Research performance in Georgia: analysis and recommendations

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LIST OF ACRONYMS

- AI: Activity Index
- CERN: Conseil Européen pour la Recherche Nucléaire (European Council for Nuclear Research)
- CI: Citation Impact
- CI: Citation Impact Index
- GERD: Gross Expenditure on Research and Development
- H index: Hirsch index
- IFEF: Internal Field Efficiency Index
- IP: intellectual property
- LEPL: Legal Entities of Public Law
- RSI: Relative Specialization Index
- SRNSF: Shota Rustaveli National Science Foundation
- WIPO: World Intellectual Property Organization

EXECUTIVE SUMMARY

- The remarkable resilience of the research community is the main strength of Georgian research today and the main reason why there is something left to save.
    - Georgia has managed to maintain areas of excellence, notably in physics, mathematics and to a lesser extent in medical and health sciences.
    - In terms of publications, it has a quantitatively lower, but qualitatively higher (impact) output than comparable former Soviet Countries. However, approximately 80% of Georgia's total output is produced in the frame of joint projects with other countries.
    - The main partner countries are USA, Germany, Russia and Italy, with physics as the leading field.
    - In spite of the average age of its members and in sharp contrast with existing research equipment and facilities, the Georgian research community has already adopted a twenty first century research lifestyle, from peer review and bibliometric assessment to competitive funding. All the researchers we met are prepared and willing to have their work assessed.

- The problems that have plagued Georgian research for years are now producing visible effects and the window to resolve them has narrowed to the point that timing has become a problem on its own.
    - The first problem is economic: given its current budget, Georgian research is no longer funded. This explains Georgia's relative decline in patent filings. The degraded image of the the National Science Foundation is another consequence: established to promote excellence in scientific research, it has *de facto* become an institution whose primary task is to manage scarcity in research funding.
    - The second problem is organizational: universities and institutes have been formally merged in 2010 to bring research into academia, but professors and researchers have kept a different status and the latter remain significantly disadvantaged in terms of salary, career prospects and working conditions.
    - The third problem is a consequence of the first two: higher education institutions no longer produce researchers. This threatens Georgian research as a whole: the country lacks a new generation of scientists capable and willing to take over a research sector predominantly populated by aging researchers that will retire in the next few years. It is thus critical to ensure that both the forthcoming reform of higher education and Georgia's innovation policy introduce incentives to go to science: doctoral studies should be the first stage of a research career track with clear options and rewards.

- Due to the current scarcity of research funding, research fields must be prioritized. This is a difficult task everywhere. In Georgia it is even more difficult because:
    - It means that some fields will be purely and simply abandoned if the research budget is not significantly increased.
    - The current picture of Georgian research is incomplete: bibliometric databases bring little insight about the research output in a number of fields (e.g. in social science and humanities). For these fields, a differentiated, peer review analysis is thus required. This means that the assessment of research as a whole can only be accomplished *via* a comprehensive, multi-layered evaluation framework.
    - Efficient research assessment systems are typically centralized, but the traditional tension between research policy and innovation policy, as well as the potentially drastic implications of the research priorities to be determined call for more check and balance. It is thus necessary to clarify at the outset how the system will be governed and whether legislative or regulatory adjustments are needed.

INTRODUCTION

The purpose of this mission is to achieve a research output analysis for the Georgian Ministry of Education and Science. Its specific objectives include:

- An analysis of the dynamics of change of research output quality and volume in Georgia in a chronological perspective, by institutions involved in production of the research output and by major fields of science as defined by international classifications;
- A calculation of the share of Georgia National Science Foundation-funded projects in total research output;
- An analysis of the research output in Georgia in a comparative perspective, using national data with similar indicators in other post-Soviet countries and Eastern Europe;
- An identification of the strengths, weaknesses, opportunities, and threats to research in Georgia that may affect the government, academics, and other stakeholders as they work to improve scientific research in the nation.

This report was supported by the United States Agency for International Development (USAID), through the Human and Institutional Capacity Development (HICD) PLUS project in Georgia.

This report is divided into four parts:

In the first part, we provide a bibliometric snapshot of the research output and performance in Georgia[1].
In the second part, we provide an intellectual property snapshot of the research output and performance in Georgia.
In the third part, we make a qualitative analysis based on a field study conducted among the various stakeholders of Georgian research.
In the fourth part, we describe the alternative methods available to evaluate – and fund - research and make some recommendations regarding the most suitable options for Georgia.

[1] The bibliometric analysis follows the methodology as laid out in Nordforsk (2010). Bibliometric Research Performance Indicators for the Nordic Countries. W. Schneider (Ed.)

1. BIBLIOMETRIC SNAPSHOT OF RESEARCH OUTPUT AND PERFORMANCE IN GEORGIA

This chapter provides a bibliometric snapshot of the national research output and performance of Georgia during the period 2004-2013.

Given the specific context of the country and subject to the limitations inherent to existing databases, it aims at fulfilling the following objectives:

- Analyzing dynamics of change in research output quality and volume in Georgia:
  - In a chronological perspective (2004-2013);
  - By major fields of science as defined by international classificators;
- Analyzing research output in Georgia in a comparative perspective (comparing national data with similar indicators in other Post-Soviet countries, Eastern Europe and World.)

This chapter is divided into five sections:

The first section discusses our methodology.
The following three sections describe the so-called "external efficiency" of the system (Georgia as compared to other countries, region, world) from various angles.
The last section assesses the internal efficiency of the national system and analyses the role and impact of the Shota Rustaveli National Science Foundation (SRNSF).

1.1 Methodological considerations

The bibliometric analysis applies whole counting method as a main principle of counting. The whole or integer count gives the number of articles and conference proceedings in which the country participated. These two types of output are included in the analysis.

In many cases, relative measures are provided to compare output of Georgia with reference groups. Relativizing the measure enables us to judge the output in light of the norm in a field or region (Thomson Reuters, 2008).

1.1.1 Availability of data

The main Georgian research institutions generally try to compile and maintain a track record of their research output. For example, the Georgian Technical University has a dedicated interdisciplinary scientific center (Techinformi) which performs this task among others. But even in this latter case, databases are incomplete because they depend on the willingness of the institutes to update them regularly on their publications.

Thus, Georgia does not have presently a nationwide database that lists the various forms of its research outputs (articles, books, conference proceeding…), except for its patents and patent applications. Accordingly, our quantitative analysis is primarily based on bibliometric data derived from the two largest international databases (Thomson Reuters ISI Web of Science Core Collection and Scopus).

As fields and subfields of science are categorized differently by these databases and the associated analytical tools, we have grouped all fields and subfields listed in the databases into 5 main categories as defined by the **Field of Science (FoS) classification in the Frascati Manual (OSCE):** Natural Sciences (including Physics and Astronomy, Mathematics, Biology), Engineering and Technology, Social Sciences, Humanities and Agricultural Sciences. More detailed analyses by subfields are done where necessary.

1.1.2 Main biases

Bibliometric measures are useful tools to assess scientific production output and performance insofar as their limitations are accounted for. Below is a brief description of the main biases we identified, as well as our responses to mitigate their impact.

- **Biases attributable to Georgia's characteristics**
  - Small countries such as Georgia produce by definition smaller datasets than large countries and this typically entails greater fluctuations. For example, highly cited papers can influence average citation rates considerably. Changes in small research areas may therefore be more visible but less significant and need to be interpreted with caution. Such categories, when found, have been sometimes excluded from the analyses. To indicate their volume, we have kept the categories in some of the publication activities reported, but we have not performed detailed analyses for these areas.
  - Pursuant to a series of decrees, most research institutes have been merged with universities in 2010, in order to bring research and academia together. Thus, a comparison of the productivity of the Georgian Universities would be premature at this point. For example, the significant drop in the volume of output of the Georgian National Academy of Science in recent years tells little about its actual productivity, since the publications of the institutes that were formerly attached to it are now attributed to other institutions. Conversely, the recent increase in output of Ivane Javakhishvili State University is a mechanical consequence of the fact that it has absorbed most of the institutes in the field of physics. Consequently, we have renounced to make a comparison by institution.

- **Biases attributable to the main databases**
  - It is well known that Thomson Reuters' Social Science Citation Index is heavily biased towards Anglo-Saxon journals and covers only 5% to 15% of the research publications produced in social science fields (Sivertsen, 2009). To provide a more balanced picture, Scopus database (Elsevier), which is considered to be more comprehensive, has been used in parallel.
  - Regardless of the database used, there is a well-known imbalance among fields: natural sciences are more accurately represented than social sciences and humanities. For example, the share of Arts and Humanities or Mathematics journals in databases is at least ten times smaller than the share of Engineering and Medical Sciences. As a result, major fields of research such as Georgian studies (in a broad sense) are hardly visible and it is important to bear in mind that in such cases, the only reliable source of bibliometric data are the institutes themselves.
  - Finally, articles are not necessarily the most valuable scientific output in certain disciplines: books in humanities and social sciences, or conference proceedings in computer sciences, matter more than high-impact journals (Adler & Harzing, 2009). To correct – in part - this bias, we have ruled out certain calculations that produced misleading results, such as, for example, the internal field efficiency index (IFEF), which measures the relative productivity per capita by fields.

1.2 Total Production

This section reviews the trends in publication activity in Georgia over a 10-year period, starting from 2004. Absolute and relative indicators are presented to characterize the trends and enable comparisons between Georgia, other former Soviet Union Countries, European countries and the world.

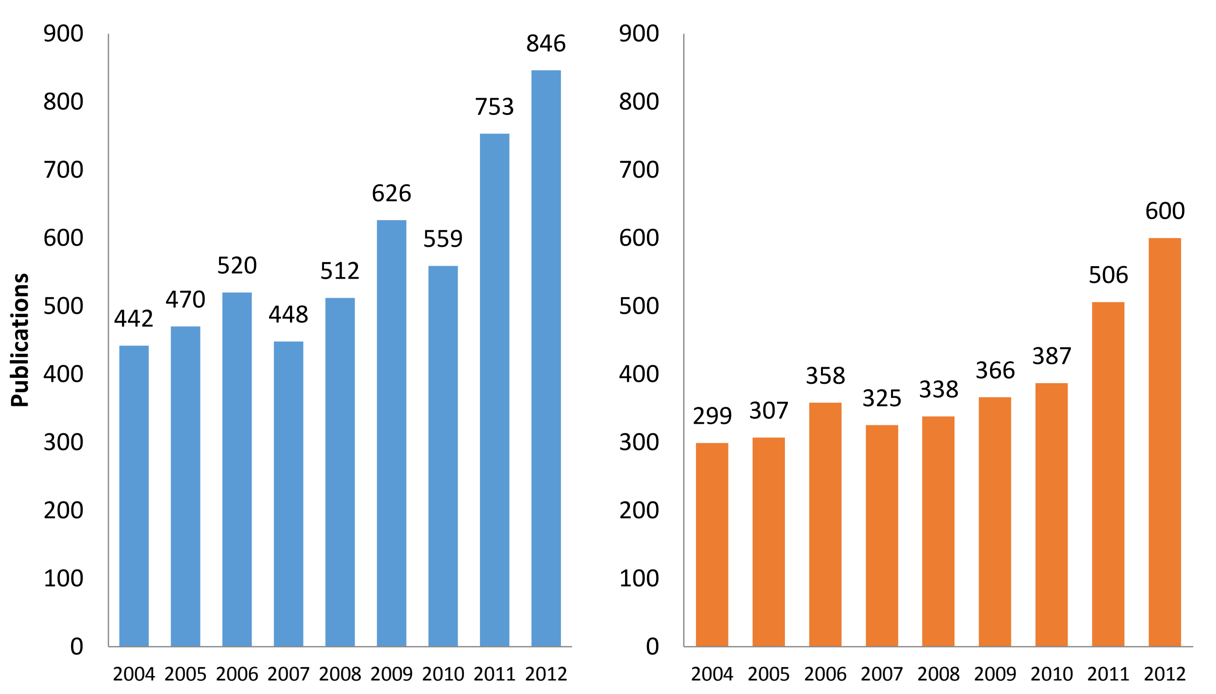
We focus only on the total publication activity (including articles and proceedings). Hence, all subject areas are combined to produce aggregated publication numbers. In some cases 3-year intervals are used.

First, the total publication activity in integer numbers is shown. Then the relative growth in publication activity is presented. Finally, relative indicators of publications per capita and Gross Expenditure on Research and Development (GERD) are analyzed to allow for more accurate comparisons among countries of different sizes and levels of economic development.

1.2.1 Key trends

Analysis of total publication activity in Scopus and Web of Science Core Collection databases shows a steady growth of research output in Georgia during the period 2004-2012, with a steep increase after 2010.

Total Production (All fields aggregated) Georgia (2004-2012)



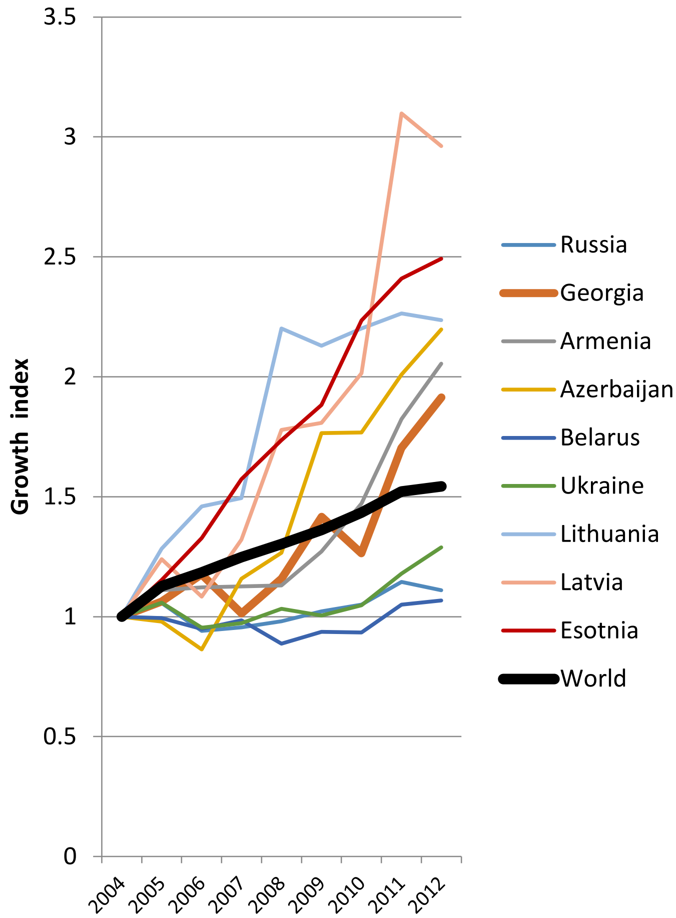
Source: Scopus database Source: ISI Web of Science (Core Collection)

The output growth speed in Georgia exceeds the overall growth rate in both databases since 2011, but depending on the database, the comparison with other Post-Soviet countries yields different results:

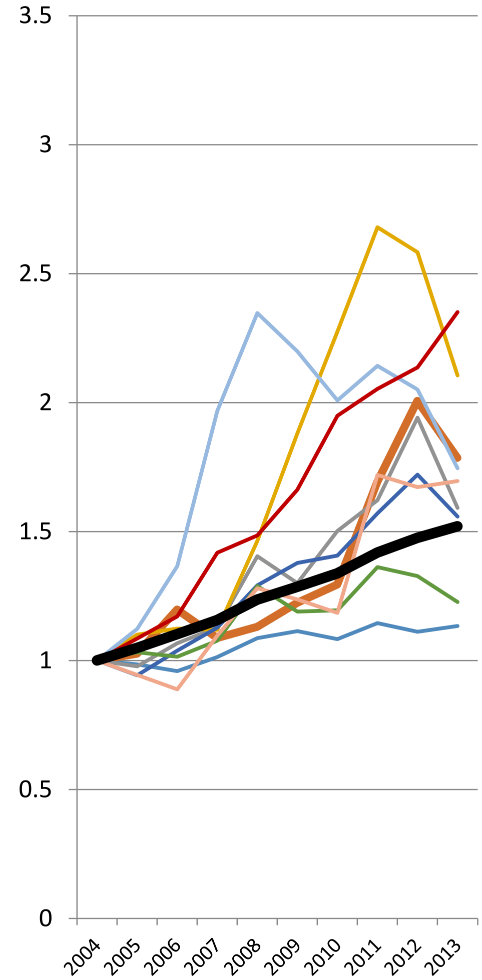
- In Scopus database, research output production grows faster than in 3 out of 9 Post-Soviet countries. In particular, Georgia shows better growth rate than Russia, Belarus and Ukraine.
- In the Web of Science database, the total output of Georgia grows faster than in 6 out of 9 Post Soviet countries and is slower than in Estonia, Lithuania and Azerbaijan.

As indicated above, however, in countries with small research output, growth rates fluctuate more and are less significant than in countries with larger research output. Therefore, in such cases (Georgia, Armenia, Azerbaijan, Latvia) the indicator should be interpreted with caution.

Relative growth in publication activity; Index 1 is 2004 publication output (World is equal to growth in the database coverage for the period)



Source: Author calculations/ Scopus database



Source: Author calculations/ISI Web of Science (Core Collection)

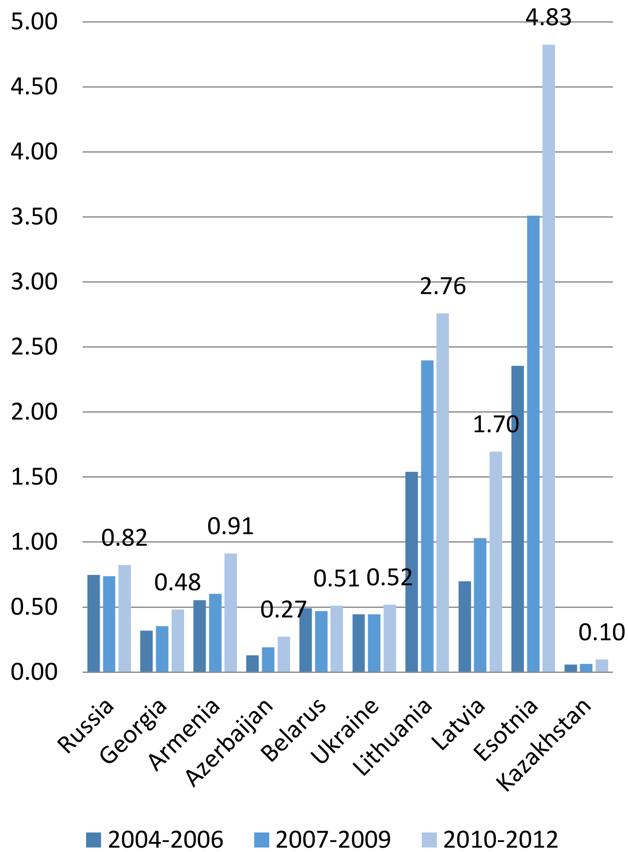
1.2.2 Total Production Efficiency

Much of the differences among countries in publication output can be attributed to differences in population size and investments in research. To better compare differences in publication output this subsection presents statistics on per capita production and total investments in research.

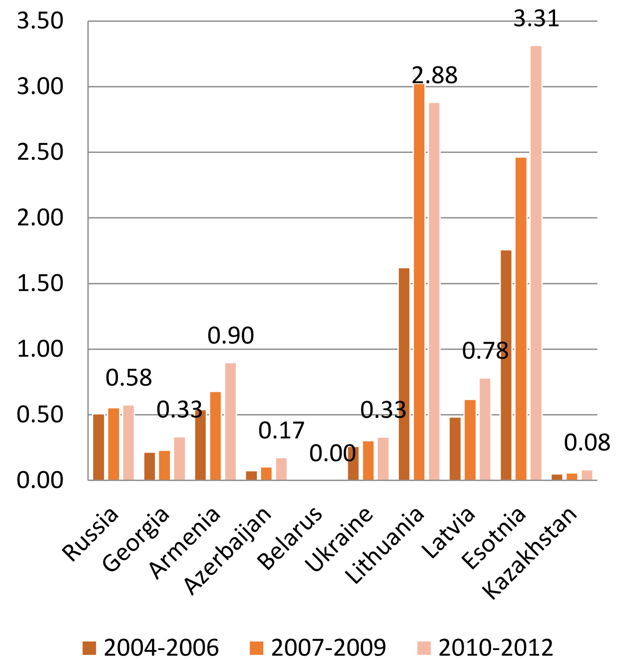
The analysis shows that research output production efficiency (measured as production per 1000 inhabitants) is lower in Georgia than in most of the comparator countries. Annual rate of production per 1000 inhabitants is 0.33 according to the Web of Science database and 0.48 according to the Scopus database. Similar indicator equals to almost 5 in Estonia.

In order to capture the efficiency growth trend the production efficiency indicator was calculated for three equal time periods – 2004-2006, 2007-2009, and 2010-2012. According to the both databases, efficiency grows in Georgia faster than in Russia, Azerbaijan, Belarus, Kazakhstan and Ukraine, but slower than in Armenia, Lithuania, Latvia and Estonia.

Total Publications per 1000 inhabitants



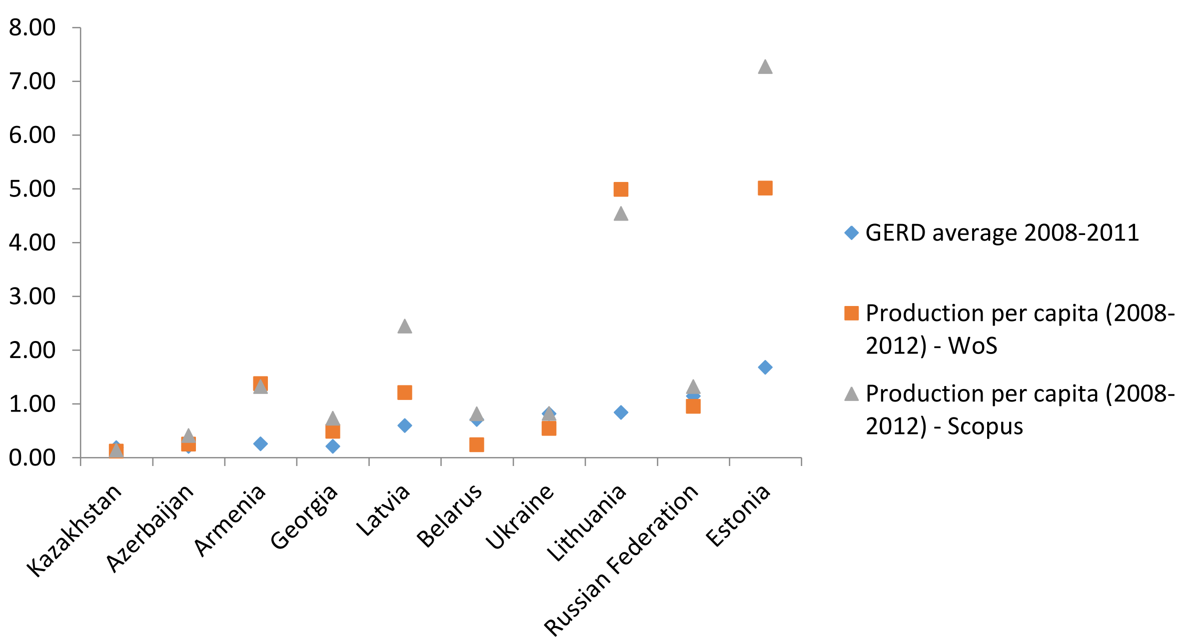
Source: Author calculations/ Scopus database



Source: Author calculations/ISI Web of Science (Core Collection)

Production per capita correlates with Gross Expenditure on Research and Development (GERD). Georgia fits into the trend line. However, some of the countries (Armenia, Lithuania, Estonia) perform significantly better than expected by the general trend.

GERD and Total Production per capita (1000 inhabitants)



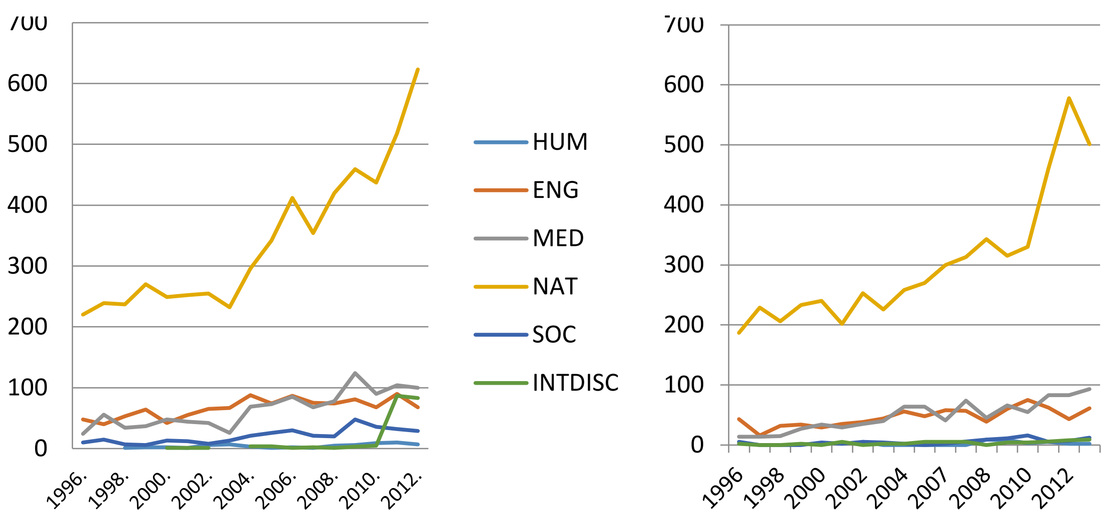
1.3 Publication Profiles (by fields of science)

1.3.1 Total Production, Growth and Efficiency by Fields

Breakdown of total production by fields shows that Natural Sciences account for most of the output growth in Georgia. There is a slight increase in production in the fields of medical sciences and engineering. Trend lines of other fields of science are mostly flat but as indicated above, databases themselves may be the cause of the problem in some fields in social science and humanities.

Total Production by fields (Georgia)

Scopus database **Web of Science database**



Georgian research production per capita in Mathematics and Physics is relatively better than in other countries.

Total Production per capita (100,000 inhabitants) by fields and countries

	Georgia	Russia	Armenia	Azerbaijan	Ukraine	Lithuania	Latvia	Esotnia
Engineering and technology	0.50	2.38	1.28	0.81	1.99	8.43	4.82	7.51
Medical and Health sciences	0.66	0.67	0.92	0.53	0.21	4.45	2.21	8.66
Social Sciences	0.22	0.23	0.29	0.07	0.07	5.05	1.11	6.01
Other Natural and agricultural sciences	0.68	1.26	0.79	0.22	0.51	5.29	2.18	14.80
Mathematics	0.82	0.74	0.90	0.26	0.44	1.45	0.86	2.13
Physics and Astronomy	1.44	2.13	3.69	0.53	1.37	3.95	2.24	4.72
Biochemistry, Genetics and Molecular Biology	0.25	0.80	0.81	0.13	0.36	1.37	0.95	4.77
Chemistry	0.27	1.20	0.66	0.32	0.61	1.74	1.52	2.95
Computer Science	4.90	9.60	9.46	2.95	5.68	32.88	17.22	53.85

Source: Author calculations/ Web of Science database (2010-2012)

	Georgia	Russia	Armenia	Azerbaijan	Ukraine	Lithuania	Latvia	Estonia
Engineering and technology	0.6	2.3	1.4	0.7	1.8	10.4	4.6	10.8
Medical and Health sciences	0.8	0.8	0.8	0.2	0.3	5.4	2.7	11.0
Social Sciences	0.1	0.2	0.1	0.1	0.3	3.2	0.6	5.1
Agricultural sciences	0.1	0.1	0.1	0.0	0.0	1.0	0.4	1.9
Other Natural sciences	0.8	2.2	1.7	0.4	0.8	5.8	3.1	19.0
Mathematics	0.7	0.5	0.7	0.3	0.3	1.6	0.4	1.0
Physics and Astronomy	2.3	2.5	5.8	0.7	1.7	4.4	2.3	6.8
Biochemistry, Genetics and Molecular Biology	0.1	0.4	0.3	0.0	0.1	0.8	0.5	3.6
Chemistry	0.3	1.4	0.9	0.4	0.7	2.3	1.3	3.4
Computer Science	0.0	0.1	0.0	0.0	0.0	0.8	0.3	0.7

Source: Author calculations/ Scopus database (2010-2012)

1.3.2 Specialization

The publication profile of national research in Georgia and other Post-Soviet countries is expressed in this subsection by the Relative Specialization Index (RSI), defined in REIST-2 (1997). RSI indicates whether a country has a relatively higher or lower share in world publications in particular fields of science than its overall share in the world total of publications.

The RSI is a relative indicator based on the Activity Index (AI). The Activity Index is defined as:

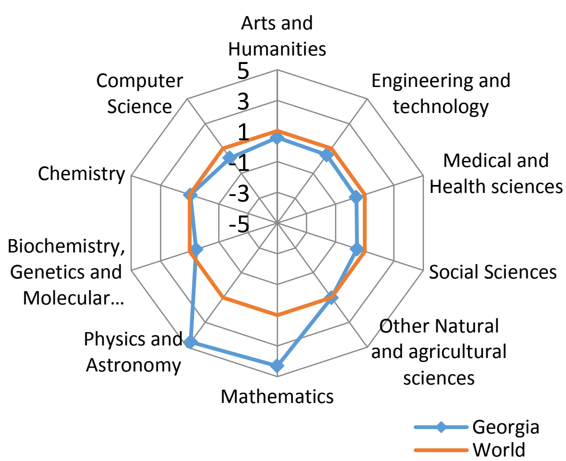
$$\mathrm{AI} = \frac{\text{The share of a given field in total publications of the given country}}{\text{The share of given field in the world total of publications}}$$

RSI is then defined by putting specific country indicators on the same scale with the common benchmark. The benchmark used for all research fields is RSI = 1, which corresponds to the world standard case and is graphically visualized by a regular polygon. Any country's deviation from this standard therefore results in more or less characteristic deformation of the regular polygon.

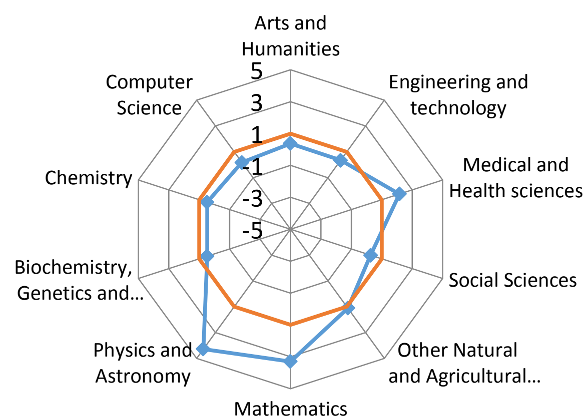
RSI indicates whether a country has higher-than-average activity in a scientific field (RSI >1) or a lower-than-average activity (RSI <1). RSI = 1 reflects a completely balanced situation. It is important to note that RSI reflects a certain internal balance among the fields in the given country, i.e. positive RSI values must always be balanced by negative ones (no country can have its RSI values all positive or all negative). Furthermore, low values indicate homogenous distributions between the various research fields.

The share of articles in physics and mathematics is greater than average in Georgia. Also the share of Medical and Health sciences slightly deviate from the norm in the Web of Science database.

Relative Specialization index (RSI) in Georgia (2010-2012)



Source: Scopus database (2010-2012)



Source: Web of Science database (2010-2012)

When comparing Georgia to the countries included in our analysis, two major clusters appear.

- The first cluster (Russia, Ukraine, Azerbaijan) demonstrate intensive activity in Physics, Mathematics and Chemistry.
- The second cluster is formed by Baltic countries that have different polygon with larger output (compared to world standard) in fields other than physics, mathematics and chemistry.

Georgia shows significant similarities with the first cluster in terms of predominant focus on physics, however, the patterns of distribution of share of output in Georgia by fields differs from both clusters as Georgia displays significantly larger output in mathematics and slightly larger output in Medical Sciences (see Annex 4 for a detailed comparison).

1.3.3 Citation Impact

The present section attempts to analyze the quality of research output based on citation impact (CI) metrics. Citations Impact is a commonly used indicator in bibliometric analysis to estimate influence and quality of research output over time or for specific groups. Citation metrics are used as indicators of scientific value because more influential work would tend to be more frequently cited. The term 'impact' is now accepted as appropriate for what citations measure or indicate, and the citation-based relative analysis of the scientific impact of different fields is also a widely accepted approach (Thelwall 2007).

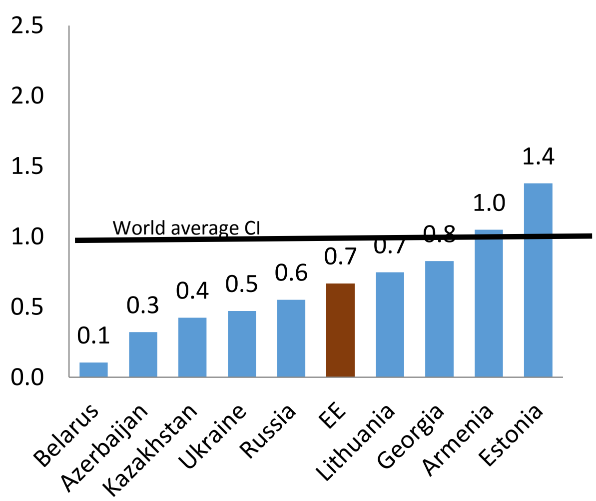
Citation impact ("Citations per paper") is computed by dividing the sum of citations to some set of papers for a defined time period by the number of papers (paper count). The citations per paper score is an attempt to weigh impact with respect to output, since a greater number of publications tends to produce a greater number of citations. Citations impact is therefore a useful indicator when comparing large and small producers.

Citation impact scores in this report are calculated for several countries including Georgia. Calculations are made for two time periods – 2004-2012 and 2010-2012. The indicator shows average citations (of the given time period) per document published during the source year, i.e. citations in years X, X+1, X+2, X+3... to documents published during year X. When referred to the period 2004-2012, all published documents during this period are considered. The scores are then normalized by the world average to present country scores as an index (compared to world average for the same period). Citation Index (CI) shows Citation Impact of countries compared to the world average.

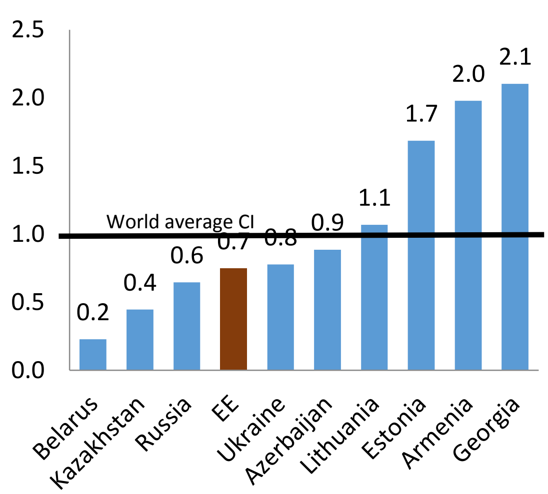
Aggregated Citation Impact Index for all fields is shown below followed by the analysis of specific Citation Impact for the largest research fields (compared to similar indicators for the Eastern Europe).

Citation Impact (CI) Index aggregated all fields (Scopus database)

Aggregated all fields (2004-2012)



Aggregated all fields (2010-2012)

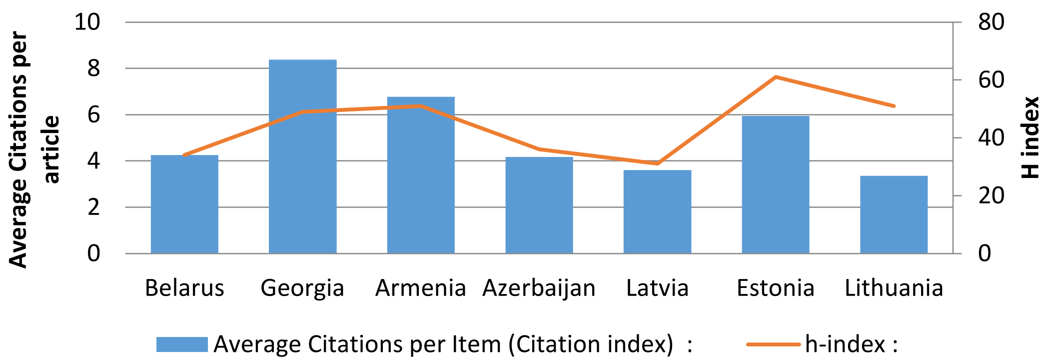


Analysis of CI in the Scopus database shows that while Georgia has moderate results in terms of production (quantity of output) its position is much better with regard to impact and influence (quality) of output. Georgia outperforms most countries by this indicator for the entire period 2004-2012 as well as shows significant increase in influence for the articles published during 2010-2012.

A similar trend can be observed in the Web of Science database.

An analysis of the aggregated Citation Impact and H indices[2] for several countries clearly shows that Georgia has a leading position among selected Post-Soviet countries. The average citation rate per article is the highest. H index 50 indicates that there are at least 50 articles in the total output for the period 2010-2012 with at least 50 citations. This indicator allows us to exclude the possibility that CI is influenced by extremely high citation rates of several articles.

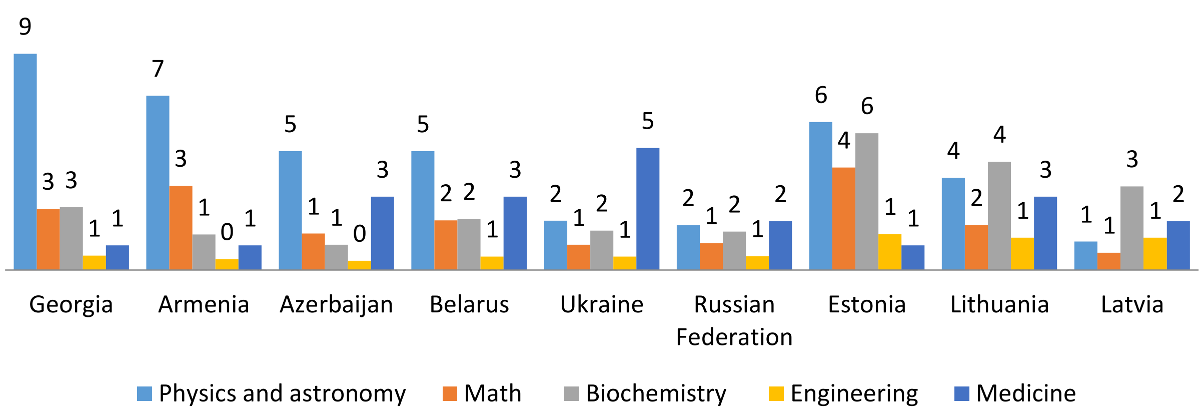
Citation Impact (CI) and H Index aggregated all fields 2010-2013



Source: Web of Science Database

The most influential articles are concentrated in the fields of natural sciences where the CI scores of Georgia are higher than in other Post-Soviet countries including the Baltic States. However, the overall picture for the country may be distorted because the share of publications produced by large international projects (Natural sciences) is extremely large in the total output of Georgia. The total number of such publications is approximately similar in all Post-Soviet countries, but due to the small volume of the total output in Georgia, Azerbaijan and Armenia, a high CI of these articles may significantly change country average indicators.

Average Citation Impact (CI) by selected fields and countries (2010-2012)



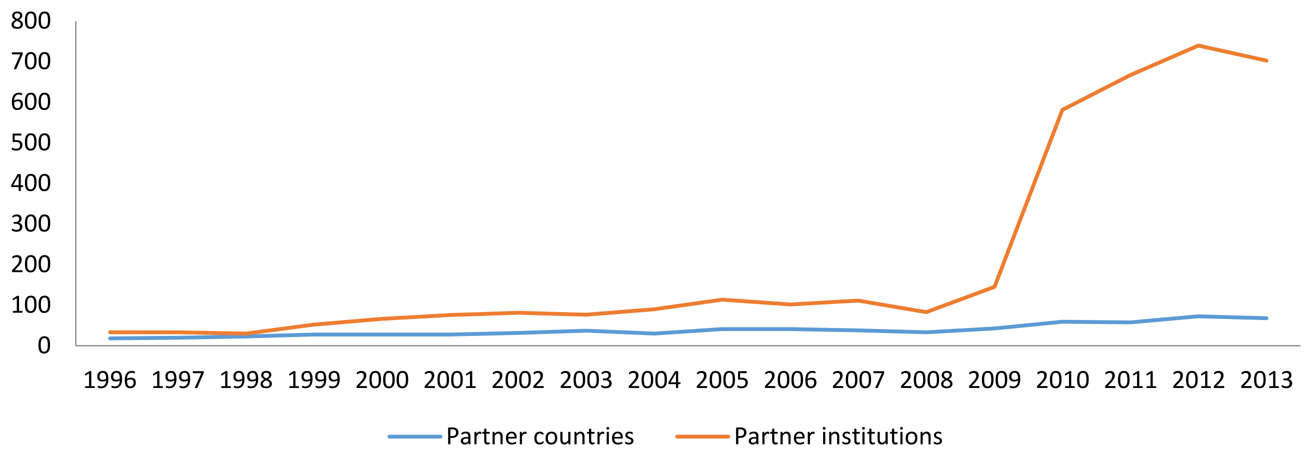
Source: Scopus Database

[2] The *h*-index was proposed by J. E. Hirsch in his paper "An index to quantify an individual's scientific research output". According to Hirsch's model, a scientist has index *h* if *h* of his/her N_p papers have at least *h* citations each, and the other (N_p-h) papers have no more than *h* citations each.

1.4 International Networking and Cooperation

Approximately 80% of the total output of Georgia (2004-2013) in the Web of Science database in all fields is produced in the frames of joint projects with other countries. Web of Science database lists 87 partner countries and 1145 partner institutions for the period 2004-2013. The number of partner countries per year has not changed significantly since 1996, but the number of partner institutions per year has grown sharply after 2010.

Partner countries and institutions (2004-2013)



Source: Web of Science Database

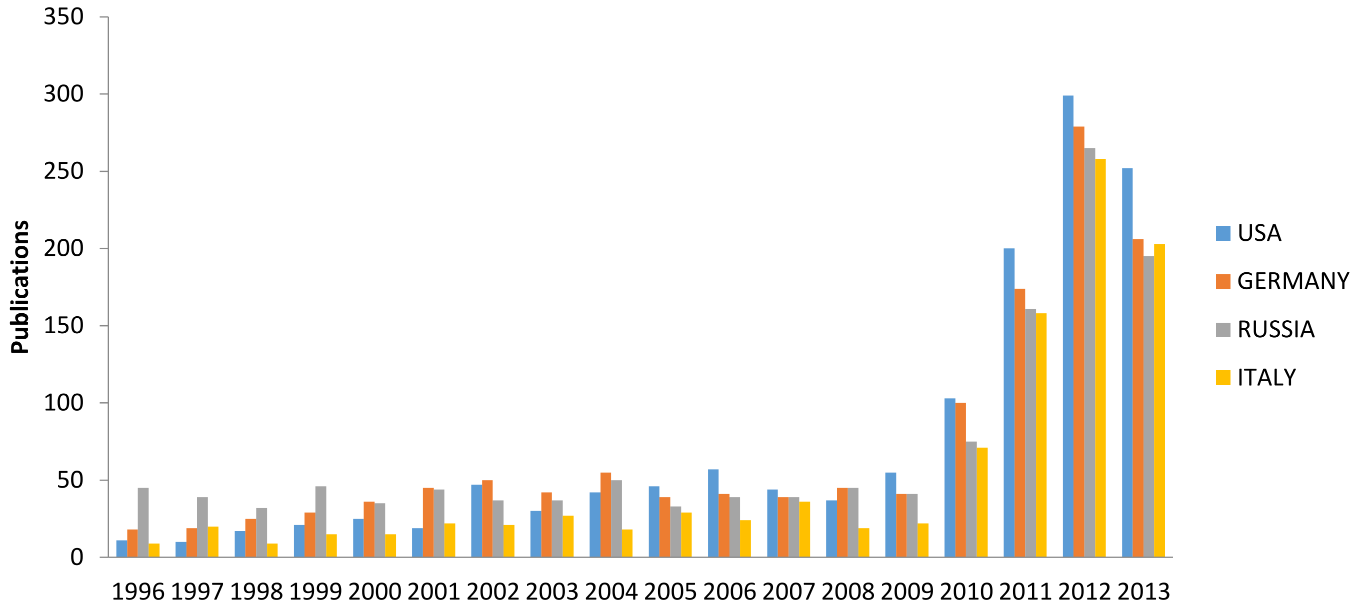
Partner countries can be grouped in three clusters, according to the intensity of their cooperation with Georgian authors. The First cluster is formed by four countries. Each of them cooperates with Georgian authors in more than 20% of total number of publications in the Web of Science database for the period 2004-2013. The second cluster includes 20 countries. Each of them contributes to more than 10% of total output of Georgia in the Web of Science database.

Clusters of Partner countries (Web of Science database)

Cluster	No of Joint publications (2004-2013)	Share of joint publications in total output (2004-2013)	Countries	No of countries in the cluster
1	> 1000	20% +	USA, Germany, Russia, Italy	4
2	> 500	10% +	UK, France, Spain, Poland, Switzerland, Austria, Greece, Turkey, Portugal, PR China, Armenia, Brazil, Czech Republic, Hungary, Serbia, Taiwan, Belarus, Colombia, Romania, Australia	20
3	<500			63

The figure below illustrates the growth in total number of joint publications with four leading partner countries. As it can be seen, the number of joint publications increases significantly since 2010 with all partner countries.

Number of joint publications by country – first cluster (Web of Science database)

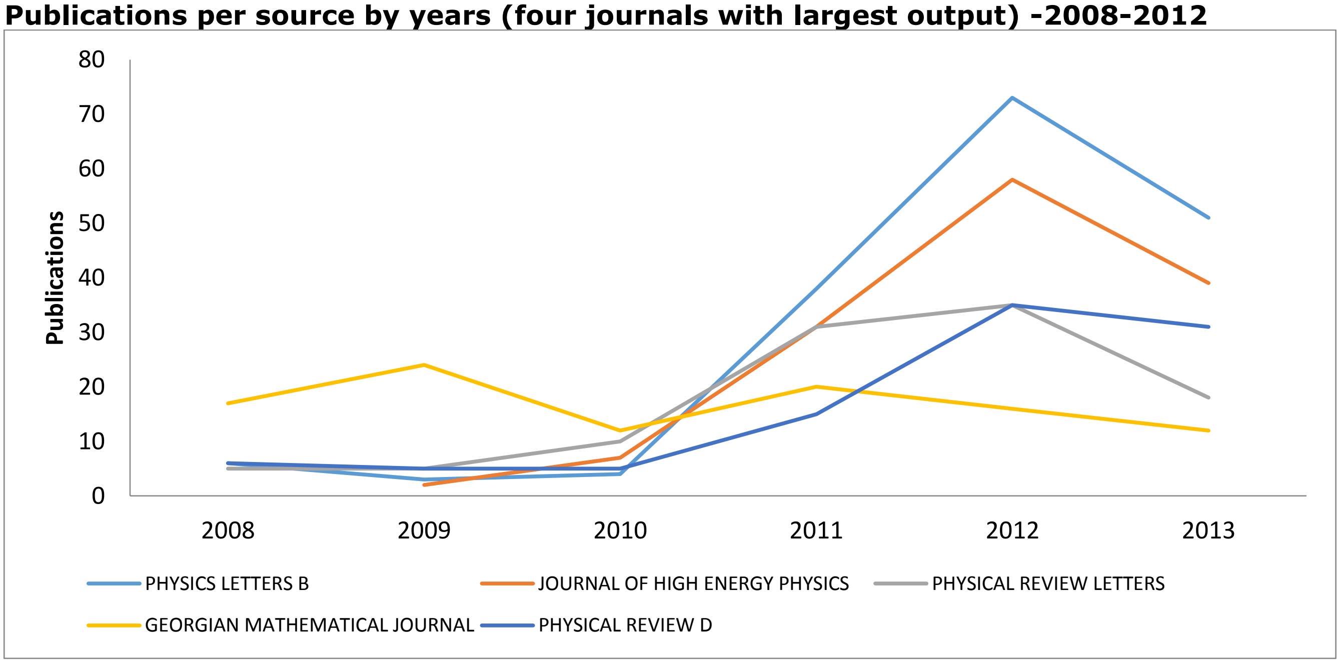


The Scopus database also shows high levels of international cooperation for Georgian researchers, especially in the field of physics. A decrease in international cooperation (compared to previous years) is evident only in the fields of biochemistry, genetics and molecular biology.

During the period 2008-2013 Georgian researchers published in 173 sources (peer reviewed journals). However, approximately 30% of these publications were concentrated in four journals and 50% in 9 journals.

The figure below shows the publication growth in four major sources in 2008-2012 and indicates a significant increase in the number of publications per journal since 2010.

Publications per source by years (four journals with largest output) -2008-2012



The largest share of ouput is produced with the financial support of the Shota Rustaveli National Science Foundation (SRNSF) and European Organization for Nuclear Research/CERN.

International cooperation (Share of papers with more than one country) by field

	Eastern Europe	Armenia	Azerbaijan	Georgia	Belarus	Ukraine	Russian Federati	Estonia	Lithuania	Latvia
Physics and Astronomy										
2004	52	64	59	70	59	57	50	54	53	76
2005	51	70	59	81	59	53	48	54	53	77
2006	49	70	66	68	62	56	46	50	40	78
2007	48	60	63	82	70	57	46	56	55	74
2008	45	64	64	71	61	48	43	51	47	74
2009	46	69	53	76	63	51	43	60	43	58
2010	44	72	62	82	65	52	41	66	47	53
2011	44	75	67	87	76	53	39	66	51	58
2012	44	79	84	91	82	54	41	79	59	52
Mathematics										
2004	40	55	45	43	32	47	38	33	28	33
2005	40	63	22	44	27	43	37	30	26	28
2006	38	62	38	48	35	42	35	39	19	23
2007	38	52	46	54	45	48	34	41	18	8
2008	37	67	39	44	49	44	33	38	19	35
2009	37	48	45	40	47	38	33	31	28	19
2010	35	64	42	67	51	44	30	49	36	18
2011	35	58	49	46	49	42	31	41	30	22
2012	35	66	58	53	58	39	32	48	31	26

	Eastern Europe	Armenia	Azerbaijan	Georgia	Belarus	Ukraine	Russian Federati	Estonia	Lithuania	Latvia
Biochemistry										
2004	37	36	27	80	48	43	31	75	59	65
2005	35	18	7	47	50	37	30	74	44	62
2006	37	44	42	55	42	45	30	66	63	82
2007	36	29	50	48	47	43	29	59	60	58
2008	35	30	67	56	44	42	27	61	67	54
2009	36	40	58	52	55	37	27	63	59	86
2010	34	46	59	40	50	39	26	61	57	67
2011	34	35	59	56	55	38	24	66	62	60
2012	35	36	72	45	58	40	25	68	54	54
Engineering										
2004	26	32	26	57	27	22	22	38	32	31
2005	26	37	23	64	34	19	24	35	26	38
2006	28	44	35	73	40	25	27	33	23	43
2007	29	52	16	65	37	28	26	39	28	43
2008	29	43	30	37	42	29	24	38	17	29
2009	23	46	49	34	38	26	21	35	19	24
2010	23	40	40	34	44	28	20	43	15	23
2011	22	37	32	40	31	23	19	50	16	23
2012	22	32	32	59	40	17	19	46	21	31

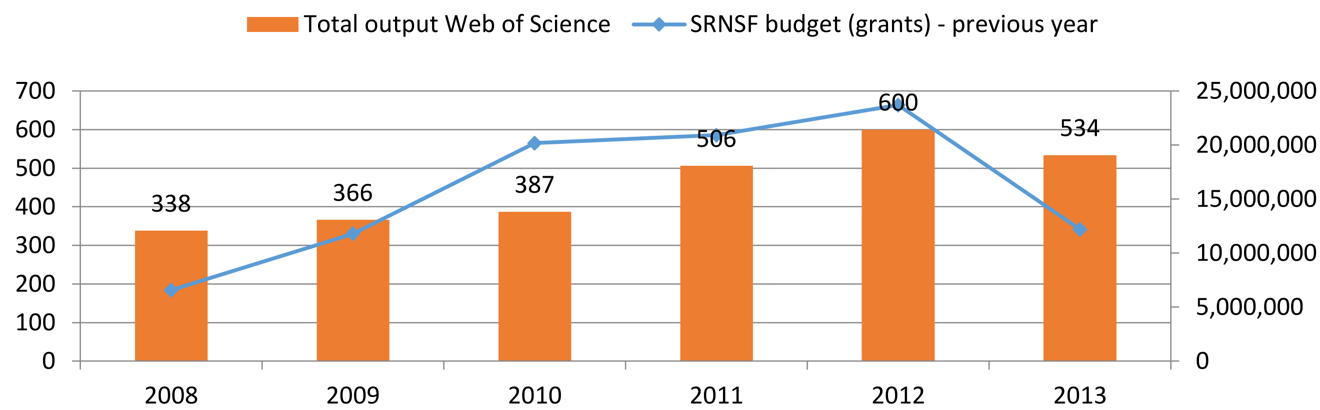
Source: Scopus database

1.5 State Grant: the role of the Shota Rustaveli National Science Foundation (SRNSF)

State grants for research represents the major mechanism of funding research in Georgia. Grants are distributed through open competition among individuals or groups of scientists. Maximal duration of projects is two years. The process is administered by the Shota Rustaveli National Science Foundation (SRNSF) - an independent entity of public law established in 2008 by the Ministry of Education and Science.

Analysis of output of Georgian researchers in the Web of Science database shows a strong correlation between the total funding provided by SRNSF for research and the total production in the Web of Science database by year.

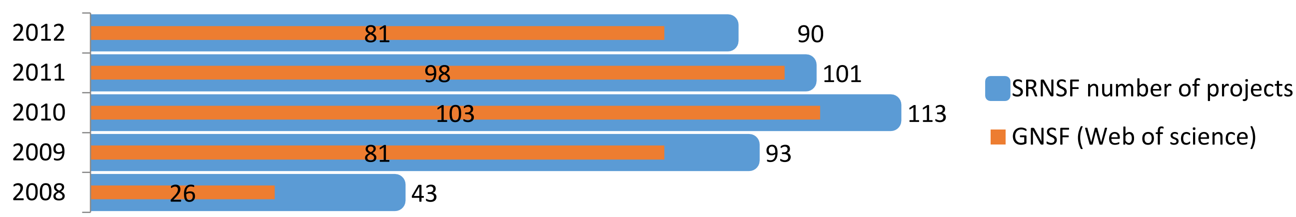
SRNSF funded projects in Web of Science and SRNSF spending on research grants by year



Source: Web of Science database

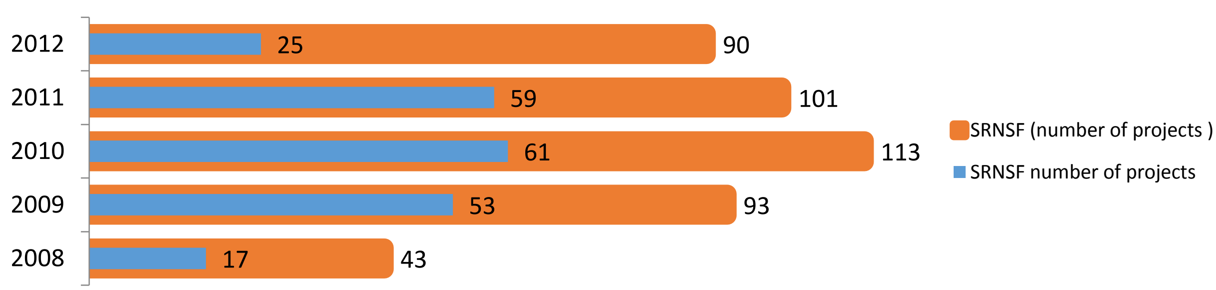
SRNSF visibility as a funding agency is high in the Web of Science database: the total number of articles that mention the foundation as a funding agency is almost equal to the total number of individual grants given by SRNSF during the specified period.

SRNSF funded projects in Web of Science and number of SRNSF individual grants by year



At first sight, the efficiency of SRNSF spending on individual grants seems to be high in terms of facilitating overall production. However, a more detailed analysis of the data reveals that most of the output where SRNSF is mentioned as a funding agency is produced within the framework of joint projects with the CERN/European Council for Nuclear Research (SRNSF provides participation fee for Georgian researchers). If joint publications within these initiatives are excluded from the total output, the visibility of SRNSF funded projects drops significantly.

SRNSF funded projects in Web of Science and number of SRNSF individual grants by year (excluding CERN publications)



2. INTELLECTUAL PROPERTY SNAPSHOT

Since the industrial share of R&D has become marginal in Georgia, patents and patent applications are direct indicators of the economic potential of academic research.

In this chapter, the main source of information used is the statistic database of the World Intellectual Property Organization (WIPO), which generally covers the period 1998-2012. Data on Georgia obtained from the Georgian National Intellectual Property Center (Sakpatenti) include the year 2013, but are not totally compatible with WIPO data, because WIPO includes additional elements in its data sheets, such as incoming applications to WIPO from Georgia and applications extended to Georgia from WIPO. Thus, to allow an international comparison we have used WIPO data for all countries including Georgia (the 2013 update from Sakpatenti is available in Annex 5).

This chapter is divided into two sections.

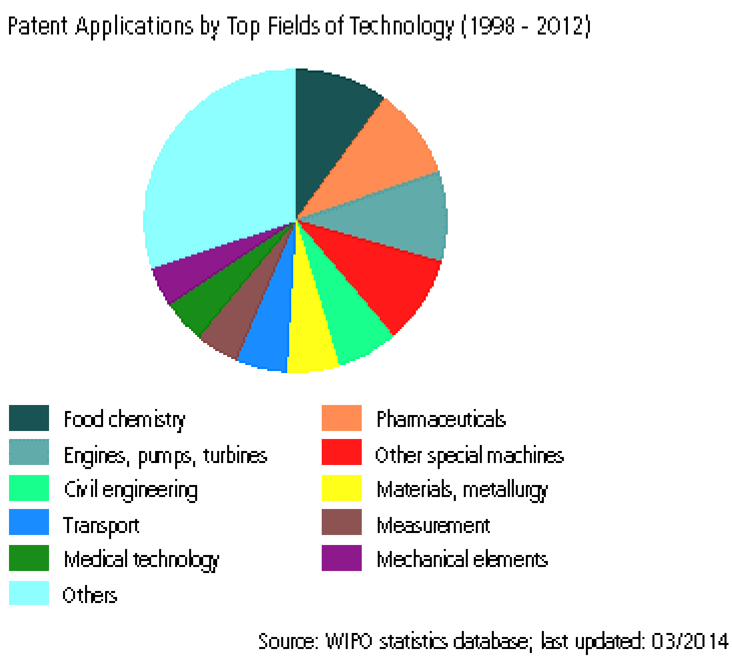
The first section compares Georgia's dominant patent fields with the results of our bibliometric analysis, and looks at the trends in patent applications in recent years.

The second examines the evolution of patents filing in Georgia and compares it to trends in other IP rights as well as in other countries.

2.1 Domestic data

2.1.1 Dominant fields of technology

The graph below shows a breakdown of patent applications by fields of technology.



To obtain a more precise indicator of the actual performance of Georgian research, we have isolated from this sample the patent applications filed by Georgian residents that have resulted in a patent grant.

The top fields are listed in the table below:

Patent grants resulting from resident applications: top five fields													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Special machines	18	16	7	19	6	8	17	15	17	/	5	12	12
Food chemistry	22	16	8	12	10	23	14	16	25	/	4	15	9
Engines, pumps, turbines	29	18	10	7	3	22	10	21	11	/	3	7	15
Civil engineering	17	19	7	9	5	11	4	5	9	/	4	9	11
Mechanical elements	3	2	3	5	4	4	9	9	10	/	5	4	14

Source: WIPO, 2014

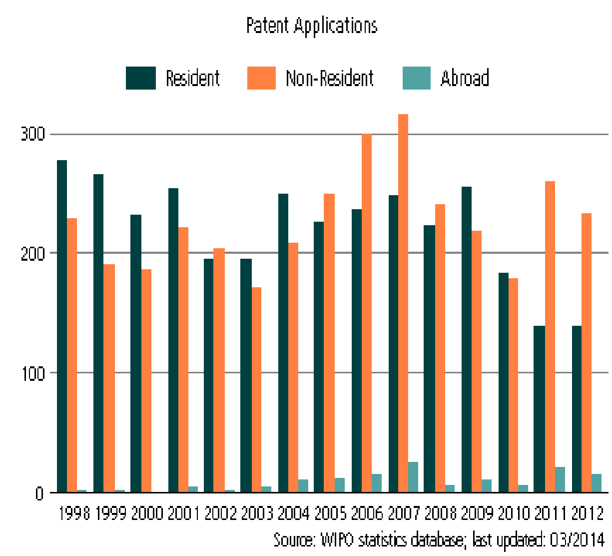
In terms of patent output, the category that is labelled "engineering and technology" in bibliometric databases is by far the most productive research field: it encompasses three of the top five patenting fields. Its bibliometric score is rather mediocre compared to other fields, but this is not an unexpected finding for such field of research.

For the opposite reason, the absence of the top Georgian fields of research identified in our bibliometric analysis is also logical, since they are in disciplines that do not produce industrial – hence patentable – applications (*e.g.* astronomy, mathematics, or computer sciences).

The fact that patent outputs and bibliometric outputs are not correlated highlights the necessity to define a specific set of research performance indicators for each research field.

2.1.2 Trends in patent applications

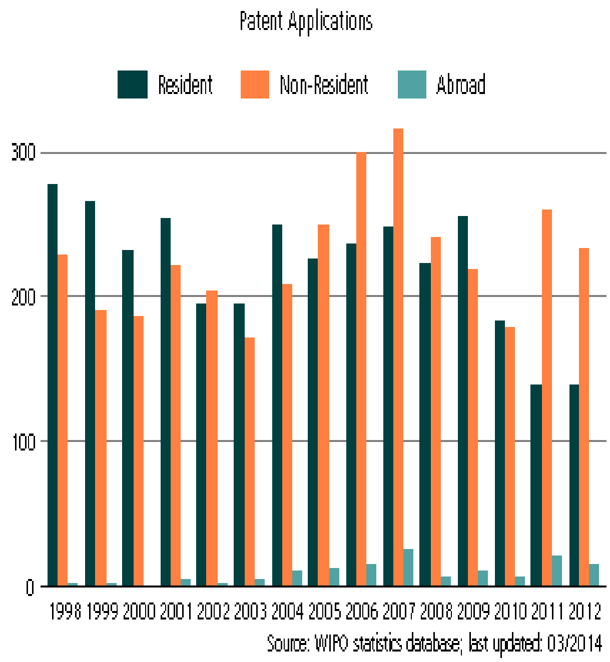
The graph below show the evolution of patent applications in Georgia since 1998:

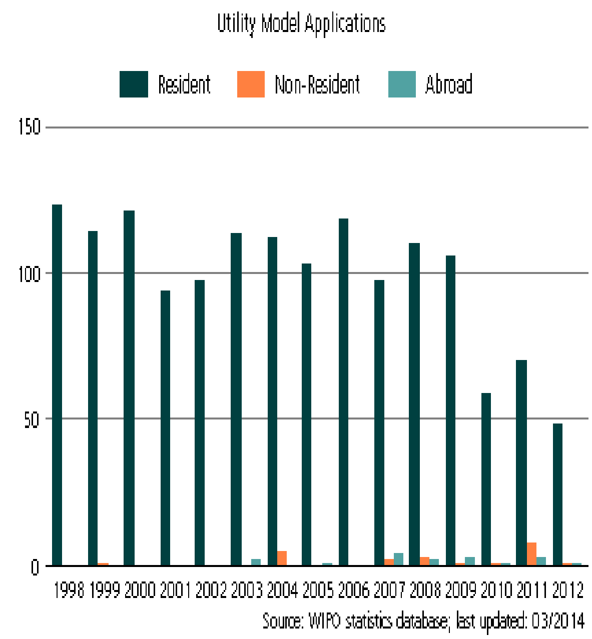


The recent drop in the number of applications filed by Georgian residents indicates either a decline in patentable research results or diminishing financial resources to pay the filing fees. Which of these two causes is the most plausible in the case of Georgia? Trends in so-called "utility model" applications bring some insight.

Next to patents, various countries – among which Georgia – grant utility models which are second-class patents sometimes referred to as "petty patents". Utility models have a shorter duration and are not suitable for all kinds of innovations. But the filing process is simpler and far less stringent than for patents, and most importantly, much cheaper. Thus, utility models are as much an indicator of second class innovation (*e.g.* incremental) as they are an indicator of limited financial resources, since they are sometimes the only IP right tha t an inventor can afford.

The two graphs below show the respective evolutions of patent and utility model applications for the period 1998-2012 in Georgia:





Although scales are different, these graphs show somewhat comparable trends in total applications filed by Georgian residents for each type of IP rights. In other words, a decrease in patent applications did not result in an increase in utility model applications.

This finding alone is more a clue than evidence, but it suggests that rather than patenting, it is innovation *per se* that is affected by low research funding.

2.2 International comparison

2.2.1 Total patent applications

In addition to Georgia, our country sample includes four former Soviet countries: Armenia, Azerbaijan, Belarus and Estonia. To allow a meaningful comparison, the table below indicates their respective GDPs and populations:

	GDP (in 2012)		Population (in 2012)	
	Billion USD)	Rank	Million	Rank
Georgia	22.95	106	4.51	120
Armenia	17	119	2.97	135
Azerbaijan	85.13	69	9.3	90
Belarus	127.18	57	9.46	89
Estonia	25.08	103	1.34	148

The table below shows the total number of patent applications filed in the five countries since 1998. For each country, resident and non-resident applications are distinguished.

Total patent applications
Resident and abroad count by applicant's origin

Origin	Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Armenia	Resident	75	109	119	140	200	151		206	192	135	226	116	136	121	137
	Non-Resident	8	16	8	15	7	6	6	2	1	5	4	11	6	19	4
Azerbaijan	Resident				203	234	246	270	281	246	287	226	264	254	193	144
	Non-Resident				10	7	18	7	6	13	8	7	17	17	12	
Belarus	Resident	910	993	994	930	895	1082	1065	1166	1188	1405	1510	1753	1759	1725	1681
	Non-Resident	79	345	204	214	379	298	200	296	337	257	220	173	174	146	190
Estonia	Resident	20	13	13	18	19	18	27	23	36	44	62	76	84	62	20
	Non-Resident	443	604	791	699	700	584	97	15	9	19	10	20	13	15	5
Georgia	Resident	277	265	232	254	194	195	249	225	236	248	222	256	183	138	139
	Non-Resident	229	190	186	221	204	171	208	250	299	316	241	218	179	260	233

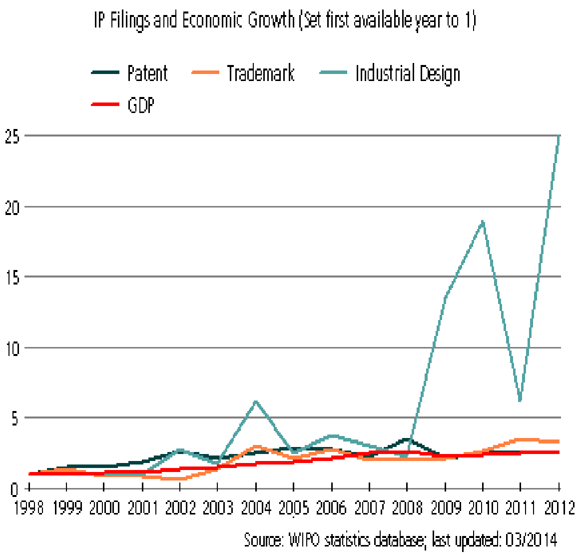
Source: WIPO, 2014

As in bibliometric analyses, IP data on small countries must be assessed with caution, because small variations in total IP filings may cause important fluctuations from a year to another. But even over a long period, this table shows that Georgia is the only country where, since 2005, the number of resident applications falls below the number of non-resident applications. Comparatively, Armenia does much better in terms of resident applications: in recent years, its ratio per inhabitant is the double of that of Georgia.

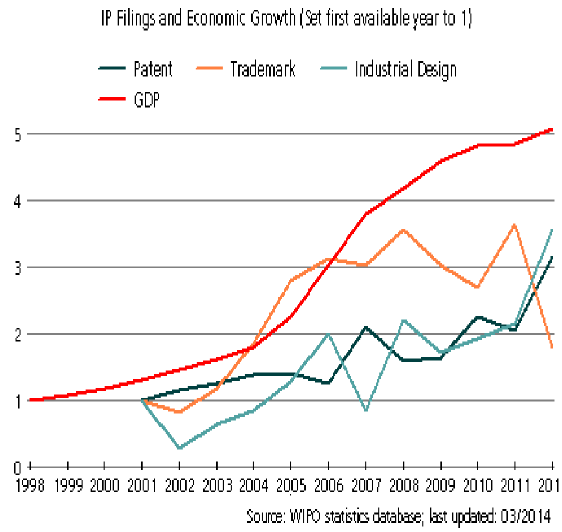
2.2.2 Comparison with other IP filings and correlation with economic growth

Although IP rights cannot be compared from a category to another in quantitative terms (*e.g.* number of patents filings *versus* number of trademarks filings), general trends in each IP category over long periods are indicators of a country's economic dynamism and are generally be correlated with its growth.

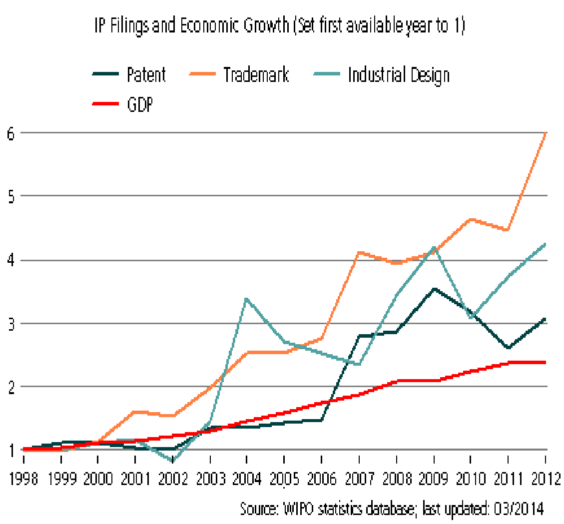
The graph below shows these trends in our country sample for the period 1998-2012 with respect to the three main industrial property rights: Patent, trademark and design.



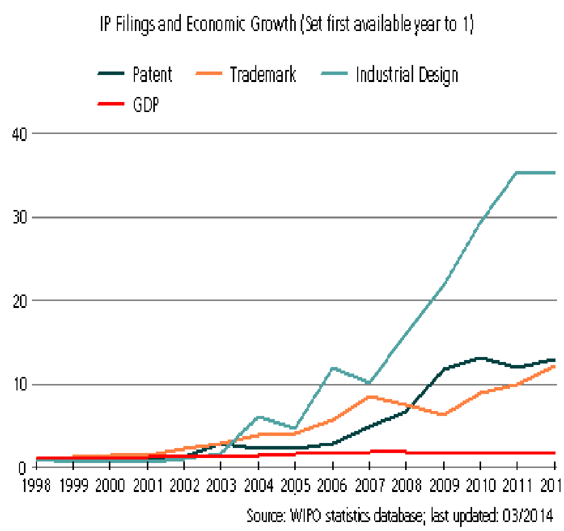
Armenia



Azerbaijan



Belarus

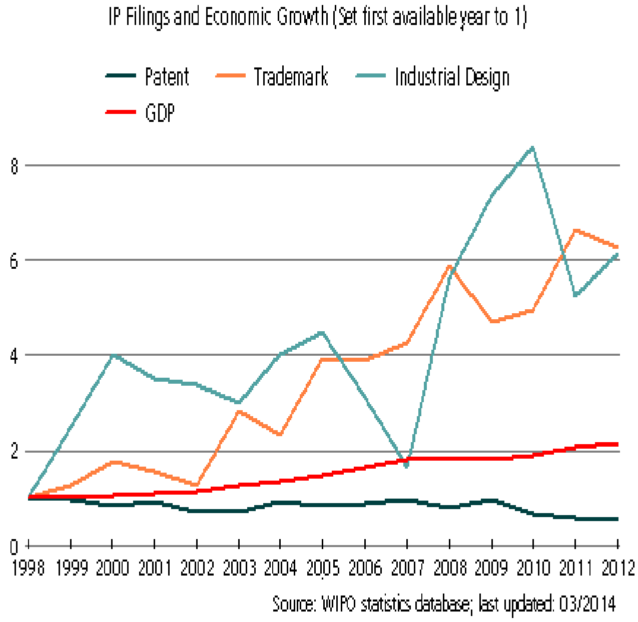


Estonia

Assuming again that fluctuations bring little information in the case of small countries and thus, that only long-term trends are relevant, these graphs show that growth in filings in the three IP categories is generally correlated with GDP growth - although to a variable extent.

In this group of countries, Estonia is arguably the most efficient, since its progression in the three IP categories is much steeper than the almost flat GDP curve. Nuances are merely a matter of degree, however: overall, the four countries display a similar pattern.

Georgia is thus an exception: it is the only country in our sample where total patent filings tend to decrease as GDP - and total filings other IP categories - tend to increase.



Georgia

Since this trend does not fit in any regional or post-soviet pattern, historical or exogenous causes are unlikely: the decline in patent filings is probably caused by domestic factors, such as the decrease of applied research as a result of its relatively higher cost in a context of scare research funding.

3. QUALITATIVE ANALYSIS

In addition to our quantitative analyses, we conducted a field study and a series of interviews and informal workshops with representatives of the scientific communities and other relevant stakeholders (see Annex 1 for a list of the visited institutions).

This chapter is divided into two sections.

The observations made by our various interlocutors revolve around a few central issues, which are presented and commented in a first section.

Based on our findings, we present in a second section a SWOT that summarizes the present stakes of Georgian research.

3.1 Field study: summary of main findings

3.1.1 Research organization

In the research community, the dominant opinion is that the merger of the institutes and the universities was unsuccessful because in practice, the two worlds seldom interact. The situation is compounded by the fact that professors and researchers have kept a different status with a major salary difference in favor of the former (the ratio is almost 1 to 4, that is, a monthly salary of about 1500 GeL (900 USD) for a professor against 420 (250 USD) for a researcher)[3].

There are some exceptions, however.

Some researchers are satisfied with their interaction with their academic counterparts. Although this opinion was never unanimous in any of the institutes we visited - there seems to be variations in sub-fields - it has been expressed in fields such as medicine, or biotechnology. These researchers explain this positive outcome by the very nature of their respective disciplines, where the divide between professors and researchers is negligible compared to other disciplines. The significant portion of scientific articles co-written by researchers and professors is an evidence of their active collaboration.

Also, some universities have apparently attempted to overcome salary differences by appointing their good researchers as professor. On the university side, the general opinion is that the "merger problem" is exaggerated – and amplified by those researchers that were not considered good enough to be granted a professor's position.

Finally, a private institution such as the Agricultural University, which enjoys more flexibility than its public counterparts to manage its human resources, has downsized its faculty from 890 to 250, retaining manly those that had the ability to both teach and research. Now, 80% of its professors are also researchers.

These are mere nuances in a globally negative picture: in the majority of the cases, the merger was unsuccessful. Some Universities have even established their own institutes, in direct competition with the institutes they were supposed to integrate. Some researchers indicated in the interviews that when they tried to obtain a professor's position to improve their salary, they could only find one in another University.

Universities are not the only source of the problem: a number of our interlocutors have criticized the pyramidal organization of the institutes themselves and the lack of collegial governance.

[3] Source: MoES internal database, 2013

In the eyes of many, a change of the legal status of the institutes, which could be transformed into so-called Legal Entities of Public Law (LEPL) would significantly improve the current situation. LEPL can be attached to several Universities, they are governed by a scientific council and they have more autonomy and flexibility, notably to seek additional means of financing.

Only a few institutes have been allowed to acquire a LEPL status to date, however. It is the case of the Eliava institute of bacteriology, for example, whose representatives consider that without such status, they could not have developed their commercial activities - that are now their main source of revenues.

3.1.2 Research funding

Figures are well-known and have been abundantly commented in previous reports. Consequently, this section only gives a brief reminder of the current situation.

With 0.17% of the country's GDP, Georgia's research budget is twelve to fifteen times below national research budgets in EU countries and almost twenty times below the 3% EU target for its members.

Given the country's actual GDP, Georgian research is critically underfunded. The number of scientists per 1000 employees is inferior to 2 in Georgia, where it is on average 5 in the EU (7 in the US). Moreover, a broad range of scientific experiments can no longer be conducted due to obsolete or inexistent equipment and lack of supplies.

The situation that prevails today was already summarized seven years ago in what appears to be the oldest report available on the state of research in Georgia:

> "The state of science, its present status, and position of scientists in the society – these are vivid examples of contradiction. At the theoretical level, important role of science as a special social subsystem in maintaining national security, reproducing technological and spiritual levels in its development, is recognized. On the other hand, low level of remuneration of intellectual labor, underestimation of its social significance, lack of opportunity for self-realization as a scientist, emergence of the situation called "status degradation" are the facts characterizing the sphere of science" (Khlevovits and Saluveer, 2007).

Since then, the only noticeable improvement concerns the introduction of a dual funding mechanism by the 2007 Law on on Georgian National Academy of Science (article 15).

Funding of research in Georgia is now assigned from the state budget via a two-level system:

- a block (fixed) funding ;
- a competitive funding based on peer-review, under the auspices of the Shota Rustaveli National Science Foundation (SRNSF). Pursuant to this system, funding is allocated under 3 types of grants:
    - for individual researchers (25%),
    - for teams, that may be composed of members from several institutions (50%);
    - for organization (25%) – these grants concern scientific equipment.

  Grants are of equal amounts (GEL 50,000 for one project of fundamental research and GEL 100,000 for one project of applied research) and distributed equitably across disciplines (three projects per discipline per annum).

Again, this system has been abundantly commented in other reports (for a recent account, see *e.g.* Bakradze, 2013). Consequently, we will focus here on the evolution of the perception of the role and contribution of the SRNSF by the research community, which is a symptomatic illustration of the detrimental consequences of its limited - and fluctuating - budget: since 2007, the amount available for grant competition has varied from about 7 to 24 million GEL, depending on the year (GEL 12.1 million in 2012, 20 million in 2013)[4].

All our interlocutors have indicated that in principle, the research community was very positive about the introduction of a dose of competition in research funding. Initially, researcher have welcomed the action of the SRNSF, whose efforts to introduce objective project assessment mechanisms have been widely acknowledged (the SRNSF maintains a database of up to 5,000 experts and the evaluation process can take up to 10 months).

However, the increase in the number of submitted projects and hence, in competition among research institutes in a context of sometimes decreasing funding has created a situation that has progressively undermined the credibility of the SRNSF.

With the increase of applicants, the decreasing percentage of selected projects mechanically corrupted the evaluation process. Instead of providing – as required – a comprehensive grading of several dimensions on a total of 100, many experts have resorted to an evaluation on a pass / fail basis, by giving an exaggeratedly high mark to the projects which they believed deserved to be selected and an exaggeratedly low mark to the other projects. Several researchers mentioned specific instances where two experts had given opposite marks to the same project.

When applicants began questioning the accuracy and fairness of their evaluations, the evaluation system adopted by the SRNSF (a written evaluation without a hearing or any possibility to appeal the verdict) lost its initial legitimacy and started being perceived as a black box.

More generally, the scarcity of resources has inevitably exacerbated rivalries among disciplines. World-class teams of researchers are now overtly questioning the competitive nature of a funding system that spreads a thin budget into too many projects without any *ex post* evaluation of their relative achievements, notably in terms of international recognition.

In a recent study covering the period 2007-2012, Matcharashvili et al. (2013) conclude that

> *"quality of peer reviewing of projects presented to the SRNSF grant competition do not enables selection of the most productive project teams; there is not any correlation between values of SRNSF reviewer's evaluation scores and bibliometric data of projects leaders in the Scopus data base. According to our results, in 2007-2012 substantial part of the governmental funding has been spent ineffectively."*

In sum, the image of the SRNSF has deteriorated as its mission was changing: established to promote excellence in scientific research, it has *de facto* become an institution whose primary task is to manage scarcity in research funding.

3.1.3 Research evaluation criteria

Unsurprisingly, depending on the fields of research, opinions vary as to what should be the main evaluation criteria.

Researchers in natural science strongly resemble their Western counterparts: they believe that teams should be assessed rather than individuals or institutes and they are very familiar and comfortable with general bibliometric indices (Chobanyan et al. 2010). At the opposite of the spectrum, independent institutes (LEPL) consider that their commercial success should be a

[4] Source: Shota Rustaveli National Research Foundation, 2014

component of their assessment. Finally, other researchers mention more traditional performance criteria such as direct contracts with the industry (a major performance criterion for engineering schools, which does not appear in bibliometric analysis), patents filed, growth of research subjects, internationalization...

Some interlocutors warned us about the potential danger of some traditional indicators in the Georgian context. For example, the number of Ph.D dissertations may be problematic in the absence of a quality control on their supervision. Likewise, a criterion such as the number of joint initiatives involving both institutes and universities might produce very artificial results considering that there are professors that are not researchers.

Finally, some noted that evaluating researchers that do not teach begs the question of the evaluation of the professors that do not do research. And as a matter of fact, this is what happened in Germany, where one assessment inevitably led to the other.

3.1.4 The Ph.D issue

There are more than 3,000 Ph.D students in Georgia, but the Head of the Tempus office in Georgia explains that the actual number of Ph.D students that will eventually obtain a Ph.D is in fact much lower: there is no state grant for doctoral students, and many cannot devote sufficient time to their studies because they have to work in parallel. In some cases the professor student ratio is 1:20. The difficulty to find Ph.D students willing to go abroad within the framework of an Erasmus mobility programs is symptomatic: potential candidates cannot afford to stop working and are afraid that they will not get their teaching position back when they return.

In every discipline, the general level of the Ph.D students is decreasing, notably for lack of proper supervision. In particular, it is extremely difficult for Ph.D students to make experiments: since only universities professors can supervise them, many cannot practice for lack of access to the institutes, which lost their right to deliver a Ph.D in 2007. Thus, absent any form of recognition or funding, researchers have no incentive to train Ph.D students on their own resources. Students that manage to do research have to volunteer to work in an institute and only a handful get a salary as lab assistant.

After completing their doctoral studies, young Ph.Ds cannot improve their limited research skills: there is no post-doctoral program in Georgia and also, they have to respond to an important university demand for teaching hours. Student tuitions being their main source of funding, universities tend to recruit more students, hence their need for more courses and curricula. At present, young Ph.Ds spend most of their time in classrooms and considering the alternative, that is, joining a research institute for a much lower salary, everything seems to be in place to ensure that they will never become researchers.

Some institutions are trying to improve this situation. Ilia State University, for example, is currently trying to assess the reality of its 400 Ph.D students and is aiming at a smaller group where will only remain those who have a reasonable chance of completing their Ph.D. In parallel, the doctoral program is increasingly demanding: publication in at least two peer-reviewed journals in the course of the Ph.D process is now mandatory. The Agrarian University has also made significant improvements: it now has only 20 Phd students (as opposed to 200 before), and each of them is involved in ongoing scientific projects in order to benefit from a real research training.

These are exceptions however: in most cases, little can be done to improve the research skills of the Ph.D students. To date, there is no legal basis to enable double affiliations (in a university and in an institute) and whilst highly desirable, such evolution is confronted to an important resistance on the part of the universities that do not want to give up their monopoly.

This Ph.D problem is potentially the biggest threat to Georgian research, because the country presently lacks a young generation of well-trained researchers, able and willing to take over a research sector predominantly populated by aging scientists that will retire in the next few years.

For the Ph.D is also the area where higher education and research are the most intertwined, it is important that the ongoing reform of the two sectors be devised in a way that introduces an incentive to go to science. In practice, this means the creation of a clear status of professor-researcher comparable to what exists in most universities in the world. Doctoral studies should be conceived as a first stage of a career track where students will have some visibility in terms of options and rewards.

3.1.5 Economic output of research

In general, researchers are well-informed about intellectual property issues. The Georgian National Intellectual Property Center (Sakpatenti) organizes regular workshops with scientists and also with universities, which do not necessarily have a clear IP sharing policy in case of discovery. In addition, it has partnerships with the largest universities, where Technology Transfer Centers are available to inform researchers.

There is no clear consensus as to the causes of the decline in patent filings. Researchers consider that it is the lack of funding that prevents them from filing patent applications. Instead, they choose to publish their results: since the invention is made public, this decision forbids future patent issuances, but at least the inventors are credited of their discovery. The Georgian National Intellectual Property Center is more nuanced about this financial argument, because it considers that it has managed to keep the cost of domestic filings at a very low level.

Given the current financial situation of the research institutes, it is not clear that all can afford even a low filing fee. But the real problem is beyond this debate: in any case, the cost of the international extension of domestic patents is out of reach: for Europe alone, it is around 20,000 USD. Considering that the commercial potential of a patent protection limited to the domestic market of a small country is negligible, this could also contribute to the decline in patent filings in Georgia.

Whilst the cost of the international extension of a domestic patent precludes any operation on a large scale, a few selected Georgian patents - those deemed to have the most promising commercial potential - should be subsidized. Who would make such selection remains an open question, however, although it seems that the newly established innovation agency is planning to establish a department dedicated to that very purpose.

3.2 SWOT Analysis

3.2.1 Summary chart

The chart below is a summary SWOT that reflects the state of Georgian research today.

Comprehensive SWOT analyses have already been conducted on this subject in the past and to a large extent, their conclusions remain valid (see *e.g.* the 2007 Policy Recommendations with the MoES). Thus, we have attempted to move one step further in the exercise by ranking issues in order of importance.

Each quadrant of the SWOT we propose is limited to the four key issues that we have identified as the most important in their respective dimensions.

Strengths	Weaknesses
• Georgia has preserved fields of excellence • Already existing pool of international experts • Research community already used to competitive funding • Researchers welcome an assessment of their work and willing to change	• Insufficient data to enable an informed research policy • Superficial merger between research institutes and universities • In a tuition-driven academic system, higher education institutions expect young professors to be in classrooms rather than in labs • Researchers isolated from academia and innovation
Opportunities	**Threats**
• Small country • Research is a component of a current reform of the education system • Georgia could internationalize its research assessment framework at the outset • Research assessment may serve broader purposes	• Aging research community • Critical underfunding of research • Existing Ph.D system • Inconsistent timing of current problems and reform agenda

3.2.2 Comments

- **Strengths**

As noted in our bibliometric analysis, Georgia has managed to maintain some areas of excellence in research, notably in physics, mathematics and to a lesser extent in medical and health sciences, where the share of articles is greater than average in former Soviet countries.

These results are more than mere nice scientific remains of the soviet period: they reflect the dynamism of a research community that has continued to progress in spite of increasingly difficult working conditions. This spirit is the main strength of Georgian research today, and the main reason why there is something left to save.

Also, in spite of the average age of the researchers and in sharp contrast with the research equipment and facilities, the Georgian research community is remarkably modern, in the sense that it has already adopted the lifestyle of the researcher of the twenty first century, from peer review and bibliometric assessment to competitive funding. In fact, all the researchers we met are prepared and willing to have their work assessed and they are welcoming a reform of the research.

Finally, in spite of its shortcomings, the state grant system implemented by the SRNSF has resulted in the creation of a database of 5,000 experts from every field to date, of which 4,000 are foreign experts. This already existing pool of national and international experts significantly broadens the options for a large-scale research assessment campaign.

- **Weaknesses**

The most important weakness of Georgia's research system is its organizational problem. In most cases, the merger with the universities remains superficial and as a result of their less favorable status, researcher positions remain financially unattractive. This problem is crucial but due to budgetary constraints, it will be at best resolved gradually, thus slowly.

More generally, researchers are too isolated and not only from academia: they are also insufficiently connected to the innovation ecosystem and they are marginally associated to the reform of their own activity.

Also, the current tuition-driven academic system has perverse effects on research. To increase their funding, higher education institutions seek to increase the number of their students and this creates an inflation of additional teaching hours to which young professors are assigned at the expense of their research activities.

Finally, the fact that outside of the major bibliometric databases, too little data is presently available on research output leaves some areas outside of the radar and this prevents the elaboration of an informed, targeted research policy.

- **Opportunities**

The small size of Georgia is clearly an opportunity from the point of view of research assessment, because a small research community enables fine-tuned and customized evaluation mechanisms. In the context of Georgia, each evaluation cycle, especially the first one, should also serve broader purposes, notably updating series of data on all forms of research output and on the researchers themselves.

Arguably, a small research community may complicate, if not compromise, objective peer review. Thus, Georgia could envisage an internationalization of the peer-review component of its research evaluation framework at the outset, in order to ensure the legitimacy of the process and hence, its acceptability by the research community.

Finally, the fact that the current research reform is part of a comprehensive reform of the higher education system is an opportunity, because both areas are obviously intertwined and their simultaneous design and implementation should enable a coordination that will avoid setting adverse priorities in key areas such as the reform of the Ph.D system.

- **Threats**

Given the current research budget, it is fair to consider that Georgian research is no longer funded. This critical underfunding is well known, but its actual implications are seldom made explicit. Next to the question whether sufficient funding will be available in the future, there is now the question whether the research sector will then be able to fully resume its development, because another threat that faces research in Georgia today is the predominantly aging research community.

Due to the nature and history of Georgian research, this demographic problem goes well beyond a matter of succession: it is a matter of transmission. Invaluable knowledge, expertise and methods developed in research institutes in the past decades will be lost when these researcher retire, for lack of young scientists willing to continue their work for an unacceptable salary and limited career prospects.

An aggravating factor is the current organization of the Ph.D system, notably its disconnection from the research institutes. The question of the replacement of the retiring researchers is thus also a question of skills: career choices aside, there is presently a scarcity of young scientists capable of taking over.

Last but not least, the legislative and regulatory agenda is a threat *per se*: if adequate measures aimed at ensuring the survival and the development of Georgian research are eventually decided and implemented, they may come too late.

4. RESEARCH ASSESSMENT MECHANISMS

4.1 Overview

4.1.1 The ingredients

The assessment of scientific research boils down to two methods: peer review and indicators. Very few countries rely exclusively on a single method, however, and this hybrid approach is symptomatic of the tensions inherent to evaluation policies and their underlying trade-offs.

From a national evaluation framework to another, nuances are thus found:

- In the relative weight of peer review and indicators;
- In the actual consequences of such assessment on research.

Depending on the prevalent ingredient, evaluation frameworks are broken down into two broad categories (Louvel, S. & Lange, S., 2010):

- « **formative** », *i.e.* with a prevalence of informed, peer-review approaches leading to a qualitative judgment expressed in the form of recommendations and / or grade(s) ;
- « **summative** », *i.e.* with a prevalence of indicators leading to a quantitative evaluation.

These two categories of frameworks are more or less relevant depending on the purpose(s) they serve, such as documenting and updating on the state of research, channeling and shaping research and rewarding excellence / sanctioning ineffective research, etc.

The type of knowledge on which they rely are characterized by five attributes (Gläser et *al*., 2010):

1) Rich (level of detail, comprehensiveness),
2) Accurate (reflecting the actual quality of the research),
3) Up-to-date (assessment periodicity),
4) Comparable (grades being more comparable than qualitative conclusions) and
5) Legitimate (in the eyes of the academic community that is being assessed).

The table below presents the quality of each type of evaluation methods according to each attribute. It shows that the richness of an evaluation is only achieved at the expense of its comparability and vice-versa:

ATTRIBUTE / TYPE OF EVALUATION	Rich	Up - to - date	Accurate	Legitimate	Comparable
Interactive peer-review	***	*	***	***	*
Peer-review (multi-factor)	***	*	**	***	*
Peer-review (single factor)	**	*	*	**	**
Multiple indicators	**	**	*	**	**
Single indicator	*	***	*	*	***

Quality :
High ***
Medium **
Low *

Adapted from Gläser, Lange et *al* and Louvel & Lange

4.1.2 Correlation between funding methods and assessment methods

As shown in the table below, types of funding and evaluation methods are not necessarily correlated, but it is important to add that when they do not explicitly include a competitive component, it means that they are not the whole picture and that another evaluation method is being used in parallel for allocation purposes.

Method of transferring resources	Type of evaluation	Example countries
Core funding or block grant funding	No evaluation of research	Block grant based on number of students (formerly Germany and Italy) Research field evaluation (formerly Norway and Sweden) Some allocation of funds according to a performance measure (Finland, Denmark)
Historical	Evaluation of research, but no link with funding	Netherlands
Negotiating	Involving quality assessment	France
Direct funding of research projects by granting councils	Peer review	Most countries
Contracts	Output	Most countries
Research performance indicators	Based on evaluation of research quality	Numerical indicators: Australia, Poland… Along with informed peer review: UK

Adapted from Iorwerth

This diversity is unlikely to last, however. For there is everywhere an increasingly explicit link between research performance and research funding, both the need for comparability and the high cost of a sophisticated peer review mechanism tends to increase the relative weight of numerical indicators and hence, the use of summative methods.

4.2 Trade-off options: cross-country analysis

Not only do research assessment trade-offs fluctuate from a country to another; they also fluctuate within the same country. The leading models have been abundantly described in recent reports (see *e.g.* Bakraze, 2013). For further comparison, we propose in Annex 6 a chart which summarizes the main features of the evaluation frameworks in additional countries (US, Australia…).

In this section, we will only focus on the prevalent features of the evaluation framework of three representative countries, namely the UK, Italy and Germany and on their evolution, using the classification of Louvel & Lange (2010).

4.2.1 UK: a competitive system with major implications on research funding

The British research assessment exercise (RAE) is a comprehensive evaluation framework with an important peer-review dimension, justified by its implications: it is a highly competitive system that conditions 90% of research funding allocation. This zero sum-game applies among institutions, but also among research units within the same institution: the best performing units capture most of the funding, the others disappear.

Although the RAE has inspired a number of countries (*e.g.* Australia, Italy…) it is often criticized for its inertia: now, assessment cycles occur every seven years only. Also, its accuracy and legitimacy are questioned because it promotes a narrow and standardized notion of quality that favors conformity at the expense of creativity and natural sciences at the expense of social sciences and humanities.

Overall, the RAE did improve research performance in the UK, but some critical observers point at its perverse effects, notably a “strategic” research totally shaped by the prevailing performance indicators.

4.2.2 Italy: a competitive system with intermediary implications on research funding

The Italian Valutazione Triennale della Ricerca (VTR) is a sophisticated variant of the RAE: a far more comprehensive – and expensive - evaluation process with less brutal financial implications.

Under the VTR, 20 disciplinary committees have mobilized no less than 6,000 national and international experts to evaluate 17,000 research outputs of various kinds such as articles, conference proceedings, books, patents, etc. Interestingly, this approach has resulted in reasonably comparable individual evaluations, since all were summarized in a global grade.

In addition to its richness, an interesting feature of the VTR lies in the fact that the impact of its results was initially limited to 30% of research fund allocation. At least in a first stage, this apparent disconnection has significantly contributed to establish the credibility of this evaluation framework in the research community.

4.2.3 Germany: a dual system

- **Level 1 : the Excellence Initiative (EI): a competitive system with intermediary implications on research funding**

The EI serves multiple purposes: it introduces a dose of competition, it increases the international visibility of German research and it creates synergies between universities and research institutes.

The EI is only one layer of research funding in Germany: it comes as a complement to non-competitive block grants that remain at the core of the research system. In practice however, the amount of such block grants that is decided at the level of the landers, is often negotiated by research institutions on the basis of the results of the EI.

As mentioned above, the EI is an important policy tool that contributes to reorganize the research landscape. It places universities in the front line and this forces them to better understand the activity of their respective research units when they apply for a given research project.

In general, the EI is considered to mobilize rich and valid data about research and its legitimacy is unquestionable, but it is criticized for the lack of comparability of the results it produces.

- **Level 2 : the Science Council Ranking (Wissenschaftsrat - WR): a formative system with no implications on research funding**

The objective of the WR is to analyze the strengths and weaknesses of research in general, identify avenues for reform or improvement and make recommendations.

This peer-reviewed mechanism being customized by discipline, it is thus accurate, legitimate and considered as very rich. But again, this very richness entails a lack of comparability that is often criticized.

4.2.4 Update and trends

Given the tensions inherent to any mix, evaluation frameworks are perpetual works in progress. They have changed and will change again because it is difficult to durably emphasize, let alone ignore, any given attribute.

To respond to criticisms, the British RAE has introduced in 2008 more richness at the expense of comparability, whereas the Italian VTR has taken an opposite route, as the link between research evaluation and research financing was becoming more important. Finally, in Germany, the EI that many researchers considered as a "black box" had to evolve towards more comparability at the expense of its richness and accuracy (Louvel & Lange, 2010).

The table below shows the main attributes of the three systems, under both their initial and present formats:

COUNTRY / ATTRIBUTE	UK		Germany		Italy	
	Initially	Now	Initially	Now	Initially	Now
Rich	**	**	***	***	***	**
Up-to–date	*	**	**	**	*	**
Accurate	**	***	***	***	**	**
Legitimate	**	**	**	***	***	***
Comparable	***	**	*	**	**	***

Quality :
High ***
Medium **
Low *

In sum, evaluations systems tend to give up their most distinctive features over time, whether because they have achieved their initial purpose, as in Germany, because they are perceived as too narrow, as in the UK, or because they increasingly become a policy tool, as in Italy.

4.3 What trade-off(s) for Georgia?

4.3.1 The need to clarify the purpose(s) of evaluating Georgian research

To be effective, the design of an evaluation framework must depend on its purpose(s). Research evaluation aims to do one, or more, of the following (Guthrie et al, 2013):

- ***advocate:*** *to demonstrate the benefits of supporting research, enhance understanding of research and its processes among policymakers and the public, and make the case for policy and practice change ;*
- ***show accountability:*** *to show that money and other resources have been used efficiently and effectively, and to hold researchers to account ;*
- ***analyze:*** *to understand how and why research is effective and how it can be better supported, feeding into research strategy and decision-making by providing a stronger evidence base;*
- ***allocate:*** *to determine where best to allocate funds in the future, making the best use possible of a limited funding pot.*

What is the purpose of research evaluation in Georgia? Considering the shortcomings identified above, the last two objectives - "analyze" and "allocate" are, in that order, the most important.

First, an in-depth analysis of Georgian research is urgently needed. It is a prerequisite to defining a research policy and it supposes that the main data are available. The main bibliometric databases are acceptable sources of information for most natural science fields, but they do not provide an accurate picture of social sciences and humanities. At least for these latter fields, a broad collection of data among the research institutes themselves followed by a peer-review assessment is a necessary investment. In this regard, Georgia's size is an asset: it allows an exhaustive and in-depth evaluation within a reasonable timeframe.

Second, even if the current research budget is significantly increased, choices will have to be made, that is, establishing priority areas so that grant allocation criteria may be defined accordingly. It is difficult to prioritize fields of research everywhere, but in the case of Georgia it is even more sensitive, because the size of the research budget means that non-priority areas will be virtually abandoned.

Unfortunately, the two objectives described above – analyze and allocate - cannot be achieved using the same evaluation framework. The first requires a comprehensive formative approach to show 'how' and 'why' the research is effective, whereas the second has to be more summative because it requires comparisons to be made among research fields and within research fields, among research institutions.

The table below describes the respective purposes of the frameworks in force in a selection of countries:

Framework purpose(s)	**UK**	**Australia**	**US**	**Canada**	**Europe**
Advocacy	✓	✓	✓	✓	✓
Accountability	✓	✓	✓	✓	✓
Analysis				✓	✓
Allocation	✓	✓	✓		

Adapted from Guthrie et al.

These examples confirm that the same framework cannot be suited for both analysis and allocation. To achieve both aims effectively requires two parallel, though potentially connected, evaluation processes (Guthrie et al. 2013).

4.3.2 Tentative framework for research funding

It is not in the scope of this mission to propose a research evaluation framework or a funding strategy. Therefore, the foregoing will be limited to general orientations identified in the previous section.

Clearly, multi-layered frameworks such as the German assessment system seem to be the relevant benchmarks for Georgia, but with a philosophy comparable to the Italian assessment system, that is, a comprehensive assessment whose initial objective will be to achieve an in-depth understanding of the state of research in every field.

Since research assessment and research funding will be inevitably linked, it is important to clarify at the outset what this will mean for each field of research. This could be done by presenting the layers of the system from the funding angle.

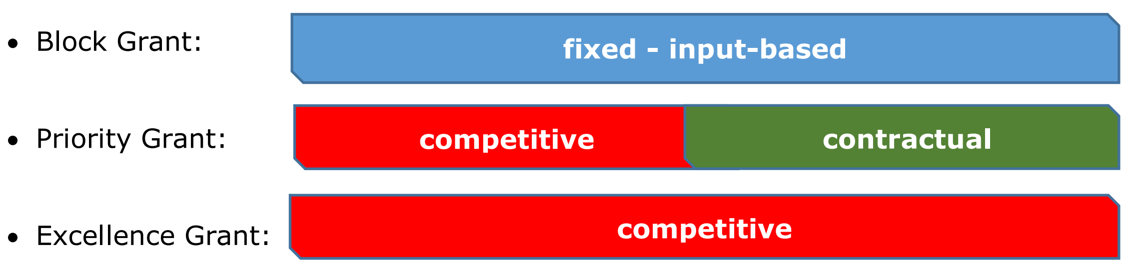
For example, the Georgian research funding system could be broken down into three layers (types of grant) as follows:

- Block grant: a fixed funding, input-based in a first phase, then objective-based. As long as there will be a lack of data on research output in some fields of research, the funding of Georgian research institutions will continue to require at least a dose of input-based funding to cover their basic needs. Once research activities and outputs will be better documented, the input-based logic could be replaced (in part or in totality) by a contractual logic (i.e. peer-reviewed, objective-based). From this point on, research institutions will be expected to define, in agreement with third party experts, their research program and objectives for the next three to five years. This will condition the evolution of their fixed funding: at the end of every cycle, their research output will be assessed and another program will be agreed upon for the next cycle.

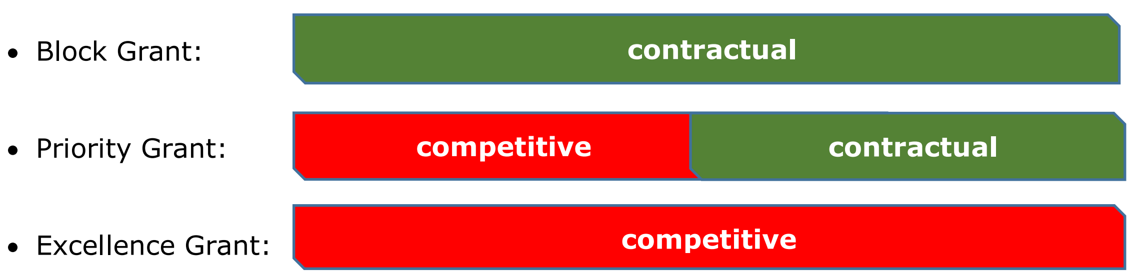
- Research priority grant: a variable funding aiming at prioritizing research fields and within such fields, at channeling research towards priority subject areas and research output. Such grant should reflect the priorities defined in common by the Ministry of Education and Science and the Ministry of Economy and Sustainable Development. It should include a dose of competitive funding (performance-based) as well as a dose of contractual funding (objective-based).
- Excellence grant: a variable funding aiming at rewarding research performance in general or within selected fields of research.

Depending on the field and on research priorities, the relative importance of these grants could evolve over time, as the knowledge about research output and its analysis progress.

In the short-term:



In the medium-term (in three to five years):



NB: the relative weight of each grant is not addressed here.

The least documented fields in social sciences and humanities should evolve gradually, whereas in natural science fields for which bibliometric databases already provide sufficient information, the medium-term target mechanism could be applied immediately.

4.3.3 Who should evaluate Georgian research?

According to Georgian law, the assessment of research activities is presently a prerogative of the Academy of Science which "discusses and evaluates annual reports reflecting the research activities and finalized research of Georgian HEIs and research institutes (Law on the Academy of Science, Article 4).

Apparently, the assessment activity of the Academy of Science has been limited so far: it does not seem that it has defined clear evaluation criteria or comprehensive peer-review assessment procedures. It has recommended five priority areas, however:

- Agriculture;
- Biotechnologies;
- Information Technologies;
- Transformation of theoretical science into practice;
- Georgian studies.

The Academy of Science has an advisory role only, but this list highlights the difficulty of the task, which is not so much about the fields that are retained than about those that are excluded.

For example the only non-natural science retained - Georgian studies - is very consensual. The fact that this cluster must be preserved and thus, somewhat excluded from competition is perhaps the only subject about which all the stakeholders seem to be unanimous.

Conversely, it is not clear why this list does not include mathematics, which in terms of publications is Georgia's main field of excellence. Also, it is implicitly suggesting that social sciences as a whole should be sacrificed, unless the vagueness of the fourth item leave some room to applied social sciences.

Next to the prerogatives of the Academy of Science, another evaluation of the academic community takes place within the framework of the quality assurance process. This framework is interesting, notably because it contains a dose of self-assessment, but although it should also encompass research activities, it is presently limited to teaching activities (Law on Higher Education, Article 25).

In sum, the assessment of Georgian research is left in the hands of very few stakeholders. On the one hand, this is not exceptional: since their inception, the German EI, the British RAE and the Italian VTR also rely on a highly centralized evaluation system that contrasts with the otherwise highly decentralized organization of these countries. On the other hand, the potential tension between research policy and innovation policy and the potentially drastic implications of research priorities call for more check and balance.

This question is also beyond the scope of this study, but it points at the necessity to clarify at the outset how the system will be governed and monitored, because this may require legislative adjustments.

4.3.4 The importance of self-assessment

To collect data with a limited cost and also, to anticipate and prepare the contractual mechanism that will be eventually introduced in the funding system, it seems important that a significant portion of the process be organized in the form of a self-assessment.

A research project does not boil down to inputs and outputs. Thus, requiring researchers to better describe their work and their objectives has virtues for the evaluators as well as for the researchers themselves.

For the sake of efficiency and comparability of such self-evaluation however, it is important to ensure that they will get a proper training to be able to clearly distinguish the various types of phases and results of a research process. Given the small size of Georgia's community, such training could be easily organized with limited means.

Below is an example of the kind of result-based management table that could be used to facilitate self-assessment:

RESULTS-BASED MANAGEMENT TABLE

Project Title:		**Name of Research Institution:**		
Expected Results	**Indicators**	**Targets**	**Actual Results for the Reporting Period**	**Cumulative Results**
Input				
Immediate Input Intermediate input				
Activities				
Outputs				
Outcome				
Immediate Outcomes Intermediate Outcomes Ultimate outcome				
Impacts				

Source: Canadian Ministry of Education

CONCLUSION

The assessment of scientific research serves multiple purposes but in Georgia, the current lack of a comprehensive research output database and the scarcity of research funding justify that two purposes, namely “analyze” and “allocate” be served first. Accordingly, a simple evaluation framework is insufficient: it has to be a sophisticated, multi-layered framework involving a peer-review process that goes beyond conference proceedings and articles to include research output such as books and patents.

Considering the potentially drastic implications of such assessment, a specific attention should be devoted to the transparency and the legitimacy of the process. From a practical point of view, this requires a significant and visible pool of international experts and also, more monitoring by more stakeholders – in short more check and balance - than what Georgian law currently requires.

Finally, it is important to recall that in parallel, it is urgent to resolve the problem posed by the lack of a young generation of scientists capable and willing to take over a research sector predominantly populated by aging researchers.

It is thus necessary to ensure that the research strategy and the innovation strategy that will be respectively implemented by the Ministry of Education and Science and the Ministry of Economy and Sustainable Development will each provide clear incentives to go to science.

REFERENCES

- Adler, A, Harzing, A-W (2009), When Knowledge Wins: Transcending the Sense and Nonsense of Academic Rankings", Academy of Management, learning and education, available at:
- Bakradze, L., (2013) Integration of Teaching and Research, *in* Strategic Development of Higher Education and Science in Georgia: Policy Analysis of Higher Education according to Five Strategic Directions Expert –, The International Institute for Education, Policy, Planning and Management
- Chobanyan L., Makhviladze N., Shatberashvili O., Tsotskolauri P. (2010) The unification of bibliometric indices to assess the level of scientific productivity at the micro- and mezzo- levels , Georgian Federation for Information and Documentation, Institute TECHINFORMI
- European Foundation Centre: Research Forum Evaluation Guidelines 3: How to evaluate (2010). Available at: http://www.efc.be/programmes_services/resources/Documents/Research_Evaluation_Guidelines_3_How_to_Evaluate.pdf
- European Science Foundation
  - Ex-post Evaluation in National Research Funding Agencies: A report of the ESF Member Organisation Forum on Ex-Post Evaluation of Funding Schemes and Research Programmes (2009). Available at: http://www.esf.org/activities/mo-fora/publications.html
  - European Peer Review Guide: Integrating Policies and Practices into Coherent Procedures. A Report by the ESF Member Organisation Forum on Peer Review (2011). Available at: http://www.esf.org/activities/mo-fora/publications.html
  - Indicators of Internationalisation for Research Institutions: a new approach. A report by the ESF Member Organisation Forum on Evaluation: Indicators of Internationalisation (2012). Available at: http://www.esf.org/activities/mo-fora/publications.html
  - A Guide to Evaluation Activities in Funding Agencies. A report by the ESF MO Forum on Evaluation of Publicly Funded Research (2012)
    - Working Group 1: Quality Assurance and Evaluation Guidelines. Available at: http://www.esf.org/activities/mo-fora/evaluation-of-publicly-funded-research.html
    - Working Group 2: Impact Assessment. Available at: http://www.esf.org/activities/mo-fora/evaluation-ofpublicly-funded-research.html
    - Working Group 3: Comparative Research Portfolios. Available at: http://www.esf.org/activities/mo-fora/evaluation-ofpublicly-funded-research.html
- Gläser, J., Lange S. et *al.*, (2010), « Informed Authority? The Limited Use of Research Evaluation Systems for Managerial Control in Universities », *in* R. WHITLEY J. Gläser Et L. Engwall *Reconfiguring Knowledge Production : Changing Authority Relations in the Sciences and Their Consequences for Intellectual Innovation*, Oxford University Press
- Guthrie S., Wamae W., Diepeveen S., Wooding S., Grant J (2013), Measuring research : A guide to research evaluation frameworks and tools. Rand Corporation, Available at: http://www.rand.org/pubs/monographs/MG1217.html
- Iowerth, A. (2005), *Methods of evaluation research around the world*. Working paper, Canadian Ministry of Finance, Available at:
- Khlevovits D.. Saluveer M., (2007), Georgian Report and Development Policy Assessment, EU Funded Project.
- Knowledge-Based Estonia: Estonian Research and Development and Innovation Strategy, 2007-2013 (2009) Available at: http://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CDMQFjAA&url=http%3A%2F%2Fwww.hm.ee%2Findex.php%3Fpopup%3Ddownload%26id%3D617

5&ei=O2ddU5vbIseyyAOdloC4Bw&usg=AFQjCNEZs5iWSlTW1WjSo5PFAbjsMXNf5A&bvm=bv.65397613,d.Yms

- Louvel, S. & Lange, S. (2010). L'évaluation de la recherche : l'exemple de trois pays européens. *Sciences de la société,* volume 79, pp. 11-26. Available at: http://halshs.archives-ouvertes.fr/docs/00/57/63/69/PDF/Louvel_Lange_Sciences_de_la_societe_2010.pdf
- Matcharashvili, T., Tsveraidze, Z., Sborshchikovi, Z. (2013) Importance of bibliometric indicators for the analysis of the research performance in Georgia – Working paper
- Nordforsk (2010). Bibliometric Research Performance Indicators for the Nordic Countries. W. Schneider (Ed.)
- Rostaing H. (1996), *La bibliométrie et ses techniques*, Collection Sciences de la société, Co-édition: Sciences de la société (Toulouse) et Centre de recherche rétrospective de Marseille (Marseille).
- Sivertsen, Gunnar (2009) Publication patterns in all fields. In Åström, Fredrik; Danell, Rickard; Larsen, Birger & Wiborg-Schneider, Jesper (eds.) *Celebrating Scholarly Communication Studies. A Festschrift for Olle Persson at his 60th Birthday*. Special volume of the e-newsletter of the international society for scientometrics and informetrics. Vol. 05-S June 2009:55-60.
- Thelwall, M. (2007). *Bibliometrics to Webometrics.* Journal of Information Science, 34 (4); http://www.scit.wlv.ac.uk/~cm1993/papers/JIS-0642-v4-Bibliometrics-to-Webometrics.pdf.
- Thomson Reuters. 2008. Whitepaper Using Bibliometrics : A guide to evaluating research performance with citation data. http://thomsonreuters.com/products/ip-science/04_030/using-bibliometrics-a-guide-to-evaluating-research-performance-with-citation-data.pdf . Accessed 1 August, 2013.
- Waltman,L. and Jan van Eck, N. (2012). Source normalized indicators of citation impact: An overview of different approaches and an empirical comparison. Centre for Science and Technology Studies (CWTS) working paper series. http://arxiv.org/ftp/arxiv/papers/1208/1208.6122.pdf. Accessed 28 July, 2013.
- Zedania G. et al. (2009) An Assessment of Research Capacities in The Social Sciences and Humanities in Georgia, Report to the Academic Swiss Caucasus Net (ASCN).

APPENDIX

Annex 1: List of institutions visited

1. Higher Education Institutions (interviews with Heads / Rectors)

- **Public universities**
  - Georgian Technical University
  - Ivane Javakhishvili State University
  - Ilia State university

- **Private universities**
  - Agricultural University of Georgia
  - The International School of Economics – ISET

2. Research institutes

2.1 Workshops with University institutes

- Georgian Technical University
  - Insitute of management systems
  - Center of biotechnologies
  - Muskhelishvili Institute of computing mathematics
  - Institute of Food technologies
  - Institute of Cibernetics
  - Institute of Geology
  - Institute of water management
  - Techinform
  - Construction technologies institute
  - Institute of natural resources
  - Institute of membrane technologies
  - Institute "Wave" (Talgha)
  - Institute of Hydrometeorology
  - Institute of electrical engineering
  - Institute of "Analytical devices"

- Ivane Javakhishvili State University
  - Institute of Morphology
  - Institute of Geology
  - Razmadze Institute of Mathematics
  - Tsereteli Institute of Law
  - Chikobava Institute of Linguistics
  - Andronikashvili Institute of Physics
  - Bagrationi Institute of Geology
  - Institute of History and Ethnography
  - Vekua Institute of Applied Mathematics
  - Tvalchrelidze Institute of Mineral Resources
  - Institute of High Energy Physics
  - Nodia Institute of Geophysics
  - Gugushvili Institute of Economics
  - Melikishvili institute of chemistry
  - Agladze institute of chemistry
  - Rustavekli Institute of Literature

2.2 Specific visits

- Affiliated institutes
    - Institute for High Energy Physics
    - Aleksandre Tvalmchrelidze Caucasus Institute of Mineral Materials
    - Petre Melikishvili Institute of Physics and Organic Chemistry
    - Institute of History and Ethnography

- Independent institutes (LEPL)
    - Eliava institute of bacteriology
    - Beritashvili center of Experimental medicine

3. Other

- Academy of Science
- Georgia’s Innovation and technology Agency
- National Intellectual Property Center of Georgia (Sakpatenti)
- Ministry of Education and Science
- Shota Rustaveli National Science Foundation (SRNSF)
- Tempus office in Georgia
- USAID office in Georgia
- World Bank office in Georgia

Annex 2: Statistical information

a. HE and research funding by years (Georgia)

Years	2008	2009	2010	2011	2012
GDP Million GeL	19069.6	17986	20740	24344	26139
Factual expenditure (State funds) on research projects* Million GeL	31,2	39,7	38	21	18,5
As % of GDP	0,16	0,22	0,18	0,09	0,07
HE and research programs** Million GeL	52,6	58,2	51,5	32,6	33,2
As % of GDP	0,28	0,32	0,25	0,13	0,13
Number of PhD students	1588	2986	-	4266	3040

b. SRNSF funding by years (2007-2013)

Organizations	Budget/research grants	Budget/administration	Year
GNSF	6,569,448	447,322	2007
GNSF	9,323,731	482,364	2008
GNSF	15,770,979	740,377	2009
RF	2,465,000	331,900	2008
RF	4,402,800	431,900	2009
SRNSF	20,919,290	1,514,420	2010
SRNSF	23,699,000	1,175,500	2011
SRNSF	12,184,757	1,228,420	2012
SRNSF	20,053,600	1,125,200	2013

Sources: SRNSF

GNSF Georgian National Science Foundation
RF Rustaveli Foundation
SRNSF Shota Rustaveli National Science Foundation

c. Researchers by age categories (Georgia)

Average age of researchers	56
More than 65 years	586
60-65 years	292
40-60 years	730
Less than 40 years	202

Source: MoES internal data, 2013

d. Number of Professors by status and years (Georgia)

Persons						
	Total	of which				
		Full Professor	associate professor	assistant professor	teacher	unidentified
In public institutions, total						
2007-2008	4642	1028	1981	1633	-	
2008-2009	3884	944	1782	1158	-	
2009-2010	4455	1056	1990	1106	303	
2011-2012	4582	929	1856	1014	445	338
2012-2013	4324	951	1854	1019	225	275
2013-2014	5386	1197	1970	982	712	525
In private institutions, total						
2007-2008	1610	538	497	575	-	
2008-2009	1568	515	508	545	-	
2009-2010	2151	755	758	420	218	
2011-2012	2415	495	786	272	681	181
2012-2013	1963	564	798	265	313	23
2013-2014	2890	647	1026	314	815	88

Source: National Statistics Office of Georgia.

e. Number of scientific heads of doctoral candidates

	2009	2011	2012	2013
Number of scientific heads	1530	904	1454	1507
of which females	517	280	541	547
from the total number:				
Professor	870	507	756	714
Associate Professor	459	209	422	489
Others	201	188	276	304
Number of scientific heads of doctoral candidates, who have non-Georgian citizenship	18	6	4	-

Source: National Statistics Office of Georgia

f. Number of PhD students (Georgia)

	2007	2008	2009	2011	2012	2013
Number of persons working for doctoral degree, total	**786**	**1588**	**2986**	**4266**	**3040**	**3213**
of which by field of science:						
Education	30	88	141	135	235	164
Humanities and Arts	176	340	628	756	634	570
Social sciences, business and law	480	709	1046	2096	919	1304
Science	12	195	343	564	607	508
Engineering, manufacturing and construction	62	107	373	385	344	338
Agriculture	22	69	192	65	5	15
Health and welfare	4	74	195	168	212	255
Services	-	6	68	97	84	59
of which females, total:	471	971	1787	2494	1673	1784
of which by field of science:						
Education	26	69	107	106	152	95
Humanities and Arts	141	275	493	585	426	397
Social sciences, business and law	251	385	574	1124	468	717
Science	5	101	188	328	313	242
Engineering, manufacturing and construction	32	47	143	138	116	118
Agriculture	12	39	110	40	3	6
Health and welfare	4	51	140	125	158	188
Services	-	4	32	48	37	21

Source: National Statistics Office of Georgia

g. Number of researchers by field

Agrarian sciences	125
Arts and Humanities	370
Astrophysics	71
Biochemistry, Genetics and Molecular Biology	100
Biology	167
Chemistry	182
Engineering and technology	336
Geography	38
Geology	48
Geophysics	69
Mathematics	102
Medical and Health sciences	316
Mixed	29
Physics	121
Social Sciences	101
Grand Total	**2175**

Annex 3: R&D related indicators per country in selected areas (Global Competitiveness Report)

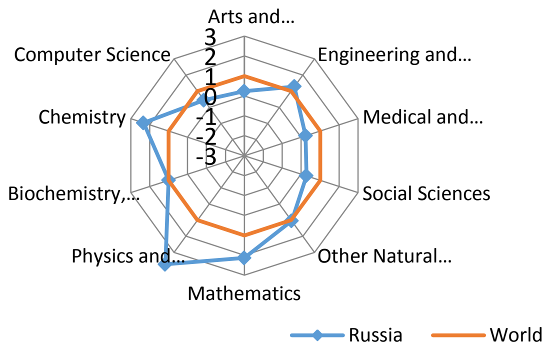
FACTORS OF SUPPLY FOR R&D IN CEE COUNTRIES	Quality of education system	Quality of maths and science teaching	Quality of scientific research institutions	Availability of scientists and engineers	PCT patents million population / Utility patents
Albania 2008-2009	80	62	133	115	88
Albania 2012-2013	40	61	132	123	119
Armenia 2008-2009	98	76	101	90	63
Armenia 2012-2013	79	71	111	73	61
Azerbaijan 2008-2009	78	92	40	28	67
Azerbaijan 2012-2013	109	99	65	44	79
Bosnia & Herzegovina 2008-2009	92	107	128	100	88
Bosnia & Herzegovina 2012-2013	106	21	72	48	50
Croatia 2008-2009	66	30	50	58	35
Croatia 2012-2013	99	26	48	86	33
Estonia 2008-2009	30	14	25	74	30
Estonia 2012-2013	49	19	25	69	26
Georgia 2008-2009	83	75	113	84	44
Georgia 2012-2013	114	101	125	124	60
Kazakhstan 2008-2009	68	80	58	83	72
Kazakhstan 2012-2013	101	81	108	104	65
Kyrgizstan 2008-2009	74	84	123	116	88
Kyrgizstan 2012-2013	123	114	140	135	102
Latvia 2008-2009	63	57	88	112	59
Latvia 2012-2013	74	48	58	110	30
Lithuania 2008-2009	64	22	46	65	43
Lithuania 2012-2013	54	16	32	59	39
Macedonia 2008-2009	65	52	95	70	88
Macedonia 2012-2013	38	67	100	106	59
Montenegro 2008-2009	57	34	92	71	88
Montenegro 2012-2013	38	44	54	76	119
Romania 2008-2009	71	18	84	60	55
Romania 2012-2013	108	55	84	82	56
Russia 2008-2009	36	24	45	34	41
Russia 2012-2013	86	52	70	90	90
Serbia 2008-2009	49	31	49	50	49
Serbia 2012-2013	108	55	84	82	56
Slovenia 2008-2009	35	28	28	85	26
Slovenia 2012-2013	63	18	29	84	23
Tajikistan 2008-2009	96	113	68	98	88
Tajikistan 2012-2013	67	91	76	83	119
Ukraine 2008-2009	40	32	48	54	65
Ukraine 2012-2013	70	34	64	25	51

FACTORS OF DEMAND FOR R&D IN EE COUNTRIES	Extent of staff training	Firm level technology absorption	Production process sophisti-cation	Buyer sophisti-cation	Company spending on R&D	Government procurement of advanced technological products	Capacity for innova-tion
Albania 2008-2009	71	110	93	109	133	119	134
Albania 2012-2013	36	80	60	62	83	46	128
Armenia 2008-2009	117	109	103	88	96	122	68
Armenia 2012-2013	98	96	84	64	111	108	62
Azerbaijan 2008-2009	39	52	47	90	67	23	39
Azerbaijan 2012-2013	12	13	7	27	13	50	9
Bosnia & Herzegovina 2008-2009	126	133	123	119	119	131	126
Bosnia & Herzegovina 2012-2013	109	105	90	124	90	94	101
Croatia 2008-2009	64	100	60	82	45	69	42
Croatia 2012-2013	124	77	104	116	76	129	72
Estonia 2008-2009	35	30	39	56	40	18	40
Estonia 2012-2013	46	34	45	103	42	35	33
Georgia 2008-2009	73	108	84	86	93	121	97
Georgia 2012-2013	101	123	112	106	125	61	116
Kazakhstan 2008-2009	92	85	52	75	62	59	50
Kazakhstan 2012-2013	72	91	76	36	94	71	92
Kyrgizstan 2008-2009	102	121	98	103	118	127	90
Kyrgizstan 2012-2013	128	136	133	97	141	138	140
Latvia 2008-2009	62	81	65	80	72	100	71
Latvia 2012-2013	53	90	66	83	67	85	49
Lithuania 2008-2009	38	58	64	67	48	83	52
Lithuania 2012-2013	66	53	50	109	64	96	47
Macedonia 2008-2009	83	131	105	104	98	111	83
Macedonia 2012-2013	126	133	111	133	123	102	99
Montenegro 2008-2009	84	91	83	63	76	67	120
Montenegro 2012-2013	51	100	89	88	63	76	53
Romania 2008-2009	54	94	73	71	74	73	58
Romania 2012-2013	111	116	103	102	87	114	77
Russia 2008-2009	80	105	66	74	46	66	45
Russia 2012-2013	89	129	113	61	79	124	56
Serbia 2008-2009	121	126	114	102	97	92	92
Serbia 2012-2013	138	142	129	138	132	115	120
Slovenia 2008-2009	43	60	34	45	27	89	20
Slovenia 2012-2013	91	78	49	108	47	106	31
Tajikistan 2008-2009	105	119	76	111	107	61	61
Tajikistan 2012-2013	79	95	72	44	65	26	51
Ukraine 2008-2009	99	80	53	81	52	54	31
Ukraine 2012-2013	106	69	80	73	104	97	59

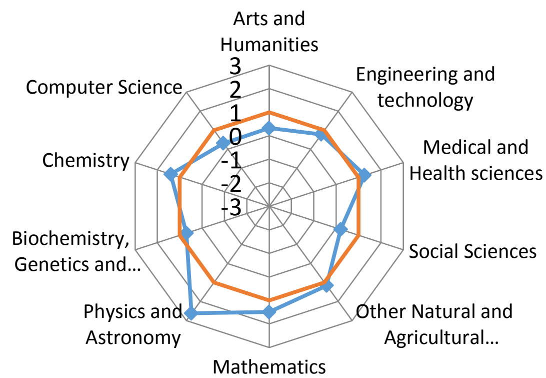
Countries	Factor driven (FD) stage	Transition from FD to ED stage	Efficiency driven (ED) stage	Transition from ED to ID stage	Innovation driven (ID) stage
Albania 2008-2009			X		
Albania 2012-2013			X		
Armenia 2008-2009		X			
Armenia 2012-2013			X		
Azerbaijan 2008-2009		X			
Azerbaijan 2012-2013		X			
Belarus 2008-2009					
Belarus 2012-2013					
Bosnia & Herzegovina 2008-2009			X		
Bosnia & Herzegovina 2012-2013			X		
Croatia 2008-2009				X	
Croatia 2012-2013				X	
Estonia 2008-2009				X	
Estonia 2012-2013				X	
Georgia 2008-2009		X			
Georgia 2012-2013			X		
Kazakhstan 2008-2009		X			
Kazakhstan 2012-2013				X	
Kyrgizstan 2008-2009	X				
Kyrgizstan 2012-2013	X				
Latvia 2008-2009				X	
Latvia 2012-2013				X	
Lithuania 2008-2009				X	
Lithuania 2012-2013				X	
Macedonia 2008-2009			X		
Macedonia 2012-2013			X		
Montenegro 2008-2009			X		
Montenegro 2012-2013			X		
Romania 2008-2009			X		
Romania 2012-2013			X		
Russia 2008-2009				X	
Russia 2012-2013				X	
Serbia 2008-2009			X		
Serbia 2012-2013			X		
Slovenia 2008-2009					X
Slovenia 2012-2013					X
Tajikistan 2008-2009	X				
Tajikistan 2012-2013	X				
Turkmenistan 2008-2009					
Turkmenistan 2012-2013					
Ukraine 2008-2009			X		
Ukraine 2012-2013			X		

Annex 4: Relative Specialization index (RSI): selected countries

RSI Russia (2010-2012)

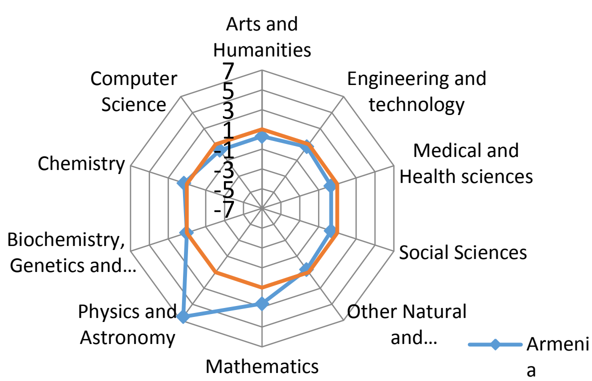


Source: Scopus database (2010-2012)

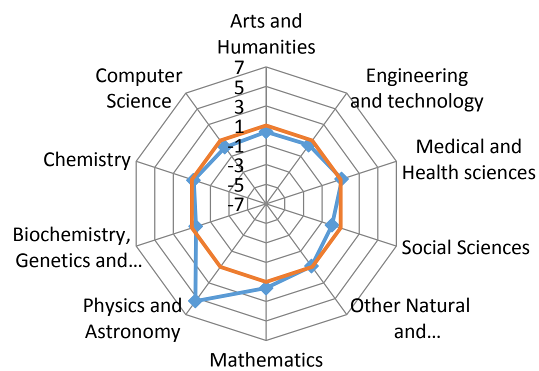


Source: Web of Science database (2010-2012)

RSI Armenia (2010-2012)

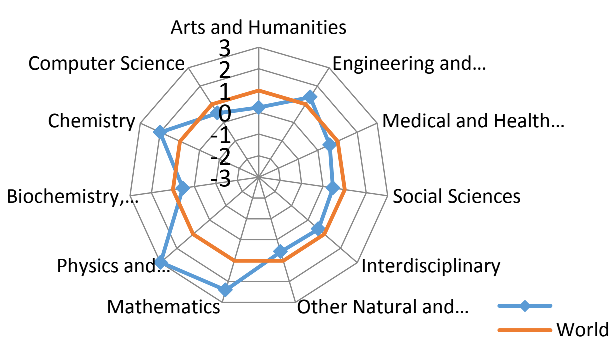


Source: Scopus database (2010-2012)

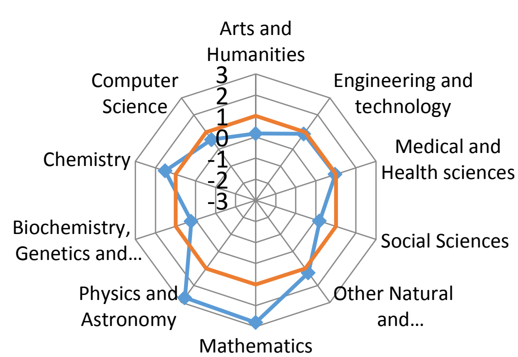


Source: Web of Science database (2010-2012)

RSI Azerbaijan (2010-2012)

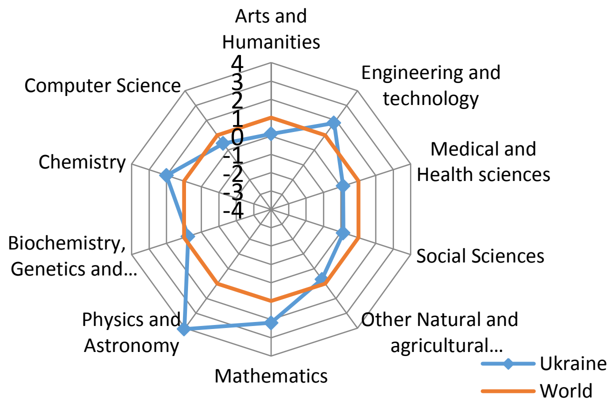


Source: Scopus database (2010-2012)

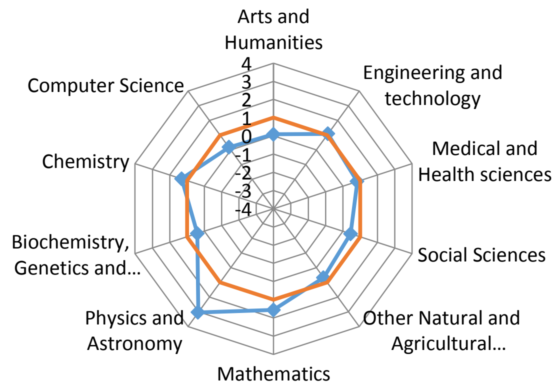


Source: Web of Science database (2010-2012)

RSI Ukraine (2010-2012)

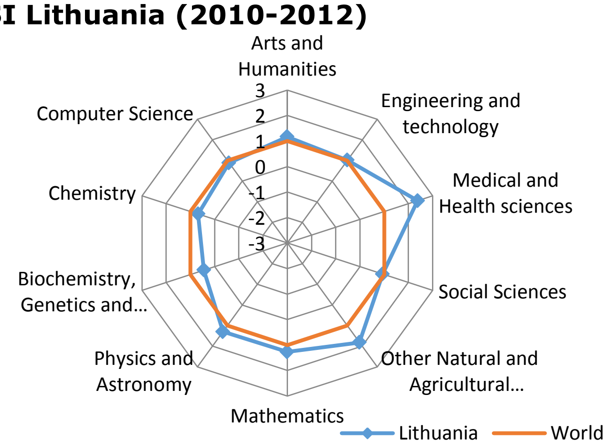


Source: Scopus database (2010-2012)

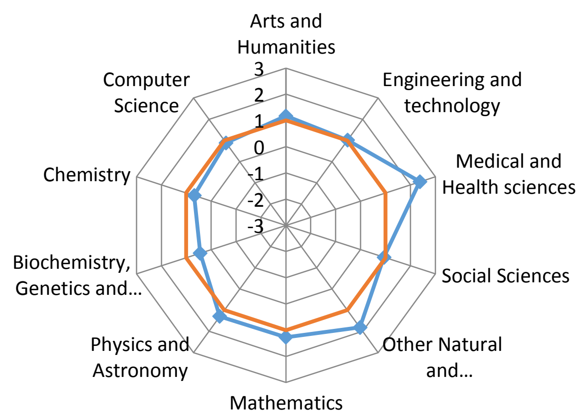


Source: Web of Science database (2010-2012)

RSI Lithuania (2010-2012)

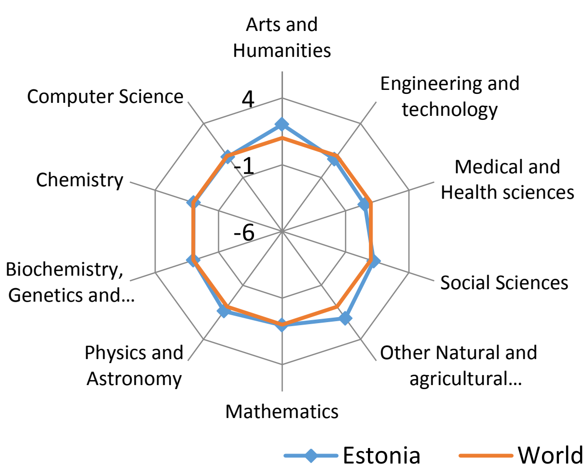


Source: Scopus database (2010-2012)

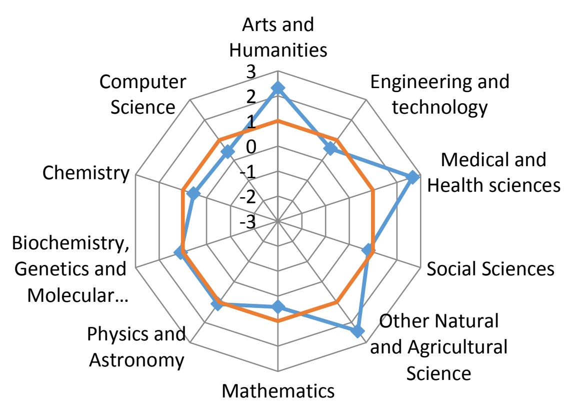


Source: Web of Science database (2010-2012)

RSI Estonia (2010-2012)



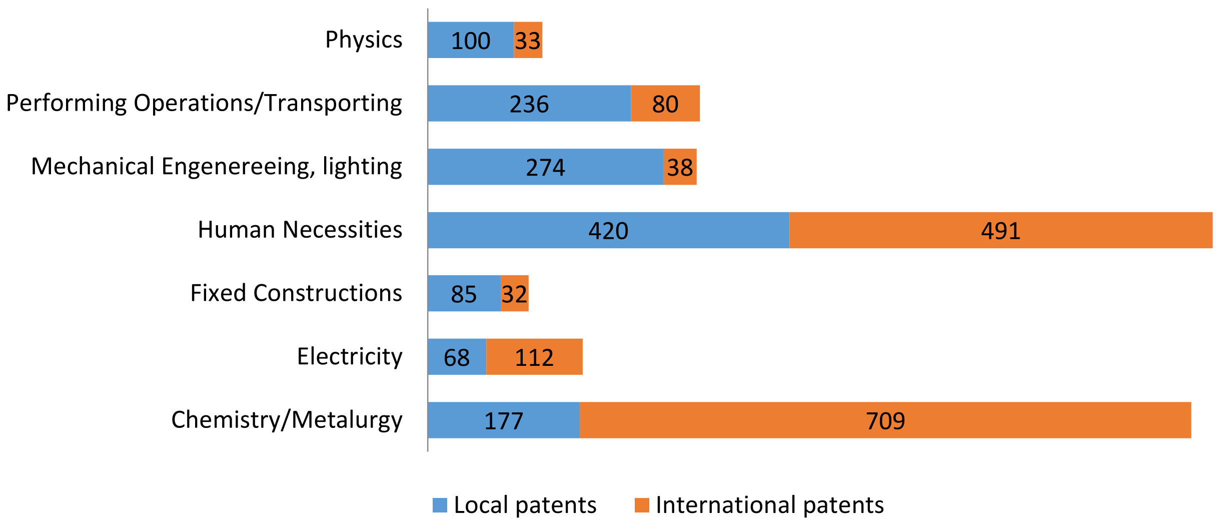
Source: Scopus database (2010-2012)



Source: Web of Science database (2010-2012)

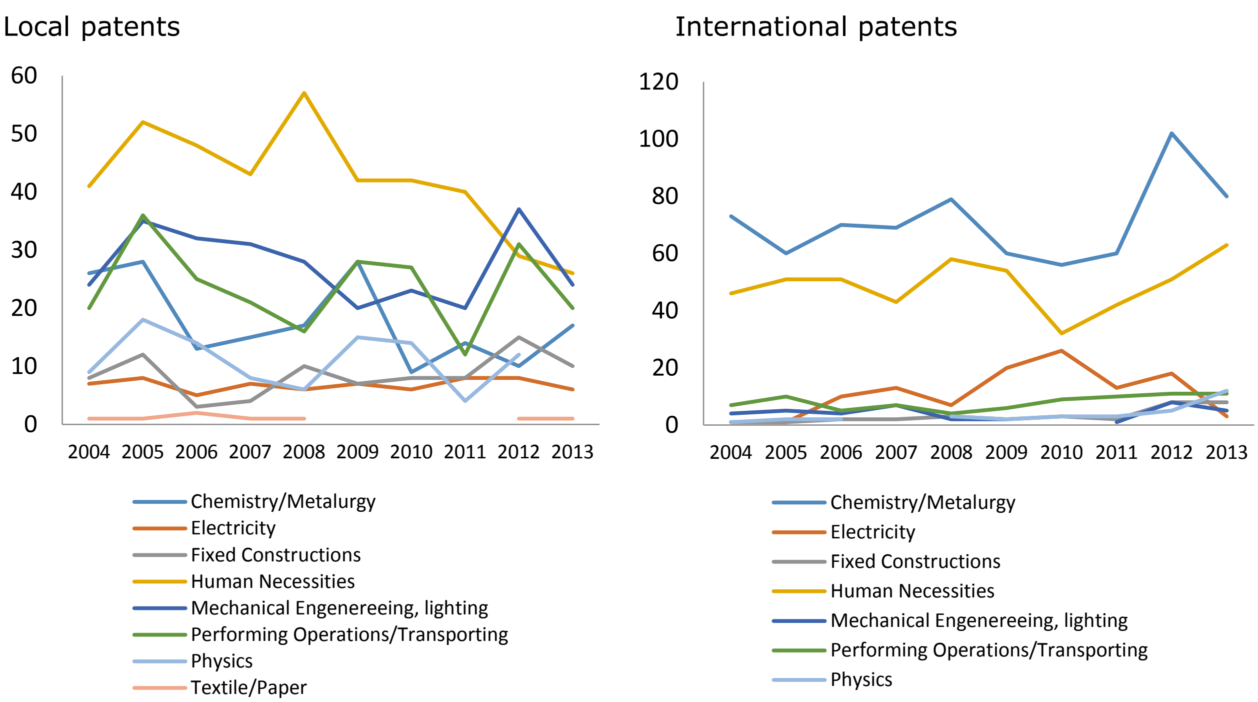
Annex 5: Patent data update from Sakpatenti

Patents granted (2004-2013)



Source: Sakpatenti, 2014

Domestic and international patents by categories and years (2004-2013)



Source: Sakpatenti, 2014

Annex 6: Cross country comparison of research assessment frameworks

Framework	Key aim	Scope	Measurement	Application To date	Analysis	Wider applicability
UK: **Research Excellence Framework (REF)**	Intended to be low burden, but pressure from researchers led to changes.	Includes wider societal impact. Assessment at subject level on three elements: - Quality of research output, - Impact of research (not academic) and - vitality of - environment.	Assessment by subject peer review panel of list of outputs, impact statement and case studies, and statement on research environment.	Piloted 2009. First round of assessment 2014; results will determine funding allocation	Burden not reduced, but adds wider impact to evaluation. Originally metrics based, but this was dropped as too unpopular.	Suitable for cross institutional assessment. High burden on institutions, and expensive, so best for significant funding allocation uses.
US: **STAR METRICS**	Minimize burden on academics. Meet US federal accountability requirements.	Two levels: Level 1, number of jobs supported; Level 2, range of research funded researcher interactions and wider impacts.	Data mining approach, automated. At present, only gathers jobs data. Methodologies for Level 2 still being developed.	Voluntary participation so full coverage unlikely.	Feedback generally positive, but feasibility of Level 2 not proven.	Potentially very wide depending on success of Level 2. There has been international interest, eg from Japan, EC.
Australia: **Excellence in Research for Australia (ERA)**	Include assessment of quality in block funding allocation (previously volume only). Advocacy purpose to demonstrate quality of research	Assesses quality, volume, application of research (impact), and measures of esteem for all Australian universities at disciplinary level.	Indicator approach; uses those appropriate at disciplinary level. Dashboard provided for review by expert panel.	First round in 2010, broadly successful. Next round 2012, with minor changes. Intended for funding allocation, but not used for this as yet.	Broadly positive reception. Meets aims, and burden not too great. Limitation is the availability of appropriate indicators.	Should be widely applicable; criticism limited in Australian context. Implementation appears to have been fairly straightforward.
Canada **Canadian Academy of Health Sciences (CAHS) Payback Framework**	Aims to improve comparability across a disparate health research system. Covers wide range of impacts.	Five categories: - advancing knowledge; - capacity building; - informing policies & product development; - health and health sector benefits; - broader economic benefits.	Specific indicators for each category. Logic model has four research 'pillars': biomedical; clinical; health services; social cultural, environmental and population health.	Used by public funders; predominantly CIHR (federal funder), but there has also been some uptake by regional organisations (e.g. Alberta Innovates).	Strengths: generalisable within health sector; can handle unexpected outcomes. But understanding needed at funder level may limit uptake. Early stages hard to assess.	Breadth, depth and flexibility mean framework should be widely applicable. However, it only provides a guide and needs significant work to tailor to specific circumstances.
Europe **Productive Interactions**	Measures productive interactions, defined as interactions with stakeholders that lead to change. Eliminates time lag, easier to measure than impacts. Assessment against internal goals intended for learning.	Intended to work in a wide range of contexts, best applied at research group or department level where goals are consistent.	Three types of interaction: direct personal contacts, indirect (e.g. via a publication) and financial. Engages users; findings assessed against internal goals.	Piloted across diverse disciplines and contexts in four European countries and at EC level. No plans to roll out more widely at present.	Tailored, so should help improve performance. No comparative ranking. Requires Significant work from participants to generate their own set of goals and indicators.	Indicators developed to meet goals, so widely applicable, but does not produce comparison between institutions, so not appropriate for allocation, and could be challenging to use for accountability.

Adapted from Guthrie et al.