Science and Technology

საქართველოს კვლევებისა და განვითარების სისტემა 1996-2005 წლებში

გოგოძე სოსო
ტექინფორმი
ურიდია მერაბი
საქართველოს უნივერსიტეტი

სტატიაში წარმოდგენილი და გაანალიზებულია ძირითადი მაჩვენებლები, რომლებიც ასახავენ საქართველოს კვლევებისა და განვითარების სისტემის დინამიკას 1996-2005 წლებში, და განხორციელებულია მათი შედარება ევროპა-ცენტრალური აზიის რეგიონის შესაბამის მაჩვენებლებთან. მიღებული შედარების ანალიზის შედეგად შეგვიძლია დავასკვნათ, რომ საანალიზო პერიოდში საქართველომ ვერ შეძლო კვლევებისა და განვითარების საკუთარი სისტემის სათანადო უზრუნველყოფა და რამდენადმე ეფექტურად მართვა.

Georgian Research and Development System in 1996-2005

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In the modern world the level of science and technology development becomes the most important precondition for the development of a given country and the wealth of its population.

The process of transition to a market economy entails gradual changes in the character of Research and Development institutions' activities, conditioned by their attempts to adjust to the new situation and survive under difficult financial conditions.

The aim of this paper is to study statistical characteristics of the Research and Development (R&D) system of Georgia in 1996-2005 and compare them with corresponding characteristics of the R&D systems for the Europe-Central Asia region.

We consider main short-term and long-term tendencies, which characterize dynamics of personnel, management, and funding of the R&D system of the following two country groups: Countries of the Europe - Central Asia (ECA) region and successor-states of the former Soviet Union. As a result, we are able to position Georgia in relation to each of these two groups. The essential part of our analysis is based on the individual data of the ECA countries.

As a corollary of presented data, we conclude that in the period under study Georgia could not secure funding of its own R&D system and could not efficiently manage it. As a result, Georgia's R&D system became plagued with a significant shortage of personnel which is by no means restorable in a short time.

By the key indicators of the R&D system, Georgia is behind the leading Soviet successor states and has a very weak position in the ECA region overall.

Method

Data sources

The following information was collected to study R&D activities of the ECA countries in 1991-2005:

ResPat - number of patents granted to residents, according to the data of the World Intellectual Property Organization (WIPO).

Source: WIPO, http://www.wipo.int/ipstats/en/statistics/patents/index.html.

USPat - Number of patents granted by the United States Patent and Trademark Office (USPTO).

Source: USPTO, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.

EUPat - Number of patents granted by the European Patent Office (EPO).

Source: OECD; http://stats.oecd.org/wbos/Index.

Number of personnel involved in R&D.

Source: UNESCO; http://stats.uis.unesco.org.

Number of researchers.

Source: UNESCO; http://stats.uis.unesco.org.

R&D funds (% GDP).

Source: UNESCO; http://stats.uis.unesco.org.

Gross domestic product (in 2000 international US dollars).

Source: WB, http://web.worldbank.org/website/external/datastatistics.

Income groups according to the official classification of the World Bank.

Source: WB, http://web.worldbank.org/website/external/datastatistics.

Pop - number of resident population.

Source: WB, http://web.worldbank.org/website/external/datastatistics .

Sampling

In accordance with the classification of the World Bank, the total number of ECA countries is 56. Because of their specifics or specific phase of development, several countries show distinguished, non-typical innovation activity for the period 1995-2005. At the preliminary stage of research, we decided that it is expedient to separate these countries. For this purpose, we use demographic and patent activity criteria. At the first stage, we set aside countries with population less then 250,000 (the demographic criterion). According to this criterion, we left out the following countries: Andorra, Channel Islands, Faroe Islands, Greenland, Isle of Man, Liechtenstein, Monaco, and San Marino. At the second stage, we separate countries with total (international as well as domestic) average annual patent activity of less than 0.1 patent granted per 1 million residents in 1991-2005 (the patent activity criterion). According to this criterion, we excluded the following countries: Albania, Macedonia, Montenegro, and Serbia. Thus, the final sampling of ECA region countries consists of 44 states (Table1).

Table 1.

Final sampling of ECA countries

ARM	Armenia	FIN	Finland	LTU	Lithuania	SWE	Sweden
AUT	Austria	FRA	France	LUX	Luxembourg	CHE	Switzerland
AZE	Azerbaijan	GEO	Georgia	MDA	Moldova	TJK	Tajikistan
BLR	Belarus	DEU	German	NLD	Netherlands	TUR	Turkey
BEL	Belgium	GRC	Greece	NOR	Norway	TKM	Turkmeni-stan
BIH	Bosnia-Herzegovina	HUN	Hungary	POL	Poland	UKR	Ukraine
BGR	Bulgaria	ISL	Island	PRT	Portugal	GBR	United King-dom
HRV	Croatia	IRL	Ireland	ROM	Romania	UZB	Uzbekistan
CYP	Cyprus	ITA	Italy	RUS	Russian Fed.	UK	United Kingdom
CYP	Czech	KAZ	Kazakhstan	SVK	Slovak Rep.		
DNK	Denmark	KGZ	Kirghiz Rep.	SVN	Slovenia		
EST	Estonia	LVA	Latvia.	ESP	Spain		

Data preparation

Preliminary analyses show that the difference between the R&D activities of the countries also depends on the category of income they belong to. Considering this circumstance and the small size of sampling, we group countries into two classes – Lower-income countries and Upper-income countries. Our classification amalgamates the official classification of the World Bank, which is based on special methodology and groups countries into four different classes: Low-income countries, Lower-middle-income countries, Upper-middle-income countries, and High-income countries. The group of countries with Upper-income in our classification consists of countries, which by the World Bank classification, are placed in the group of High- income and Upper-middle-income. The group of countries with Lower-income consists of countries, which by the World Bank classification are placed in the group of Low-income and Lower-middle-income. The totality of the group of countries with Lower-income had been changing to some extent in years 1991-2005, but in essence it is represented by the countries of the former Eastern Bloc.

We also present data which reflect dependence of the effectiveness of the R&D system in the institutional environment in which it is functioning. We estimate the functioning quality of the R&D system by the patent activity. We use the following relative indicators: ResPatPop, USPatPop, and EUPatPop. These indicators represent patent activity per one million inhabitants:

ResPatPop $=10^6$ ResPat/Pop, USPatPop $=10^6$ USPat/Pop, EUPatPop $=10^6$ EUPat/Pop.

Essential correlation between the indicators USPatPop and EUPatPop suggests unifying them in one integrated indicator of the international patent activity:

IntPatPop = USPatPop + EUPatPop.

There is one more reason which justifies introduction of this integrated indicator. Preliminary analysis shows that in the period under study the ECA region countries with lower- income did not have distinct preferences while choosing patent offices for international patent aims. We think that analysis conducted on the basis of patents granted only by USPTO or EPO patent offices would detract from the real estimation of possibilities of countries with Lower-income.

To characterize the institutional environment in which the R&D system is functioning, we use six indicators of governance quality which has been tracked by the World Bank since 1996 (Kaufmann, Kraay, & Mastruzzi, 2009). The indicators reflect a relative condition of the country by the following six attributes of governance quality:

Voice and Accountability (VA) – capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

Political Stability (PS) – capturing perceptions of the probability that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

Government Effectiveness (GE) – capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Regulatory Quality (RQ) – capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

Rule of Law (RL) – capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Control of Corruption (CC) – capturing perceptions of the extent to which public power is used for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

Described indicators strongly correlate. This is the reason why we use an integrated indicator of governance quality.

G= (VA + PS + GE + RQ + RL + CC)/6.

Results

In 1996-2005, the R&D system of Georgia was characterized by a sharp decline of financial and personnel security. This situation can be explained by two main factors. First is the combination of influences generally characteristic of transition economics (Radosevic, 2003). The second factor is reflects the specific circumstances characteristic of Georgia.

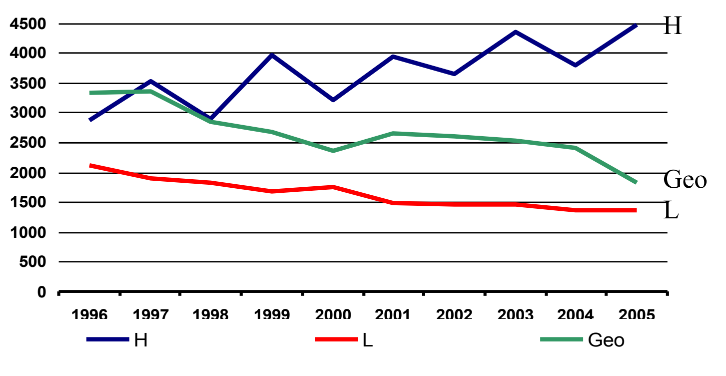

Fig.1.

Researchers (HC) per 1 million inhabitants.
H-ECA countries with Upper-income.
L-ECA countries with Lower-income. Geo- Georgia.

In the period under study, the number of researchers in the R&D system of Georgia per one million inhabitants has significantly decreased. The range of decrease in the period 1996-2005 varies from approximately 3,500 to 1,800 persons per one million inhabitants. In 1996, this number was in close correspondence with the average number of researchers per one million inhabitants for Upper-income ECA countries. In 2005 this number practically became equal to average number of researchers per one million inhabitants for Lower-income ECA region countries (Fig.1).

As far as Georgia belongs to the group of ECA region countries with Lower-income, one may consider these circumstances less important. On the other hand, if we take into consideration all the difficulties inevitably associated with reproduction of scientific personnel, we definitely have a reason to worry. Comparison with the former Soviet States (Fig. 2) shows that the Baltic states, which are demographically close to Georgia, managed much better in taking care of their scientific personnel. In particular, the number of researchers in Estonia in 2005 came closer to the average index of counties with Upper-income. We think this fact is directly connected with Estonia's progress in the development of knowledge-oriented highly effective economy.

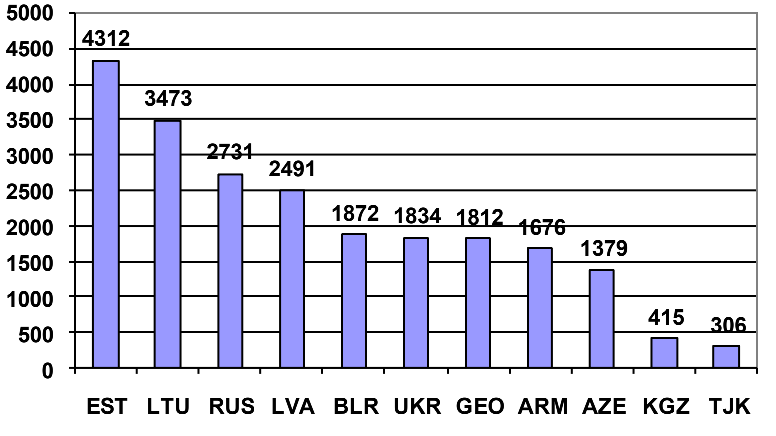

Fig.2. Researchers (HC) per 1 million inhabitants, former USSR countries, 2005

The structure of the R&D personnel in Georgia has changed essentially. In particular, the share of researchers in the whole R&D personnel decreased significantly from 85% in 1996-1998 to 60% in 2005. Note that at the beginning of 21st century the average of this indicator for the EU member-states was 59% and for the non-EU states from the ECA region - 65%. Thus, one may say that Georgia approaches the "European level," but on the other hand the specific pattern in Georgia in 1996-2005 was that, simultaneously with the 3.3% average annual decrease in the number of the R&D personnel and 6.8% decrease in the number of researchers, the annual growth in the number of assistant personnel was on average 10.3%.

Gross domestic expenditure on R&D (GERD) as % of the GDP reached its minimum in 2000 at about 0.2% and has stayed steady on this level until 2006 (Fig. 3). This is two times less than the average levels of this indicator for the Lower-income countries of the ECA region. Note that in 2001-2005 this indicator in Estonia was 0.8%, in Russia -1.19% (Fig. 4), and the average for the Upper-income ECA countries was approximately 1.5%.

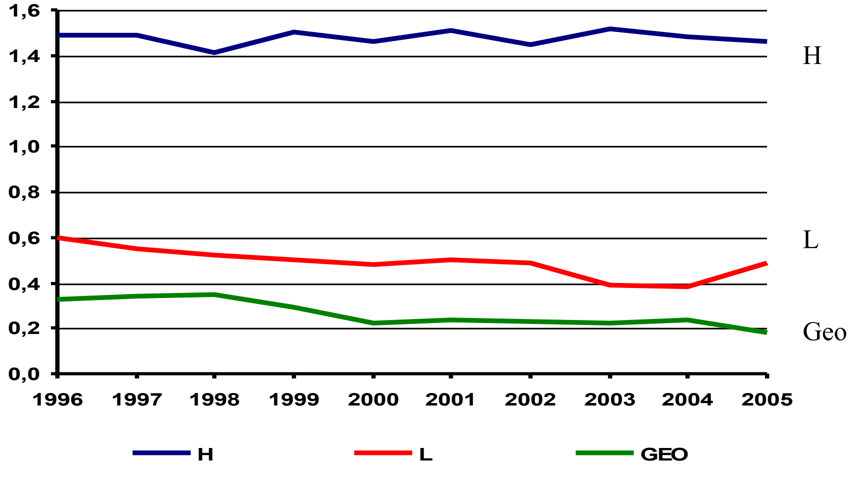

Fig.3. Gross domestic expenditure on R&D (%GDP)
H-ECA countries with Upper-income.
L-ECA countries with Lower-income.
Geo-Georgia.

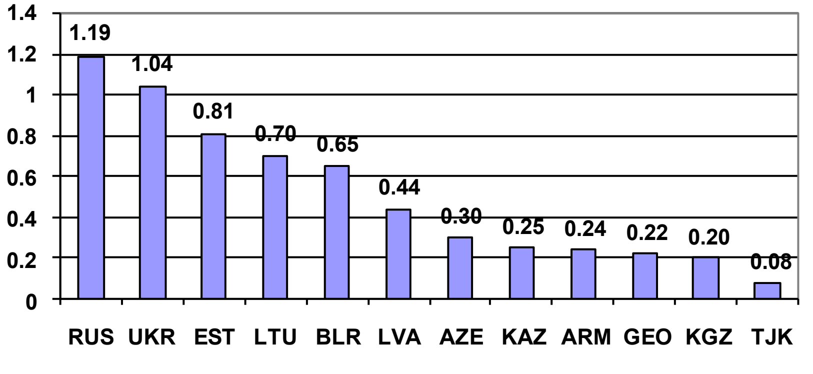

Fig.4.Gross domestic expenditure on R&D (%GDP), former USSR countries, 2005

The picture is even more dramatic when we consider the comparison of R&D funds per one researcher (Fig. 5). In particular, in 2005 Georgian R&D funds in total were 2,972 $PPP 2000 which is practically 10 times less than the same indicator for Russia, Ukraine, the Baltic states, and Belarus (Fig. 6).

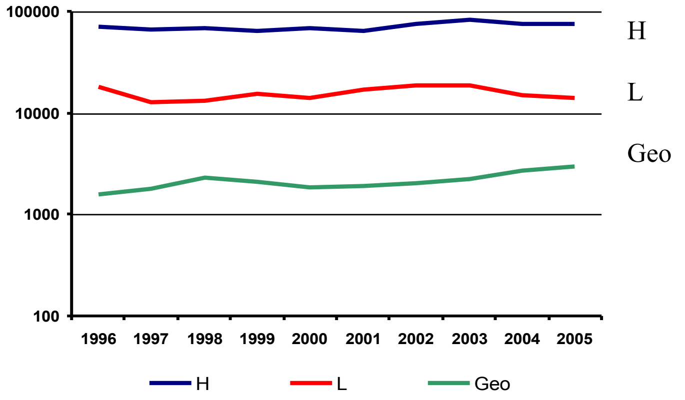

Fig.5. Gross domestic expenditure (USD-2000 PPP per Researcher)
H-ECA countries with Upper-income.
L-ECA countries with Lower-income.
Geo-Georgia.

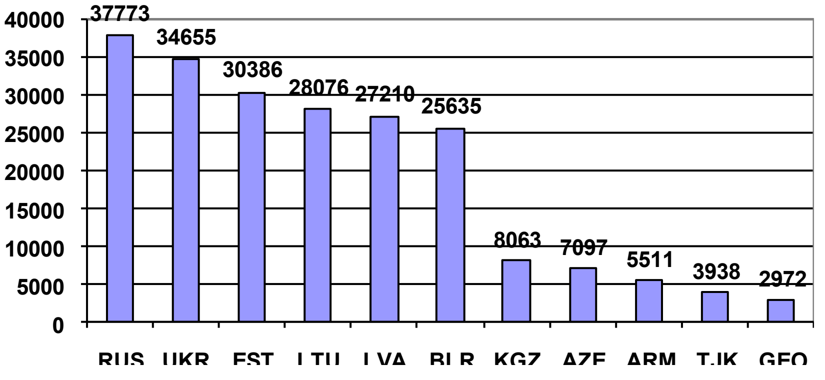

Fig.6. Gross domestic expenditure (USD-2000 PPP per Researcher) former USSR countries, 2005

We must mention that the sharp decrease of financial support for the R&D sector in Georgia began in 1991, when the USSR as well as the Soviet R&D system stopped functioning. This was the period, when Georgia (as well as other Soviet successor states) began to take care of its own R&D system independently. It is a deplorable fact that for objective or subjective reasons – mainly because of the lack of necessary political will - Georgia failed to manage its R&D system to any extent. Moreover, Georgia could not even find the necessary funds to protect its R&D system from structural disintegration.

We also have to mention that no data concerning formation and distribution of funds for the R&D system of Georgia could be found in the UNESCO database. Neither can one find any trends of expenditure of these funds in the years 1995-2005. This means that aforementioned data was not delivered to the UNESCO or quality of the data was unsatisfactory. It is only natural to suppose that this fact in itself reflects the approach to the R&D system from the general institutional point of view. It also reveals the level of government management of this area in the period 1995-2005. The influence of the general institutional environment on the quality of functionality of the R&D system is proved by the following observation. If we consider IntPatPop and ResPatPop as indicators of the quality of functionality of the R&D system in a given country and G as an indicator of the institutional environment of this country, then after necessary calculation we will see that the natural logarithm of IntPatPop - ln(IntPatPop) is strongly correlated with G in the positive direction (coefficient of correlation k=0.89). This shows the importance of the general institutional environment on the functionality of the R&D system. We have to mention one consequence of the conducted analysis. There is an interesting observation about how the indicator G relates with the residential patent activity. If we exclude from sampling Armenia, Georgia, Moldova, Russia, Ukraine, and Uzbekistan (we have to point out that we could not get data for domestic patent activity in 2005 of Azerbaijan, Belarus, Kazakhstan, Kyrgyz Republic, Tajikistan, and Turkmenistan), then the indicator G and ln(ResPatpop) are strongly correlated in the positive direction with coefficient k=0.68, whereas the coefficient of correlation k is equal to 0.35 if these countries are included in the sample. We hypothesized that the patent offices of these countries overestimate the degree of innovation in the work of resident inventors. This also characterizes the institutional environment in which the R&D system of Georgia is functioning. Certainly this fact is a post -Soviet "syndrome" and is not characteristic of Georgia only.

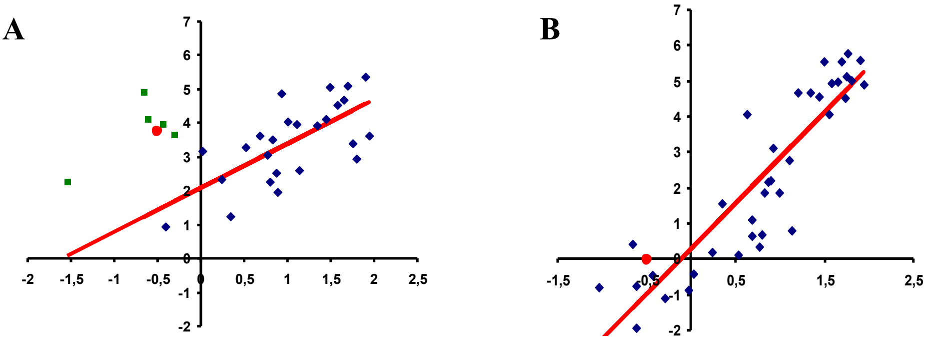

Fig.7. Relation between patent activity and governance quality 2005
A) Vertical axis – ln(ResPatPop) B) Vertical axis – ln(IntPatPop); Horizontal axis – Governance Quality Indicator G. Star-Georgia, Squares-former USSR republics except Baltic States, Rhombuses-other countries from sampling.

After becoming independent, Georgia began to resume inner patent activity only in 1993 and granted first 19 patents to its residents. First international patent (registered in USPTO) was granted to residents of Georgia in 1995. In total in years 1991-2005 Georgia granted 2053 patents to its residents. Also residents of Georgia obtained 38 international patents (registered in USPTO and EPO), from which 20 were done with co-authorship with foreign colleagues (1 with a resident of Czech Republic, 2-Germany, 4-UK, 1-Finland, 6-US, and 11-Russia). Table 2 gives the structure according to main sections of the international patent classification (IPC) of the stream of patents registered in patent offices of Europe and US in years 1991-2005.

Table 2.

		World	Georgia
A	HUMAN NECESSITIES	14.6%	46.0%
B	PERFORMING OPERATIONS, TRANSPORTING	19.2%	-
C	CHEMISTRY, METALLURGY	13.2%	4.0%
D	TEXTILES, PAPER	1.3%	-
E	FIXED CONSTRUCTIONS	2.8%	-
F	MECHANICAL ENGINEERING, LIGHTING, HEATING, WEAPONS, BLASTING	8.4%	9.7%
G	PHYSICS	21.7%	11.0%
H	ELECTRICITY	18.8%	29.3%

As described on the diagram below, in 1991-2005 the international patent activity of Georgia has middle rating among former Soviet states (Fig.8). At the same time, Georgia is far behind the leaders of this group.

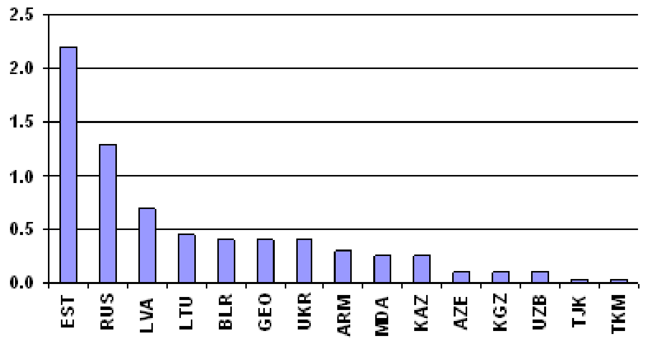

Fig.8. Patents granted by UPSTO and EPO (Unit per 1 000000 inhabitants) former USSR countries, 1991-2005

Probably this circumstance has systematic character and middle average rating of patent activity of Georgia is explained by the influence of certain inertial factors. The same is shown by analysis of the annual patent activity (Gogodze I., Chubinishvili T. 2009). It seems that the R&D system of Georgia is exploiting its early achievements and this resource is probably being exhausted in short time.

Discussion

By analyzing the statistical data presented above, we conclude that in the period under study:

- The R&D system of Georgia suffered from a significant shortage of personnel which is by no means restorable in a short time.
- Due to certain circumstances, in particular because of the lack of political will, Georgia could not protect its R&D system by adequately funding it and therefore could not effectively govern it.

As a result, from the point of view of its productivity, Georgia's R&D system does not display a distinct tendency of growth in the period under study. This shows its orientation on exploitation of the early achievements. Thus, by the key indicators of the R&D system, Georgia is rather behind the leading Soviet successor state and has a very weak position in the ECA region. This is determined by causes of a systemic character and is related to several factors, which negatively affect the functionality of the R&D system of Georgia.

Presented material underlines the following problems:

- Disintegration of the old structure of relations in the science and technology sector and difficulties creating a new one.
- Disadvantageous institutional environment for innovational activity.
- A lack of clear goals and policy in the R&D sector.

The listed factors as well as other reasons had a negative impact on the effectiveness of the R&D system of Georgia in the period under study.

We think that investigation of the factors (non-advantageous as well as assistant), which define the functionality of the R&D system of Georgia, and analysis of their quantity must be a subject of detailed future research. This kind of research will definitely be an important step towards determination of a necessary policy for raising the effectiveness of the R&D system of Georgia.

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