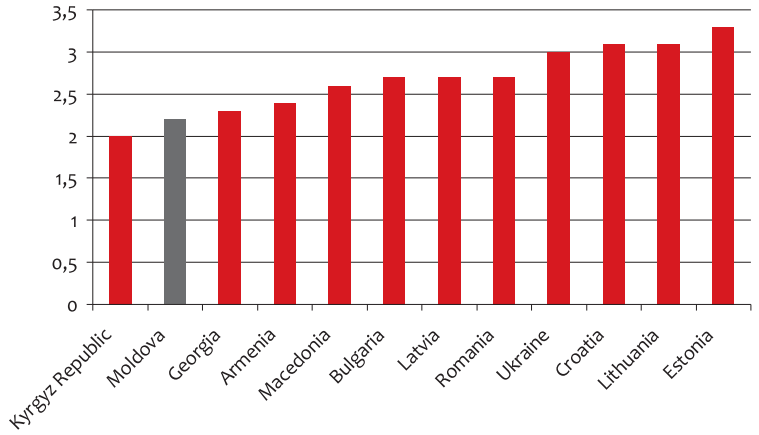
tions and universities, while applied research is more often conducted by private sector. Therefore, the access of private sector to public R&D resources is very important. In latest decades the trend in developed economies is to encourage public R&D organizations to engage more in applied research, typically in collaboration with private companies. These collaborations open up additional potential sources of financing for public R&D organizations, but the environment (legal system, statutes of the organizations, tax system, system of intellectual property protection in the country) should encourage this collaboration. Although direct financing of the private sector is not a common practice in EU, it may be used to set aside the market failure of low R&D activity. However, Moldovan legislation limits the access to public finance for R&D of private companies. Although any organization, regardless its ownership state and legal registration type can participate in R&D activity, since 2005 in order to benefit from public funds it should be accredited by the ASM, the accreditation criteria being very tough. According to the Code on Science and Innovation in order to be accredited by the ASM an organization needs[1]:

- to record precisely the amount of work in scientific and innovational activity in the activity plans, activity reports and scientific publications;
- to establish a scientific council;
- to have appropriate facilities for the research process and auxiliary services for the development of the activity;
- the staff should include at least 13 PHD and post-PHD graduates;
- not have arrears in wage and services payments;
- to spend at least 20% of their budget for the acquisition of scientific equipment, specialization spending, trainings, technical-scientific cooperation, participation of the staff at conferences, symposiums, exhibitions for change of experience,
- to publish a scientific journal, with at least 20% of authors from abroad.

[1] Code on Science and Innovation no. 259 from 15.07.2004, art. 99.

Obviously, for a small private entity it is very difficult to meet these requirements (mostly relevant for basic research and providing a solid obstacle to applied research) and therefore mostly big public institution benefit from public money. On the other hand, the R&D expenditures are usually very high and not always gainful. Not many companies can afford such a luxury as investments in R&D, taking into consideration the low profitability reported by Moldovan enterprises. Therefore, private R&D expenditures are very low, Moldova being actually placed on the 135th place in 139 country ranking of the World Economic Forum (WEF) according to the company spending on R&D, lower than most transition economies (Chart 2).

Chart 2. WEF score on company spending on R&D, 2009-2010



Note: The score was calculated based on answers to the questions „To what extent do companies in your country spend on R&D?" [1 = do not spend on R&D; 7 = spend heavily on R&D], 2009–2010 weighted average.
Source: Global Competitiveness Report 2010-2011, WEF.

Thus, the R&D activity is concentrated in few big institutions that fulfill the accreditation requirements and few private companies that can afford such spending, mostly in the design-investigation organizations and design offices for construction works (Table 2).

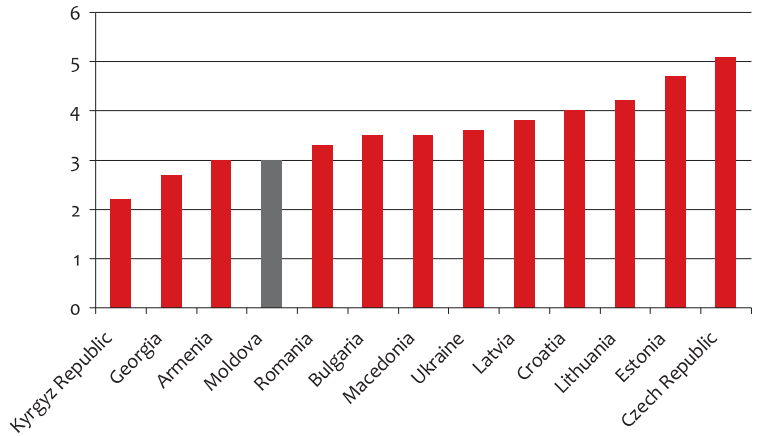
Table 2. Number of institution that conducted R&D activity, 2008

	Total	Public	Private	Mixed*	Joint ventures
Total	70	58	7	4	1
Scientific-research institutions	42	40		2	
Design-investigation organizations and design offices for construction works	16	7	6	2	1
Higher education institutions	12	11	1	–	

*Note: * - public and private, without foreign participation*
Source: NBS

Moreover, the quality of these research institutions is not satisfactory. Despite the increasing expenditures on R&D (both capital and current expenditures during the last few years), the research institutions are still weak and did not advance in the WEF ranking on the quality of scientific research institution since 2007, Moldova being situated on the 105th place, lower than the average ranking in transition (Chart 3).

Chart 3. WEF score on quality of scientific research institutions, 2009-2010



Note: The score was calculated based on answers to the questions „How would you assess the quality of scientific research institutions in your country? [1 = very poor; 7 = the best in their field internationally]", 2009–10 weighted average.
Source: Global Competitiveness Report, WEF, 2010-2011.

The quality of research institutions depends on the quality of equipment, quality of researchers and quality of management. After 2005 many research institutions benefited from the renewal of equipment and in most of them new laboratories were installed in order to fulfill the requirement of 20% budgetary spending on the acquisition of equipment needed for accreditation. However, in some cases this was just a renovation or an upgrade of old equipment rather than full endowment with new equipment. Also, serious breaches in spending of financial resources designated for the procurement of scientific equipment were tracked down by the Court of Accounts, when equipment was paid simultaneously from several projects or the money were used for other purposes[1]. Generally, the report identifies many irregularities in spending of the public money by the Academy of Science and finds the process non-transparent.

As regards the research staff, in the first decade of transition Moldova lost many talented and well-educated individuals. The difficult economic situation and poor financing of science and R&D sector contributed to the brain-drain process. Low wages in the sector encouraged migration of many good researchers and could not motivate young graduates to continue their careers in the research field. Currently, there are significant improvements. In 2009, the average wage in R&D sector was 32% higher than the average wage in economy. Although this is an administrative increase and does not reflect higher outputs in the sector, it was necessary to keep people in the sector.

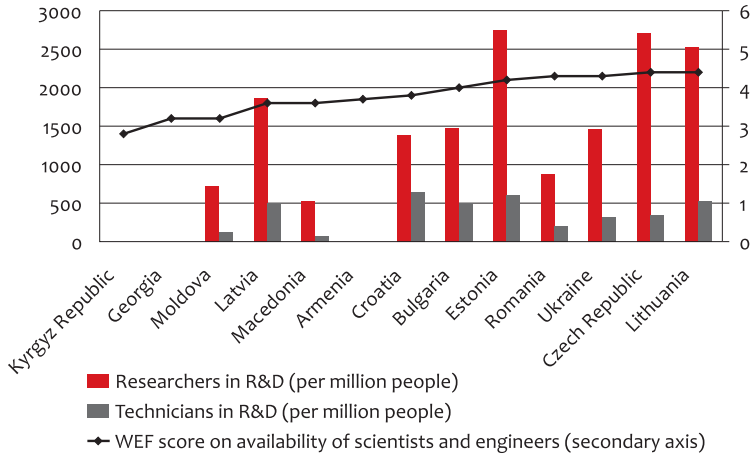
In the recent two decades the situation in educational sector changed tremendously with an impact on the research staff. Firstly, the students' preferences have changed: the demand for technical sciences decreased, while the demand for social sciences increased. In 2008 only 18% of tertiary education graduates got a degree in technical, medical and IT fields of studies (but 35% of PHD and 39% of post-doctoral graduates). Secondly, the quality of education has decreased as shown by WEF ranking of quality of tertiary education and training. Although recently (2006-2008) the number of researches increased, Moldova is not positioned very well in terms of availability of scientists, engineers and researchers (Chart 4).

The 2004 Code on Science and Innovation stipulated the creation of the Agency for Innovation and Technological Transfer (AITT), which is also subordinated to ASM, as well as incubators and science parks. AITT was established in 2005 and is responsible for the coordination, promotion and implementation

[1] Courts of Accounts Decision no. 48 from 29.10.2009 regarding the Audit Report on the utilization of the financial resources allocated for science development in 2008 to ASM

Research, Development and Innovation in the Republic of Moldova: problems and options

Chart 4. Availability of scientists, engineers, researchers and technicians, 2009-2010



Note: The score was calculated based on answers to the questions „To what extent are scientists and engineers available in your country?" [1 = not at all; 7 = widely available], 2009–2010 weighted average.
Source: Global Competitiveness Report, WEF, 2010-2011, World Development Indicators, WB, 2007.

of mechanisms of innovation and technological transfer activities[1]. AITT is responsible for the reception, expertise, financing, administration and control of technological transfer projects, including those for residents of incubators and science parks. This is also an unusual practice as usually such agencies only provide assistance and help to those who need it and do not control the technology transfer. In developed economies universities, incubators and science parks usually have their own technology transfer offices and/or sometimes they share technology transfer offices on regional basis.

Since 2009 private institution and non-accredited organization can apply for technological transfer projects, which is an important development as between 2006 and 2008 only institutions accredited by National Council of Accreditation and Attestation (NCAA) could be beneficiaries of these projects. The beneficiaries should transfer 2% of sales (of innovative good

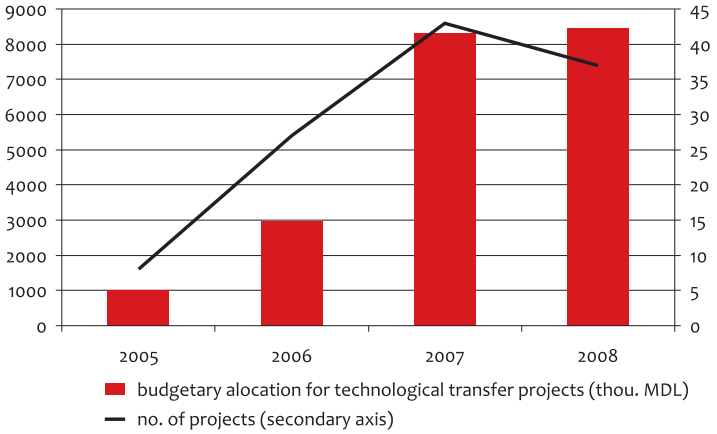
[1] For detailed competences of AITT see Code on Science and Innovation no. 259 from 15.07.2004, art. 89.

or service) to AITT during the first five years of the project that is used for the stimulation of innovation activity and marketing activities.

Projects of technological transfer are financed from the state budget up to 50% of the project value (before 2009 up to 40%), the priority being given to projects with higher co-financing share from non-budgetary sources. Only institutional members of ASM can be beneficiaries of projects financed entirely from budgetary resources.

During 2005-2008 period more than 20 million MDL were allocated to finance 115 projects of technological transfer (Chart 5). Most of the projects were in agricultural biotechnologies, soil fertility and food security (60.5%), biomedicine, pharmacology (16.6%), efficiency of energy complex and energy security (8.7%), nanotechnology, industrial engineering (7.6%), use of human, natural and informational resources for sustainable development (6.6%). The decreasing demand in financing of projects of technological transfer (decreasing number of project proposals submitted to the AITT) indicates over the poor advertising and insufficient resources allocated from the state budget that makes companies give up such opportunities. Unfortunately, there are no available data on the results and economic benefits of the implementation of any of these projects, which is a serious flaw in management of R&D-allocated resources and a symptom of weak public and political control over public financing of this sector.

Chart 5. Number of technological transfer projects financed and the amount of budgetary resources allocated

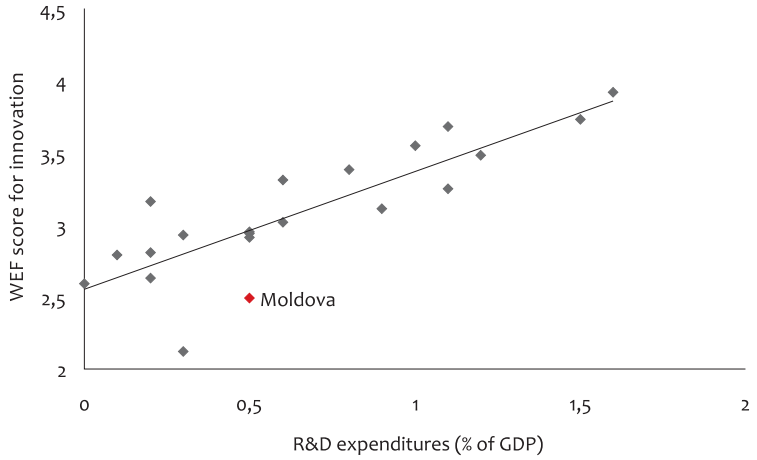


Source: AITT Annual Activity Report, 2008.

Main Outputs of R&D Activity

Relatively high spending on R&D activities in Moldova does not result in proportional outputs of the sector. The general WEF score on Innovation for Moldova is much lower than the expected level for 0.5% share of GDP expenditure spent on R&D. (Chart 6). Countries like Armenia, Azerbaijan, Kazakhstan, Tajikistan and Serbia spend relatively less on R&D, but have a higher WEF score for innovation; other countries like Bulgaria and Slovak Republic achieved better results with the same level of R&D expenditures as Moldova.

Chart 6. Correlation between R&D expenditures and WEF score for innovation, 2009-2010

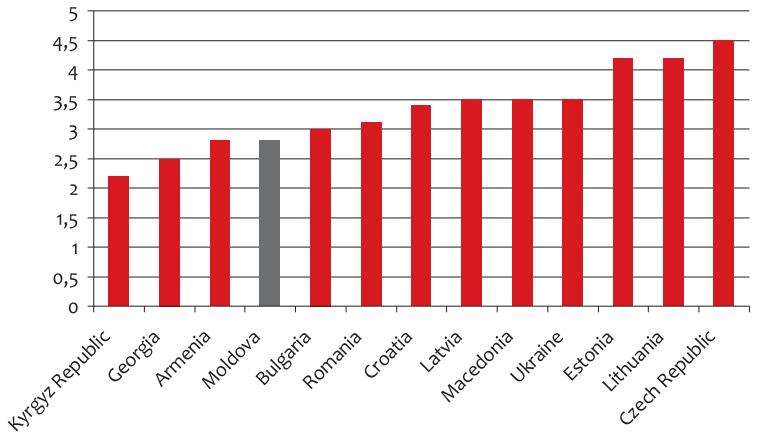


Source: Global Competitiveness Report, WEF, World Development Indicators, WB.

Low performance of Innovation sector is explained by poor organization and excessive centralization of R&D process in Moldova. At the same time, international experience indicates over better results in innovation and applicability of inventions in private sector, where the interest to meet the market demand and to fetch profits from the new introduced products/services/technologies is higher than in public sector or sometimes in public research organizations when the legal system allow them to sell their R&D results and keep the benefits.

Universities represent another important participant in R&D process in most developed countries. Partially financed from public funds and partially from private resources coming from companies they collaborate with, these are important centers of innovation. In Moldova, although most of the universities conduct some research activities, they cannot be considered real innovation centers. Financed from public money, universities were not interested in raising resources from private sector. Thus, cases of collaboration between universities and private sector are rather exception than common practice in Moldova that is reflected in the low WEF score for university-industry collaboration in R&D (Chart 7).

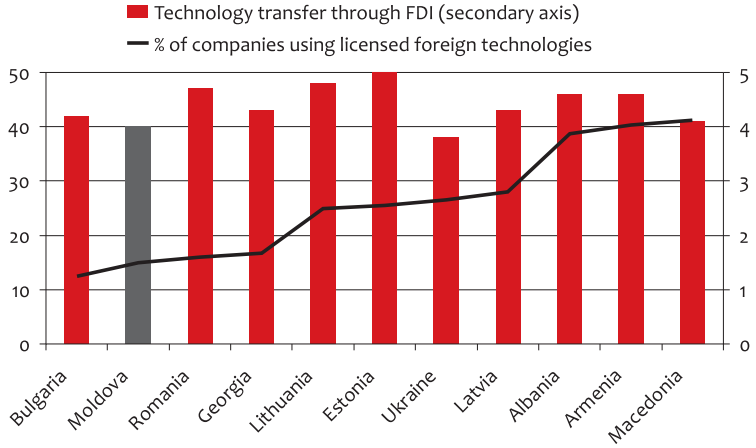
Chart 7. WEF score for University Industry collaboration in R&D, 2009-2010



Note: The score was calculated based on answers to the questions „To what extent do business and universities collaborate on research and development (R&D) in your country?" [1 = do not collaborate at all; 7 = collaborate extensively], 2009–2010 weighted average.
Source: Global Competitiveness Report, WEF, 2010-2011.

Despite poor performance of the domestic R&D sector, economies may still be competitive if new technologies are introduced in the country trough technological transfer and/or by companies with foreign capital. However, even in this respect Moldova is behind most transition economies, as suggested by low share of companies using foreign technologies.

Chart 8. Companies using foreign technologies and technological transfer through FDI

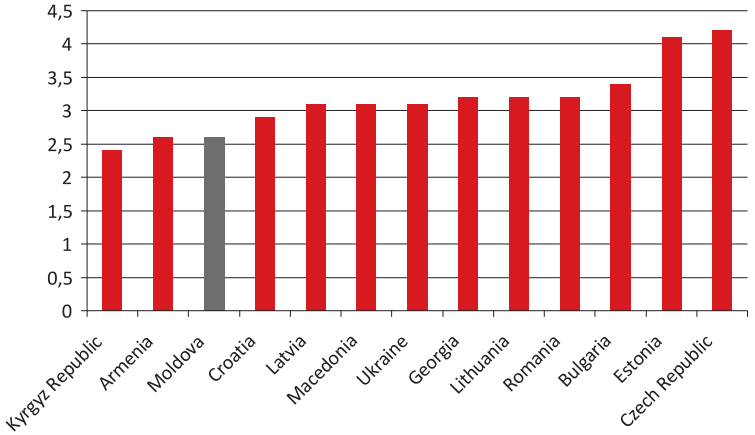


Note: The score was calculated based on answers to the questions „ To what extent does foreign direct investment (FDI) bring new technology into your country?" [1 = not at all; 7 = FDI is a key source of new technology], 2009–10 weighted average.
Source: Global Competitiveness Report, WEF, 2010-2011.*; Enterprise Survey 2009, WB.*

Government's implication in the acquisition of new technologies is also limited. Non-effective use of available financial resources and deficiencies of R&D policy, place Moldova on a quite low position regarding the procurement of advanced technology products.

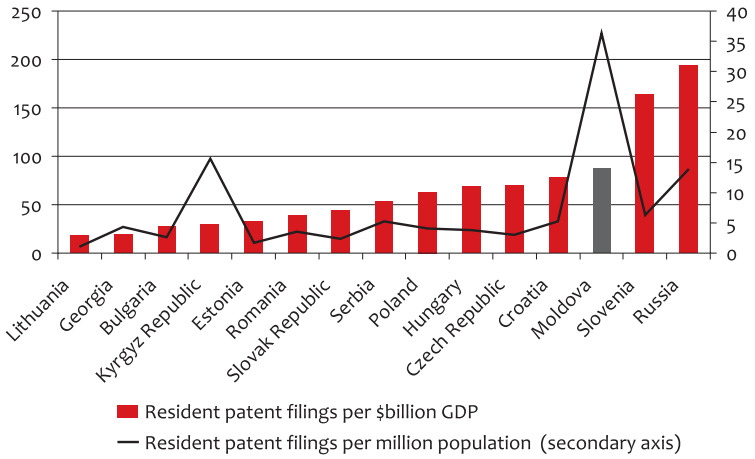
On the other hand, data on patent applications from residents of Moldova at the National Intellectual Property Agency (AGEPI) show a relatively impressive achievement when compared to the number of population and the size of economy (Chart 9).

Chart 9. WEF score for Government procurement of advanced technology products, 2009-2010



Note: The score was calculated based on answers to the questions „Do government procurement decisions foster technological innovation in your country?" [1 = no, not at all; 7 = yes, extremely effectively], 2009–10 weighted average.
Source: Global Competitiveness Report 2010-2011, WEF.

Chart 10. Number of residents' patent applications, 2007



Source: WIPO.

High number of patent application in Moldova is explained by low costs of patent registration in the country[1]. However, the applicability of protected inventions is much lower, as suggested by the number of renewed patents. At the end of 2009 only 1162 patents were in force (only 31% of the granted patents) and only 282 had duration of over 5 years (7% of granted patents and 24% of valid patents). This can be explained by the remission from taxes for a period of five years of individuals certified in R&D sector. Another indicator of usability of inventions is the transfer of rights over the economic utilization of the inventions, but this may not be suggestive for Moldova as there is no legal obligation to register cession and license contracts at AGEPI. The low share of patents in the companies' assets in Moldova (that varies between 0.9% and 4.9%) also suggest low applicability of registered inventions[2].

Moldova performs poorly also at science component. It is placed on the 93rd position (out of 178 countries) according to the number of published documents between 1996-2007 (Table 3). Although the number of documents may not be a relevant criterion for the ranking, because it depends on the population of the country, the change in ranking may be more suggestive. Moldova moved down in ranking from 82nd position in 1996 to 101st position in 2008.

According to the H index that attempts to measure both the productivity and impact of the published work of a country, Moldova is on 103rd place (H index=42), but this has not changed significantly over the years. The index is based on the set of the country's most cited papers and the number of citations that they have received in other countries' publications. In the most important journals' databases (Thomson Reuters ISI Web of Knowledge and Scopus) there are no publications from Moldova included.

[1] Low taxes before 2008 and considerable discounts for national applicants after 2008.
[2] Integrarea activelor nemateriale în bunurile corporative, Badîr Iurie, Cravcenco Raisa, Intellectus 1/2009, p.59-64.

Table 3. Country ranking on number of scientific publications, 1996-2008

Rank	Country	Documents	Citable documents	Citations	Self-Citations	Citations per Document	H index
30	Czech Republic	93,563	91,278	649,726	165,673	7.69	168
33	Ukraine	74,325	73,902	253,451	75,267	3.46	106
41	Romania	42,320	41,858	186,021	45,957	5.24	97
44	Slovakia	35,274	34,417	211,727	49,365	6.39	114
45	Croatia	31,748	30,897	145,119	36,722	5.14	95
46	Bulgaria	29,893	29,399	174,697	34,490	6.2	101
47	Slovenia	29,493	28,922	192,212	44,163	7.37	106
54	Belarus	17,401	17,322	68,529	15,867	4	76
58	Lithuania	12,834	12,650	72,953	16,624	7.32	83
61	Estonia	10,647	10,489	102,112	20,250	11.04	94
72	Armenia	5,610	5,548	35,844	6,783	6.64	72
74	Latvia	5,426	5,374	38,170	6,157	7.4	65
75	Serbia	5,280	5,157	6,428	1,977	2.55	20
78	Georgia	4,490	4,426	27,136	3,897	6.68	58
93	Moldova	3,020	2,997	14,064	3,160	4.8	42
97	Macedonia	2,201	2,136	11,675	2,071	6.2	41
134	Albania	649	630	3,703	403	6.3	28
139	Kyrgyzstan	589	584	2,430	251	4.7	22

Source: SCImago Journal & Country Rank, http://www.scimagojr.com

Problems and Options for Moldovan R&D Sector

As shown in the above chapters, the R&D sector in Moldova is specific and faces serious drawbacks that determine low returns of investments in R&D. The need of changes in the system is obvious and there are several issues that should be addressed.

- ***Excessive centralization of R&D activity.*** One single institution – ASM – is responsible for the whole R&D process. ASM is responsible for the elaboration of the strategy in science and innovation field, choice of strategic directions for R&D field, distribution of budgetary funds according to the strategic directions, elaboration of control mechanisms of the results of R&D activity, financing of scientific journals and scientific libraries, training of research staff. ASM has 19 institutional members (18 accredited) that conduct research and are the main beneficiaries of the budgetary funds for R&D. Many research institutions have poor linkages with potential users of research. ASM also manages the technological transfer through AITT which is an auxiliary institution subordinated to ASM.
- ***High share of expenditures for basic research.*** Basic research benefits from around one third of actual research expenditures[1]. Basic research is conducted for the acquirement of new knowledge. It is useful and demands significant financial resources. At the same time, the outputs of basic research do not necessarily bring economic benefits, a fact that determines the low interest of private sector to conduct/support it. Therefore, public financing of basic research is indispensable. However, in most of the developed countries the share of total funding directed to basic re-

[1] Law on state budget for 2010 no. 133 from 23.12.2009.

search is much lower. The largest share goes to oriented research (applied and experimental), due to the co-financed by the private sector. In EU countries the largest share of R&D spending goes to applied research, while in US, China, Japan and Russia it goes to experimental research[1]. The distribution of expenditures between different types of researches contributes to the magnitude of achievements of R&D sector.

- ***Non-participation of private sector in the R&D activities***. In Moldova the R&D sector is almost entirely financed from public money. The R&D activity is almost lacking in the private sector, either because the economic activity of most companies takes place in the lower technological end, or because the low profitability of the companies does not provide enough resources for these types of investment and because of the very low chances of benefiting of public co-finance. In EU countries private R&D expenditures represent above 50% of total R&D expenditures (37% in new EU member-states), while in US, China and Japan the rate is even higher. At the same time, private R&D has higher output elasticity than public R&D and physical capital investments. The low level of privately-financed R&D activities also diminishes the return to R&D[2]. However, this study was conducted on developed economies, other studies suggest that government spending on R&D is a partial substitute of business spending on R&D in the less developed economies due to the general lack of business interest in domestic R&D. At the same time, public R&D spending should offer clear and positive incentives for private R&D[3].
- ***Low level of FDI in Moldova***. Although a direct correlation between the level of FDI and the efficiency of R&D expenditures might not be evident, there is some evidence indicating over the different impact of different types of R&D

[1] Franc, Simona. 2006. "R&D expenditure in Europe". European Communities. Statistics in Focus 6/2006.

[2] Park, Walter G. 1995. "International R&D Spillovers and OECD Economic Growth." Economic Inquiry XXXIII: 571-591.

[3] Torok, Adam, Balazs Borsi and Andras Telcs. 2005. Competitiveness in Research and Development: Comparisons and Performances.

expenditures - business R&D, public R&D and foreign business R&D - on productivity growth. According to a study, the long-term elasticity of foreign R&D on productivity is three times higher than domestic business R&D elasticity[1]. And smaller countries benefit even more from foreign R&D than larger ones. Also, the FDI were the main determinants in the expansion of some industries in developing countries (as for example automotive sector in Czech Republic and Slovakia, or pharmaceutical Industry in Hungary and Slovenia), which stimulated the national investment in the sector, including R&D investment in mid- and long-term.

- ***Low involvement of universities in R&D process.*** Although 12 higher educational institutions are accredited by the NCAA and can benefit from public money for R&D projects, their actual involvement is very low as a result of the current system, which discourages cooperation with industry and applied R&D activities. A study that makes a detailed evaluation of the effect of different types of public R&D on productivity for OECD countries finds that the elasticity of public R&D is positively affected by the share of universities as opposed to government laboratories in public research[2].
- ***Quality of research staff.*** There are very tight and important relations between R&D and education. Quality of education and especially of BS, MS and PhD programmes is crucial for the R&D sector as it provides the necessary knowledge and abilities to students and generates the incentives to use their knowledge under new conditions in creative ways. The universities should educate also by doing R&D. The situation will be getting worse in time if this will not change as information dates much more faster now than in the past - innovation cycle is much quicker. Unfortunately, the quality of Moldovan educational system decreased during the transition period, ultimately reflected in the quality of human capital. This is not only a constraint for research

[1] Guellec, Dominique and Bruno van Pottelsberghe de la Potterie. 2001. "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries." OECD Economic Studies No. 33.

[2] Guellec, Dominique and Bruno van Pottelsberghe de la Potterie. 2001. "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries." OECD Economic Studies No. 33.

activities, but also a determinant of low labour productivity and low value-added across all economic activities in the country that impede the transition to an economy based on competitiveness and innovation.

Thus, based on the mentioned deficiencies of R&D sector and on experience of several countries with high RDI achievements, several important changes are needed in order to improve Moldovan innovation capacity. The suggested changes include:

- ***A clear division between basic and applied research is necessary, with separate funds and separate financing policies for the two components***. The largest share of public resources should be directed to applied and experimental/development research plus conditions must be created where results of applied research can be applied by industry. As basic research is conducted for the acquisition of new knowledge and does not always have measurable economic benefits, we can expect a higher interest for this type of research from public institutions (ASM institutional members and universities). The allocated public funds for research should reflect the expected benefits of the new knowledge/product/service/technology developed. State may finance up to 100% of basic research projects and a lower share of applied and development research projects, promoting co-financing from the public sector. This is the EU practice, where the possible level of state contribution to the basic research is up to 100% of the costs, to applied research – up to 50% of the costs and to the development research – up to 25% of the costs[1]. Also, some R&D institutions that meet the conditioned of the EC framework on public support of R&D and innovation and may also get 100% support, for both basic and applied research. Some differential criteria may be introduced, for example, higher share of public funds for projects coming from the SMEs sector.

[1] National research and development policy of the Czech Republic approved by Governmental Resolution from January 5, No. 16, 2000

- ***R&D strategy of the country should be defined by the councils*** composed of top government figures (e.g. prime minister) ministers from relevant ministries (education, economy, industry), Academy of Sciences, representatives of universities and representatives of the private sector (companies engaged in R&D). National R&D policy should be in line with industrial policy and general economic development policy. Applied research should be supported in the same priority areas which are/will be supported in industrial policy - there should be a match.
- ***Government should not define priorities for the basic research, so that it does not predetermines the main beneficiaries of the public funds***. The area of research is determined by the researches and/or institution and it must respect only the internationally recognized moral and ethic principles. However, the state should develop a clear mechanism of the evaluation of such projects, as public resources are limited and cannot cover all potential projects. The state may use such evaluation criteria as the expected results of the project, the probability of success of the project. At the same time, some priority fields can be set for oriented research that are in line with the priorities of the development of the country.
- ***ASM should further manage basic research, by evaluating project proposals, deciding on the public financing of the research projects and evaluating research results***. For example Finland has a system of evaluation of government programs which determines their impact on jobs, turnover and exports, and so improves the performance both of the programs and the companies involved[1]. The stipulation regarding the accreditation of the research institutions may stay in force for the basic research, but the accreditation of the institutions should be transparent and fair, with equal chances for ASM institutions, universities and private sector.

[1] Roos, Goran et all. "National innovation systems: Finland, Sweden & Australia compared. Learnings for Australia", 2005.

- ***At the same time, oriented research, technological transfer and innovation should be managed by a separate institution***. International experience shows that this competence may be delegated to one or few resort ministries. In Czech Republic this responsibility was delegated to Ministry of Industry and Trade that co-finance R&D activities in business enterprises through CzechInvest until recently. In Sweden, the model is more complicated, with several ministries being involved: Ministry of Education, Research and Culture that finances mostly universities (and spending for this about 52% of total public R&D expenditures), Ministry of Industry, Employment and Communication (13%), Ministry of Sustainable Development (3%) and Ministry of Defense (20.5%)[1]. But it is not sufficient to delegate responsibility to any individual ministry, agency or department; all the main actors, including industry, universities, labour market organizations and other central players must be represented in the policy discussion.
- ***When resources are scarce, they should be focused on specific industry clusters***. This is suggested by the Finish experience of investing public resources in specific industries. To facilitate specialization and positive externalities, it is necessary to promote linkages, knowledge flows, and technology diffusion within the cluster[2]. Priority areas for R&D - should be in line with the national industrial policy - priority areas for development of companies - and with the general national policy for economic growth.
- ***Stimulation of R&D activity by additional incentives may be necessary in order to get the sector a new development impulse***. Although there are already some benefits for institutions and companies that conduct R&D activities, such as VAT exemption at the import of goods and services for research purposes and income tax exemptions before 2008, these were not very efficient to stimulate private investments. In case of reintroduction of corporate income tax

[1] Andersson, Thomas and Ejermo, Olaf, "Effort and Performance of R&D in Sweden", IKED, 2005.

[2] Roos, Goran et all. "National innovation systems: Finland, Sweden & Australia compared. Learnings for Australia", 2005.

in Moldova investments in R&D should be 100% tax deductible[1]. Also, partial or total deduction of expenditures on purchased research outputs from public R&D institutions may have a positive impact on research activity. This should be paired with stimulation of universities and R&D institutions to collaborate with the industry and sell the results of R&D to them.

- ***All education competences should belong to the Ministry of Education***. Implication of science academies in the education process is unusual in most of the countries. Nevertheless, in Moldova, ASM manages an elitist secondary school and a university. These should be transferred to the Ministry of Education. Also, the PhD programs should be included as the third stage of university education and managed by the Ministry of Education.
- ***At the same time, the educational system, especially tertiary and post-graduate education, should be reformed in order to provide valuable human resources capable to be engaged in research activity***. The most important actions to be undertaken are the creation of an independent agency for accreditation of educational institutions and promotion of collaboration between national and international universities, including the facilitation of establishment of branches of foreign universities in Moldova.
- ***Engage Moldova more actively in international R&D collaboration***: adapting the legislation for international cooperation in R&D activities (joint financed projects), bilateral cooperation between research organizations, including an increase in international mobility of researchers involved in R&D.
- ***Promote of public and private partnerships in innovation***. If the decentralization of R&D sector takes place and the research policy is amended, the cooperation between universities and private companies is very feasible. Finish experience indicates that networking between industry and

[1] Currently the legislation stipulates that R&D expenditures are tax deductible in the presence of evidence that these were necessary for the company activity and development, which sometimes is difficult to prove to the tax officers.

science can increase essentially the research outputs. In the mid-1990s, in Finland, 40% of all innovative firms reported that they cooperated with universities or public research institutions[1].

- ***Elimination of discriminatory treatment towards private entities*** such as the provision that only institutional members of ASM can be beneficiaries of projects financed entirely from budgetary resources.
- ***Further develop the R&D support infrastructure***. In this respect, the list of necessary actions would include consolidation of scientific parks and incubators capacity by facilitation of access to appropriate space, training of the management team, support from local research institutions and rational co-financing of their activity.
- ***Reformed Moldovan R&D system should be compatible with the system in the EU countries.*** Of course it is possible to develop systems comparable with other non-EU neighbor countries, but Moldova may benefit in the future of EU funds that can be an important source of finance of R&D sector in case of compliance with EU systems and requirements.

[1] Roos, Goran et all. "National innovation systems: Finland, Sweden & Australia compared. Learnings for Australia", 2005.

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