October 2015

Comparative Study on Research Policy

Final Report

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Funded by FORMAS: The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

I. Purpose of the Study

In most OECD countries governments spend large amounts of resources on science, technology and innovation. They do this either by direct funding of research or through supporting R&D and innovation within firms. An important component of government expenditures on research is directed at science and technology to address social needs and goals. The underlying rationale is that addressing such goals is the key to realising future economic growth. This requires advances in basic research and technological developments that companies left to themselves may not be willing to fund. In recent years this function of research policy has been articulated under the notion of grand societal challenges. One of the aims of this report is to examine the extent to which research policies in different countries are based on this vision of addressing such challenges. Additionally the report examines the extent to which this has resulted in specific policies and funding priorities. More specifically the report addresses the following questions:

1. What are the main research priorities in different countries? Are these related to broad political goals and societal challenges? How important are the following areas of policy in the chosen countries and what are the main policies being implemented: (a) internationalization of research and (b) University-industry collaborations?
2. What are the main trends in the funding and structure of public sector research (e.g. basic vs applied)? How far does funding favour generic research compared to thematic priorities? What is the relative importance of universities compared to research institutes in the conduct of public sector research? What are the main priorities according to the different objectives of government budget appropriations for R&D?

The countries chosen for comparison are the four Nordic countries (Sweden, Denmark, Finland and Norway) plus the USA, the European Union, China, Brazil and India. The report is based on two different types of sources. The first is the statistical databases available from the OECD, Eurostat and UNESCO. These contain systematic data based on internationally agreed definitions and are specifically designed for international comparisons. However such data do not always provide detailed information necessary for meaningful policy analysis. To address this problem the report also uses a range of reports covering national research and innovation policy developments, as well as the country reviews produced by the OECD and ERAWATCH.

This Report

The report consists of three sections. The first section is focused on systematic comparisons of public funding of R&D and the second presents the country reports for each of the 8 countries. The final section presents an assessment of the main results.

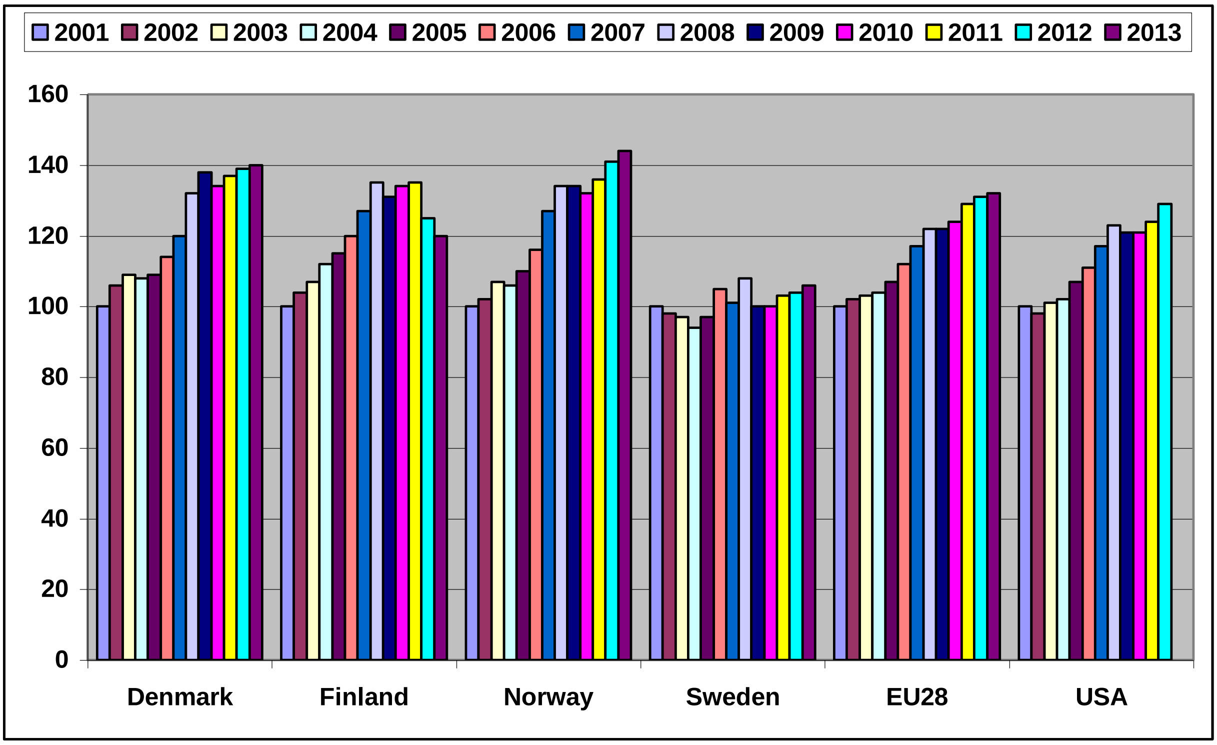
II. Trends in Public Funding of R&D

Setting the scene: Broad Trends in National R&D expenditures

In terms of growth rates of national R&D expenditures the countries in our sample can be divided into 3 groups. The first group comprises the three BRICs (China Brazil and India) which have spectacularly increased their spending in real terms in the period since 2001 (see Chart1b). The strongest increase has been for China where GERD has increased 6-fold, flowed by Brazil and India.

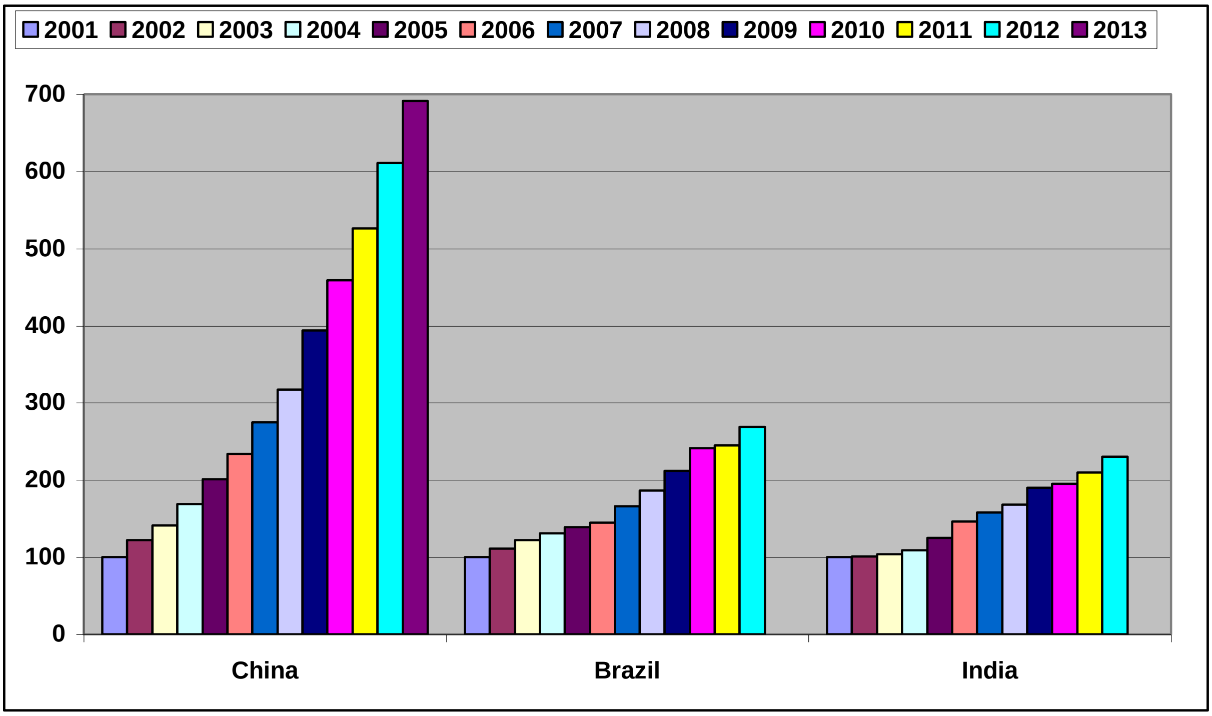
The second grouping has one country: Sweden where national R&D expenditures have only grown by 6%. Indeed in the period from 2001 to 2005 there was a decline in spending after allowing for inflation). The third group consists of the other Nordic countries (Denmark, Finland and Norway), together with the USA and the EU-28 (see Chart1a). For this group, since 2001, total R&D has increased by between 20% (in the case Finland) and 44% (in the case of Norway). The EU as a whole and the USA have seen almost identical growth of around 30%.

Chart 1a. Growth rate of National R&D Expenditures (at constant prices)



SSource: EUROSTAT (see Annex 1)

Chart 1b. Growth rate of National R&D Expenditures (at constant prices)

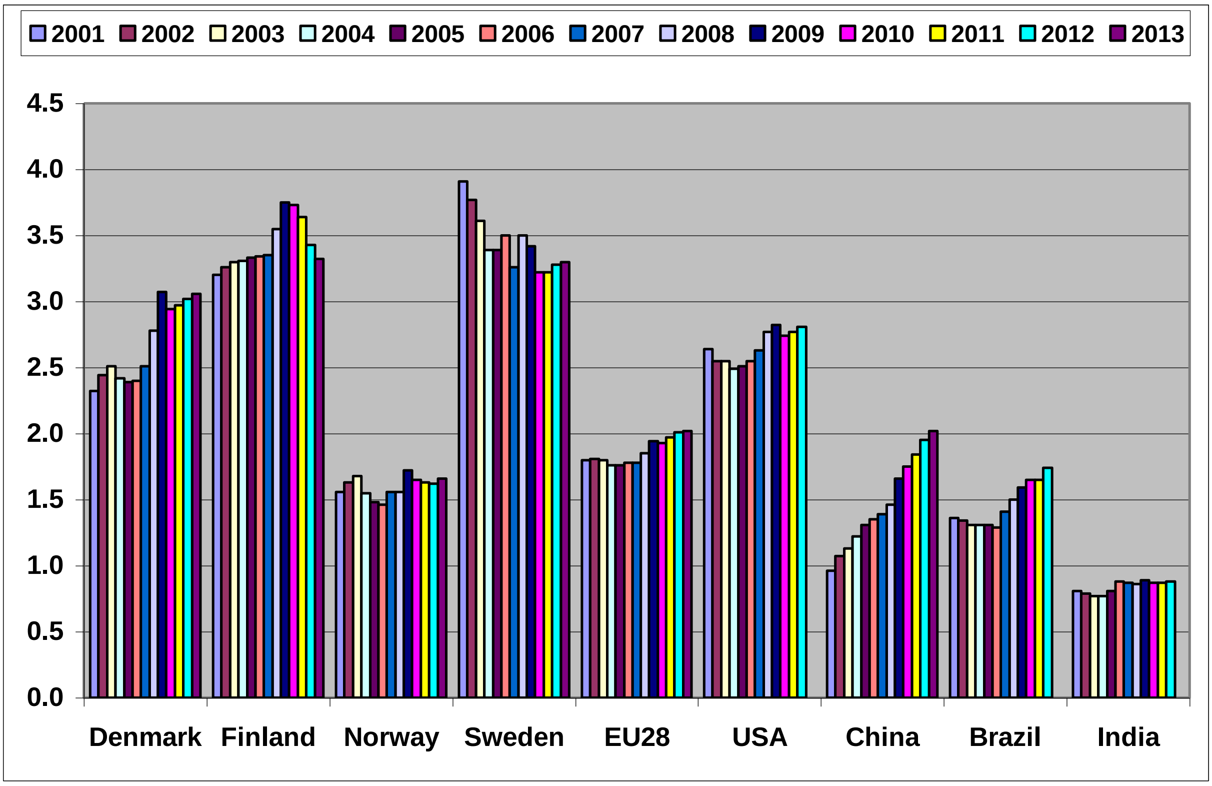


Source: EUROSTAT AND UNESCO (see Annex 1)

One of the key indicators used in international comparisons of R&D is GERD as a percentage of GDP. It is also the headline target (the so-called 3% target) adopted in the EU2020 strategy (European Commission, 2010). Both Sweden and Finland have national objectives of reaching 4 per cent of GDP allocated to R&D as part of the European Union's overall 2020 target, whereas Denmark has a national target of 3 per cent.

Chart 2 shows the trends in the R&D GDP ratio for of the different countries under consideration. The first point to note from this analysis is that Finland and Sweden have the highest R&D intensity throughout the period: over 3%. However in terms of trends these countries show differing patterns. In the case of Sweden there has been a decline from nearly 4% in 2001 to 3.2% in 2010. In contrast Finland saw an increase in the same period: from 3.2% in 2001 to 3.7% in 2010. Three other countries have seen big increases in their R&D intensity over the period: Denmark, China and Brazil. China now spends the same amount of its economic resources on R&D as the EU-28 as a whole: 2%. In the case of three other countries the changes have been negligible: India, Norway and the USA.

Chart 2. Trends in GERD as a % of GDP 2000 to 2013



Source: EUROSTAT and UNESCO (see Annex 1)

Broad Trends in Government Funding of R&D

There are two sources of data on public expenditures on R&D. The first is government financed Gross Expenditures on R&D (GERD) and the second is Government Budget Appropriations or Outlays for R&D (GBAORD). The main difference between these two sources is that they are collected from different surveys. In the case of the former data are gathered from entities that *perform* R&D and the latter from *funding* bodies (mainly government agencies). GBAORD data refer to budget provisions and not to actual expenditures. Additionally GERD denotes R&D that is carried out nationally and GBAORD includes payments to foreign performers. Another difference of note is that that government financed GERD includes funds from both central and local government and GBAORD is mainly based on funds from central government.[1]

The analysis below is based on two indicators:

Growth rate of funding. This measures the real increase in funding over time

Funding as a % GDP. This measures the importance of R&D relative to the overall size of the economy.

[1] However in some countries budgets from provincial government are included.

Trends Government financed GERD

The highest growth in public R&D expenditures in the period 2001 to 2013 has been in China and India. In the former these expenditures have increased by more than 3-fold and in the latter have doubled. At the other end of the spectrum, US Government financed R&D has declined in this period, with steepest decrease from 2001 to 2008 (whereby the 2008 figure was 77% of that in 2001).

There are contrasting trends amongst the 4 Nordic countries. The highest increase in has been for Norway where public R&D expenditures have grown by 76%. In contrast for Finland the increase has been much more modest: around 30%. Sweden and Denmark show almost identical trends with growth in public R&D expenditures of 55%. These two countries also exhibit another similarity. In each case government R&D expenditures have grown rapidly since 2007, compared to the period before. In contrast for both Norway and Finland the most rapid increases were in the earlier period.

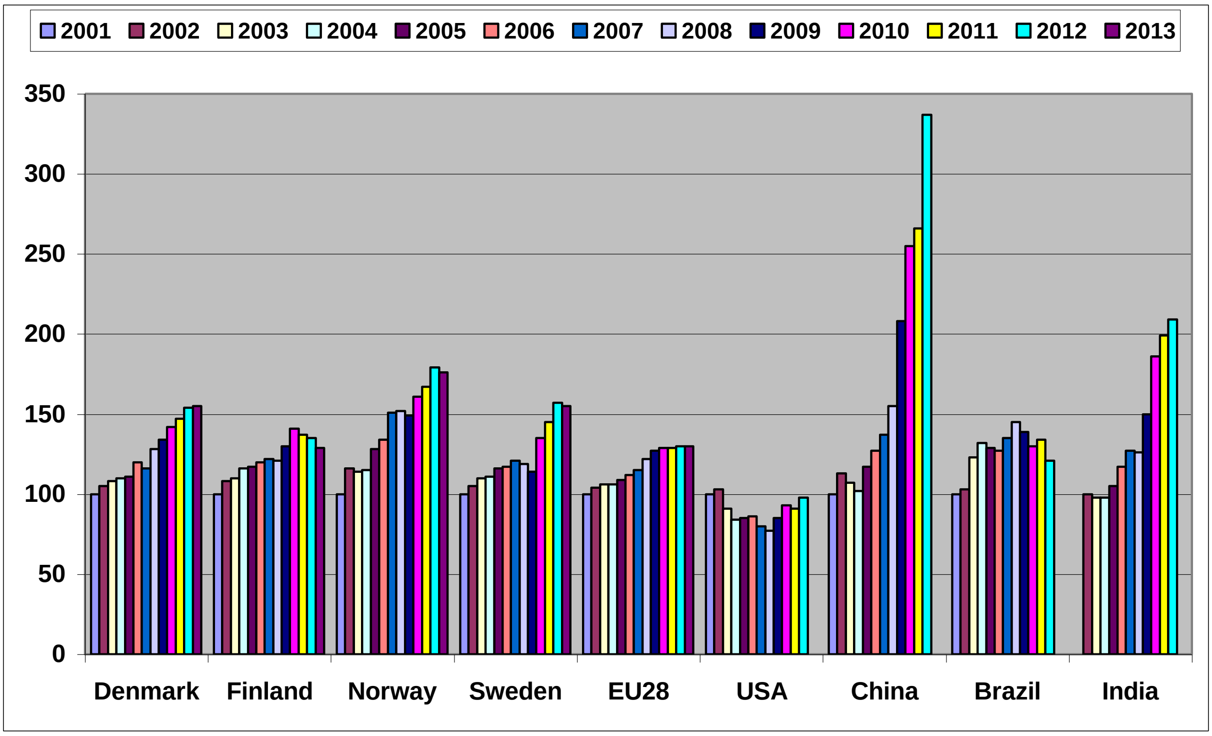
Comparing trends in public funding of R&D with trends in total national R&D expenditures (GERD, Chart 1a and 1b above) shows some interesting patterns. In the case of the Nordic-4 the increase in public R&D funding are more rapid than the increases in aggregate R&D (GERD). This indicates that for these countries the relative importance of public R&D has increased over time. The opposite occurs for China, India, Brazil and the USA. Here the increase in total R&D is much more rapid than that in Government R&D. Taking China as an example, GERD has increased by 600% but public R&D by only 337%, indicating that the relative role of public R&D has declined.

This comparison also shows that one of the responses to the financial crisis seems to be an increasing relative importance of public funding in total R&D. In the period from 2008 to 2013 the relative growth of public R&D has been higher than that of total R&D for all countries in our sample, except for Brazil and the EU-28.

Three countries spend more than 1% of their national economic resources on public R&D: Denmark, Finland and Norway. The average public R&D intensity in the EU-28 and that in the US is around 0.7%. The contrast between the three BRICs countries is interesting with the lowest intensity for China, the highest for Brazil (higher than the EU and USA) and with India in between.

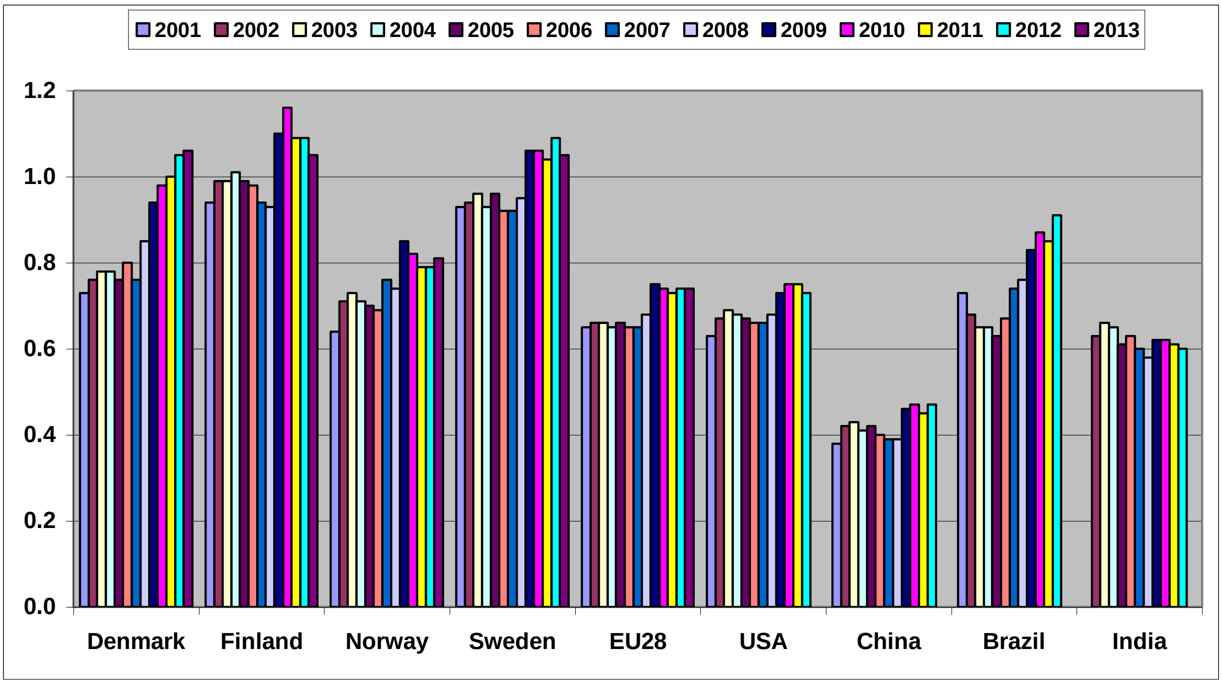
In terms of trends there have been very modest changes in the R&D financed by government as a proportion of GDP in the US, EU-28, China and India. The largest increase has been for Denmark, followed by Brazil.

Chart 3. Growth Rate of Government expenditures on National R&D



Source: EUROSTAT and UNESCO (see Annex 1)

Chart 4. Government financed GERD as a % of GDP



Source: EUROSTAT and UNESCO (see Annex 1)

Trends Public R&D Budgets

The above analysis was based on the public funds received by R&D performers. Here we turn our attention to the reported R&D expenditures in government budgets (GBAORD). The main limitation of these data is that they are not available for the 3 BRICs countries either from the OECD or from EUROSTAT. The data below are our own estimations based on national sources and UNESCO. However to date we have failed to find the information for China.

Many of the trends observed in public financed GERD are observed here in the case of government budgets: for example the high growth in Brazil and India and that in Denmark, Norway and Sweden. The main difference is in the case of the US where government budgets have increased, compared to the stagnation in actual expenditures shown above.

Table 1. Growth Rate of Government R&D Budgets (GBAORD).

	Denmark	Finland	Norway	Sweden	EU28	USA	Brazil	India
2001	100	100	100	100	100	100		
2002	98	101	112	109	105	111		
2003	99	107	115	118	106	121		
2004	98	112	116	116	103	130		
2005	101	118	112	119	106	131	100	100
2006	106	122	117	121	106	131	109	108
2007	117	122	126	118	110	134	131	116
2008	125	124	121	118	115	133	140	141
2009	137	129	142	128	119	150	144	164
2010	136	138	141	133	118	135	157	
2011	146	135	137	128	116	128	168	
2012	146	131	137	137	111	125	181	
2013	146	124	141	137	110	115		

Source: EUROSTAT and UNESCO (see Annex 1)

Table 2. Government R&D Budgets (GBAORD) as a % of GDP

	Denmark	Finland	Norway	Sweden	EU28	USA	Brazil	India
2001	0.73	0.94	0.68	0.77	0.71	0.86	0.57	
2002	0.71	0.94	0.74	0.82	0.73	0.94	0.53	
2003	0.72	0.96	0.76	0.87	0.73	1.00	0.52	
2004	0.69	0.97	0.74	0.82	0.69	1.03	0.48	
2005	0.70	0.98	0.70	0.82	0.69	1.00	0.48	0.72
2006	0.70	0.98	0.71	0.80	0.66	0.98	0.50	0.70
2007	0.77	0.93	0.74	0.75	0.66	0.98	0.57	0.67
2008	0.83	0.94	0.71	0.76	0.69	0.98	0.58	0.72
2009	0.96	1.07	0.85	0.86	0.75	1.14	0.60	0.73
2010	0.95	1.11	0.84	0.84	0.73	1.00	0.61	
2011	1.00	1.05	0.80	0.79	0.70	0.93	0.64	
2012	1.00	1.03	0.78	0.85	0.68	0.89	0.68	
2013	1.01	0.99	0.80	0.83	0.67	0.80		

Source: EUROSTAT and UNESCO (see Annex 1)

Trends in Public R&D Priorities

The aim in this section is to present an analysis of public priorities for R&D. One way of assessing such priorities is by analysing GBAORD data broken down by socio-economic objectives on the basis of NABS (Nomenclature for the analysis and comparison of scientific programmes and budgets).[2] Some of these objectives can be mapped onto the societal challenges that are one of the main focal points of the study, namely *Health*, *Environment* and *Energy*. Others include *General Advancement of Knowledge*, which can be disaggregated into institutional funding for Universities (and other higher educational establishments) [3] and non-oriented funding.

Before presenting the analysis of GBAORD data we begin by discusses the broader changes in policy priorities in recent years as reported by the OECD in the recent Science, Technology and Industry Outlook.[4] Taking all OECD countries together top 5 self-declared priorities[5]:

- Strengthening Public research infrastructures
- Improving Human resources and skills
- Improving Framework conditions for innovation
- Supporting Business innovation and entrepreneurship
- Addressing Social challenges

In terms of our sample of countries the OECD analysis shows that *Social challenges* are amongst the top priorities in the case of China, India, Sweden and the EU as a whole. *Sustainable/green growth* is a top priority in China, India, Finland and the USA.

We begin our discussion of government priorities according to the GBAORD socio-economic objectives by focusing on *Defence* (see Chart 5). The chart below shows that this is a priority for two of our sample countries: the US and India. In the case of the US, more than half of total budget appropriations are for *Defence*, for India the proportion is around a quarter. In terms of trends the biggest change has been for Sweden where the share of *Defence* has gone from 17% of the total to 4%. The same trend can be seen for the whole of the EU and Finland and Norway.

For the remainder of the analysis we focus on *Civil* budgets, i.e. total GBAORD less *Defence*. For majority of the countries in our sample *General Advancement of Knowledge* (GAK) is the main category of public R&D expenditures. This is research that is mainly carried out in Universities and public research institutes.

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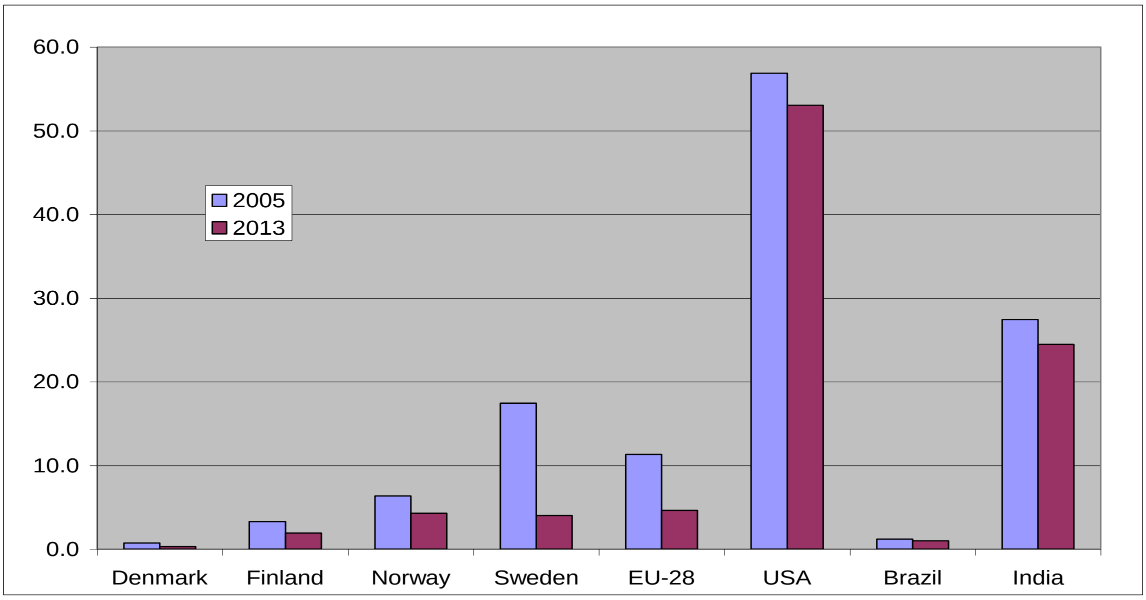
[2] See Annex 2.
[3] Named GUF, General University Funds
[4] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en
[5] Policy priorities are defined by country self-assessment answers to the question: “What are the major STI policy priorities in your country? Please select three (maximum five) STI policy priorities in the drop-down lists below and describe briefly “in your words” (one sentence) these major policy priorities”.

Chart 5. Trend in Defence as a % of Total GBAORD 2005 to 2013*



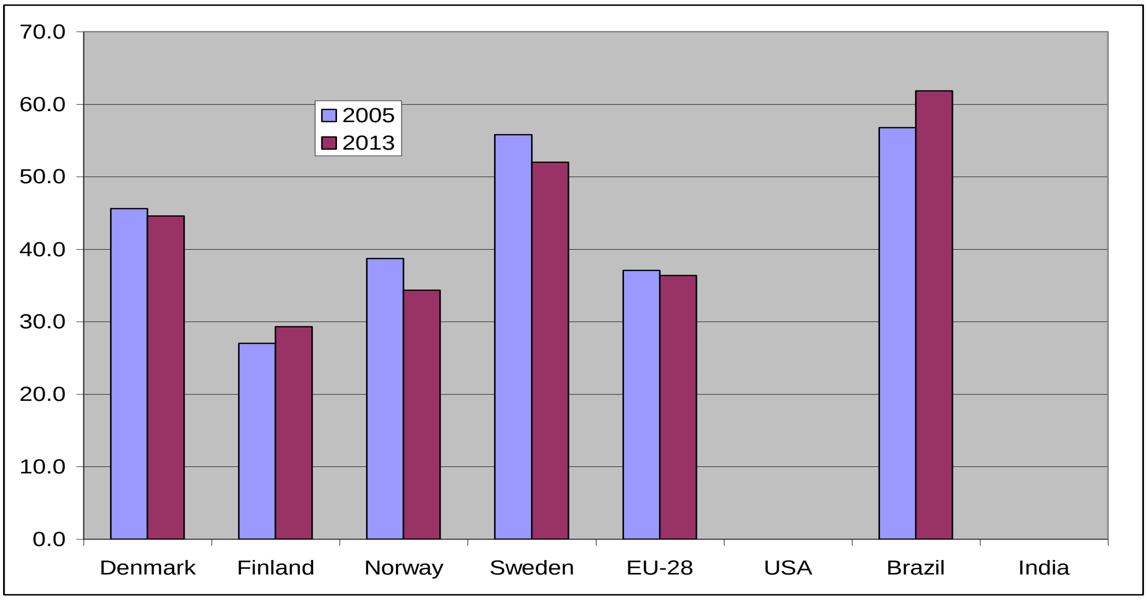
Source: EUROSTAT and National Sources for Brazil and India (see Annex 1)
*Note EU-28 2007 to 2013; Brazil 2005 to 2012; India 2005 to 2009

In Chart 6 we present one of the components of GAK, namely *General University Funds* or *GUF*.[6] These are institutional funds (or block grants) for universities to undertake basic research. For two countries in our sample, namely USA and India, GBAORD data does not include such funds as they have a different mechanism for funding universities. However for the EU as a whole, such expenditures account for more than a third of the total. In the case of Sweden, Denmark, Norway and Brazil *GUF* accounts for even a larger proportion of GBAORD. Indeed for Brazil and Sweden more than half the total of public funding is devoted to institutional funding of universities and public research institutes. There has been little change in this indicator over time.

There are three components of GBAORD that map onto the grand societal challenges: *Health, Environment* and *Energy*. Charts 7 to 9 below show the relative importance of these three categories of expenditures over time in the different countries included in this study.

[6] The other component of *GAK* is Non-oriented Research, which is not discussed here.

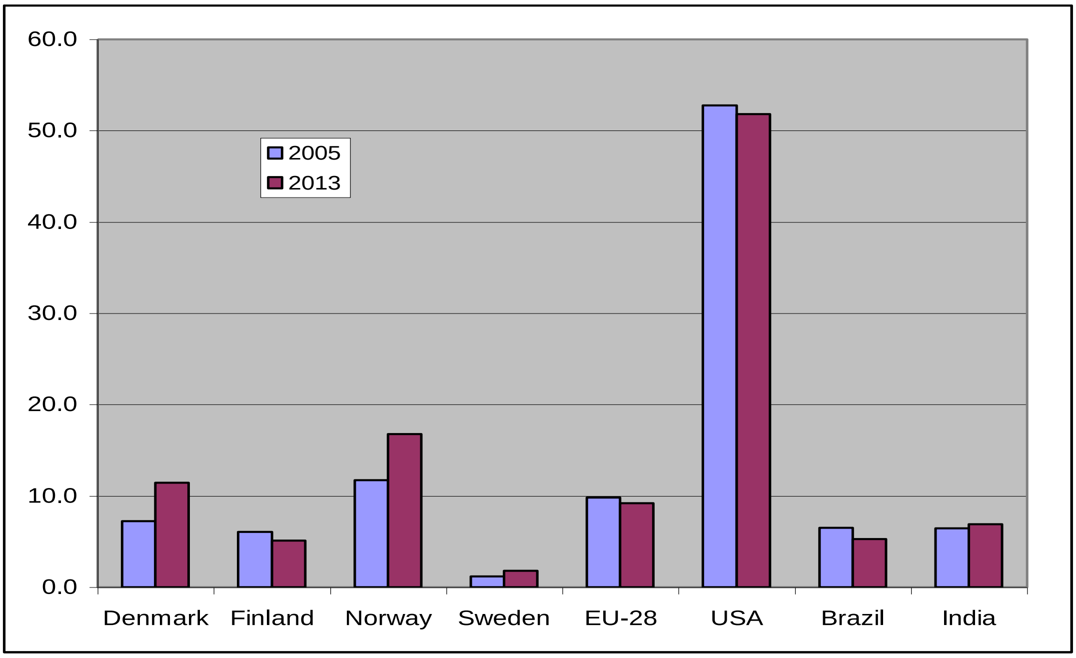
Chart 6. Trend in GUF as a % of Civil GBAORD 2005 to 2013*



Source: EUROSTAT and National Sources for Brazil and India (see Annex 1)
*Note EU-28 2007 to 2013; Brazil 2005 to 2012; India 2005 to 2009

For the US *Health* is by far the most important category of federal R&D budgets, accounting for more than half the non-defence total. In the EU-28 *Health* accounts for around 10% of total Civil GBAORD, a proportion that has changed little over time.

Chart 7. Trend in Health as a % of Civil GBAORD 2005 to 2013*

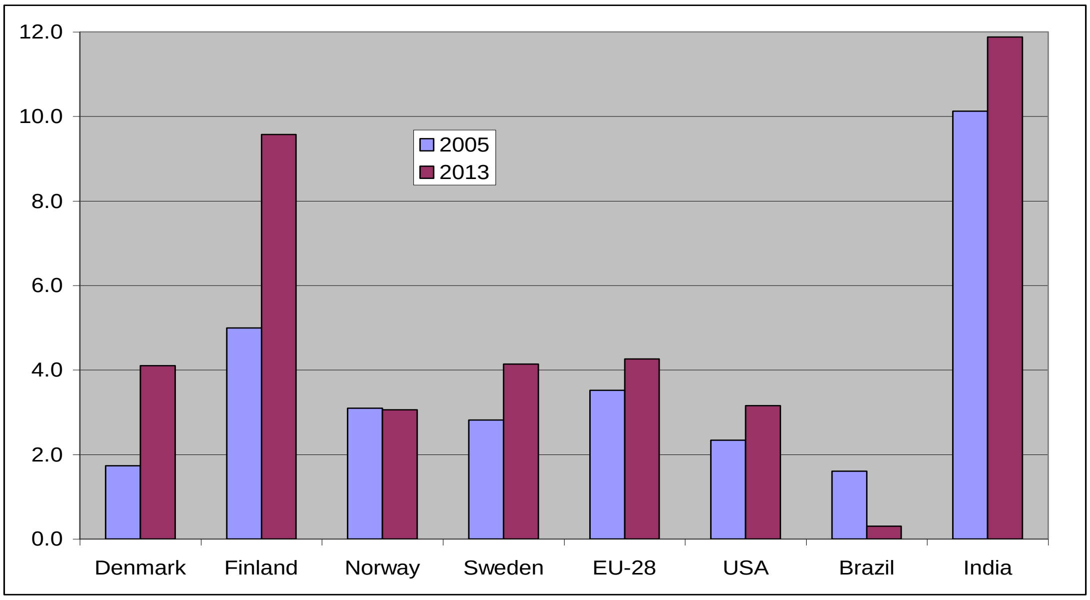


Source: EUROSTAT and National Sources for Brazil and India (see Annex 1)
*Note EU-28 2007 to 2013; Brazil 2005 to 2012; India 2005 to 2009

There are contrasting patterns amongst the Nordic-4. For Norway *Health* is one of the main priorities for public R&D budgets (accounting for more than 15% of the total), and for Sweden it is amongst the least important (accounting for less than 2% of the total). For Denmark and Norway this category has increased in importance over time. Brazil and India have very similar proportions of expenditure on *Health* R&D.

Chart 8 shows that the relative importance of funding for *Energy* research has increased for most countries since 2005. The most pronounced change has been for Finland where the share of Civil GBAORD allocated to *Energy* has risen from around 5% to around 10%. Of the sample countries only India has a higher share of around 12%. Denmark and Sweden have both increased their budgets for *Energy* research. The only country to show an opposite trend is Brazil.

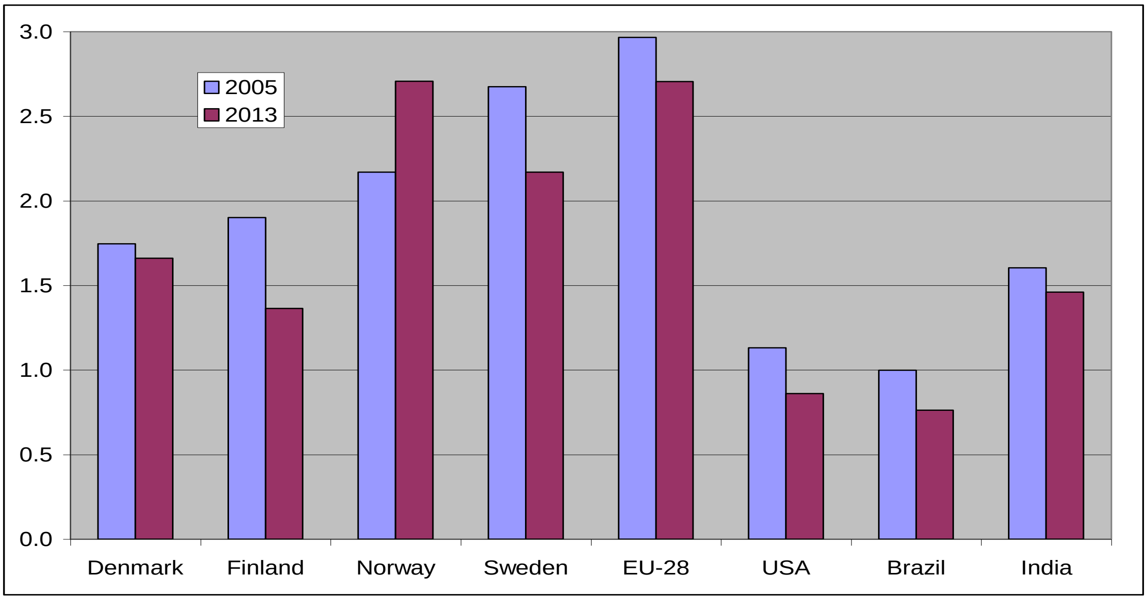
Chart 8. Trend in Energy as a % of Civil GBAORD 2005 to 2013*



Source: EUROSTAT and National Sources for Brazil and India (see Annex 1)
*Note EU-28 2007 to 2013; Brazil 2005 to 2012; India 2005 to 2009

Finally we turn to government support for R&D in *Environment* related issues (Chart 9) The main message from this analysis (and that of the more detailed annual data) is that there have been some small decreases in the relative importance of *Environment* in public budgets but the pattern remains reasonably stable.

Chart 9. Trend in Environment as a % of Civil GBAORD 2005 to 2013*



Source: EUROSTAT and National Sources for Brazil and India (see Annex 1)
*Note EU-28 2007 to 2013; Brazil 2005 to 2012; India 2005 to 2009

III. Country Reports

This section contains reports on developments in research polices in our sample of countries. Of course such policies are a part of wider range of innovation policies in most countries and their delineation is not always straightforward. Nevertheless we have attempted to base the reports on research policies as far as possible.

The reports set out to address a number of questions:

Are there high-level documents (policy declarations, white papers etc.) that give prominence to societal challenges?

What are the specific government policies that support S&T research in societal challenges?

Are there budget commitments mentioned?

What is the structure of funding (e.g. basic vs applied)?

How far does funding favour generic research compared to thematic priorities?

What is the relative importance of universities compared to research institutes in conduct of public sector research?

Country Report: Sweden

Top level priorities of Research Policy

The overall aim of government research policy is to strengthen Sweden's position as a research nation and thereby to increase its global scientific standing. This is to be achieved by increased funding and by improving the quality of research, especially in areas of strategic importance to society and the economy. The government has used three criteria to determine the strategic area to be given priority:

- Research that can contribute to solving important global problems
- Targeting areas in which Sweden already carries out world-class research
- Identifying areas where Swedish companies carry out their own R&D, and where state investment can reinforce their development.

(Research and Innovation Bill 2008/2009 updated in 2012)[7]

Specific Policies

The strengthening of Sweden's scientific standing is to be achieved by substantial growth in government funding, amounting to total increase of €1billion over 8 years from 2008 to 2016 (the largest in history). This compares with an annual government expenditure on R&D of around €3.4 billion (ERAWATCH Swedish Report 2013)[8]. The improvements in the quality of research are to be achieved by introducing a performance based system of allocation of funds to universities and re-organization of research institutes.

The 2012 bill contains very few specific policies. The main highlights in this bill are:

- Increased funding for the life sciences and "other specially chosen areas of particular importance for Swedish long term competitiveness". The latter include forestry and sustainable development.
- Increased funding for universities and strengthening of the research institute sector
- Funding for a program to recruit international scholars to Swedish universities.

The predecessor Bill of 2008/9 identified 24 strategic areas of science and technology that would be prioritized. These fall into three broad areas that are related to societal challenges: Medicine and Biosciences; Energy and Climate change; and IT, Transport and Nanotechnology.[9] These three areas each receive between 34% and 30% of the total funding allocation announced in the Bill.

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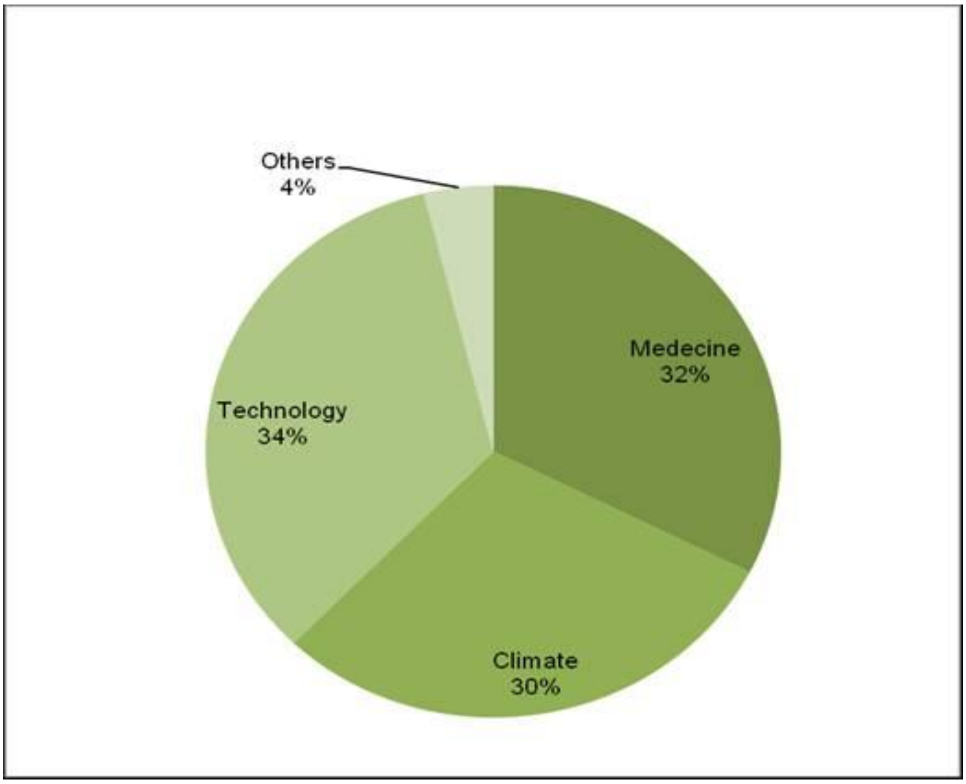
[7] http://www.government.se/sb/d/16288
[8] http://erawatch.jrc.ec.europa.eu/erawatch/export/sites/default/galleries/generic_files/file_0542.pdf
[9] Detailed areas are as follows: Energy; Sustainable exploitation of natural resources; Impact on natural resources, ecosystems and biological diversity; Climate models; Marine environmental research; Cancer; Diabetes; Epidemiology; Molecular biology; Neuroscience; Stem cells and regenerative medicine; Health; Psychiatry;

Figure 1-Se. Funding Allocation (Total 1.8 Billion SEK)



Source: Government Bill 2008/2009 (http://www.regeringen.se/sb/d/108/a/130765)

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for Sweden. In cash terms, total R&D appropriations have increased by 36% in the period from 2007 to 2013.

Nearly half the government R&D budget is allocated directly to Universities (*GUF*), with a further 22% going to other funding related to *general advancement of knowledge* which may end up with Universities. Both these categories have increased their share in the period since 2007. The other major trend has been the decrease in Defence related R&D from 16% of the total to only around 4% in 2013.

Two other areas with substantial budgets are *Transport and Telecommunications* and *Energy*. In terms of relative priorities the largest proportion increase has been in the *Health* area followed by *Space* research and that related to the Environment.

Nanoscience and nanotechnology; E-science; Material science; IT and mobile communication; Production technology; Transport research; Aviation; Space; Security and crisis management; Politically important geographical regions; Conditions for growth.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth (2007 to 2013)
Exploration and exploitation of the earth	0.89	0.35	-46.4
Environment	1.39	1.92	88.3
Exploration and exploitation of space	0.77	1.74	206.5
Transport, telecommunication and other infrastructures	4.02	4.90	66.5
Energy	3.39	4.23	70.1
Industrial production and technology	5.04	2.71	-26.6
Health	0.64	1.67	259.1
Agriculture	1.48	1.49	37.0
Education	0.33	0.16	-31.7
Culture, recreation, religion and mass media	0.15	0.14	31.0
Political and social systems, structures and processes	1.90	2.60	86.5
General Advancement of Knowledge General University Funds (GUF)	44.44	49.80	52.9
General Advancement of Knowledge Other Funds	19.14	22.27	58.7
Defence	16.42	3.75	-68.8
Total R&D appropriations	100.00	100.00	36.4

Source: EUROSTAT

Structure of funding

By far the largest proportion of government funding is directed to Universities, with the Public Research Institutes playing a minor role. In terms of the balance between *generic* versus *thematic* research, the Swedish system favours the former mode. Thus generic research accounts for nearly 75% of all budgetary expenditure (OECD STI Outlook, 2014)[10].

One interpretation of the data in Table 1 is that more than 70% of government funding is for *basic* research (defined as advancement in knowledge).[11] Another interpretation of the same data is that *institutional* funding (defined as GUF) is much more important than *competitive* funding (defined as funding for advancement in knowledge from sources other than GUF).

[10] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en

[11] There appears to be no breakdown readily available on the disaggregation between Basic and Applied research for Sweden.

Policies for Promoting Internationalization of Public Sector Research

There is explicit recognition of the importance of international collaboration in public sector research. The 2008 Bill mentions:

> "International cooperation is necessary to carry out high quality research, as well as recruiting students, doctoral candidates and researchers from other countries"

The 2012 Research and Innovation Bill allocated specific funds for the recruitment of internationally prominent researchers to Swedish universities. Moreover participating in international infrastructures is actively encouraged, with the Swedish Research Council investing €45m in 2009 in such activities. Several of the recently allocated national infrastructures are expected to serve as Swedish nodes in co-operation with their European counterparts.

Outside the EU, Sweden has a dedicated agency (SIDA, Swedish International Development Agency), to promote research co-operation with developing countries. The budget for this agency was €190m in 2010. The overall aim is to help create knowledge that will enable poor people to improve the quality of their lives (ERAWATCH report for Sweden 2013).

Policies for Encouraging University-Industry Linkages

The 2008 Bill emphasizes the important role of transferring knowledge and expertise between universities and business sector for the Swedish economy. The main policy instruments in relation to the former include the establishment of innovation support structures at universities (technology transfer offices) and the strengthening of the public research institutes. Mobility of scientists and engineers between the public and private sector is encouraged through programs that encourage the hiring of professors in industry, accepting industry PhDs and establishing graduate schools with some emphasis on industry collaboration (ERAWATCH report for Sweden 2013).

Country Report: Denmark

Top level priorities of Research Policy

The current strategic priorities of research policy in Denmark are based on the RESEARCH2020 catalogue published in 2012[12] and the INNO+ catalogue published in 2013[13] . Together these two catalogues form the basis for prioritizing strategic research investments as laid out in the Budget Bills in 2013 and 2014. The priorities are largely demand led and are focused in 3 areas:

- Innovation driven by societal challenges
- Increased translation of knowledge into 'value'
- Education as a means to increase knowledge capacity.

Specific Policies

The INNO+ catalogue identifies 21 specific priority areas for research and innovation that are aimed towards finding solutions to grand societal challenges. They fall under the following themes: transportation, environment, urban development, food, bio- economy, health, production, digital solutions and energy.

More specifically, in relation to research, one of the major actors is the Danish Council for Strategic Research (from 2014 re-organized as the Danish Innovation Fund) which has financed research according to the following thematic priorities:

- Sustainable energy production and use of energy;
- Food, nutrition and health;
- Nanotechnology, biotechnology and ICT.

The three main policy options being pursued are:

- Strengthening of basic research by increasing the support for Centres of Excellence.
- Providing new matching funds for cooperation between public and private institutions
- Supporting internationalization of research by providing funds for universities that participate in international partnerships and networks

There is little information on the specific allocation of funds to different priority areas in the Catalogues and Bills mentioned above.

[12] http://ufm.dk/en/newsroom/press-releases/2012/research2020-catalogue-to-create-strategic-basis-for-danish-research
[13] http://ufm.dk/en/publications/2013/inno-catalogue?set_language=en&cl=en

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for Denmark. There has been a large increase in government budgets in the period 2007 to 2013: 45% in cash terms.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth (2007 to 2013)
Exploration and exploitation of the earth	0.57	0.39	-22.4
Environment	1.73	1.63	22.7
Exploration and exploitation of space	1.99	1.28	9.5
Transport, telecommunication and other infrastructures	0.85	0.97	76.5
Energy	1.72	3.31	59.8
Industrial production and technology	6.25	8.15	85.3
Health	7.17	12.82	123.7
Agriculture	5.58	2.49	-28.6
Education	2.50	3.91	128.4
Culture, recreation, religion and mass media	1.35	1.60	57.1
Political and social systems, structures and processes	3.68	2.68	11.4
GAK: R&D financed from General University Funds (GUF)	45.26	44.46	52.9
GAK: R&D financed from other sources than GUF	20.60	15.96	6.6
Defence	0.74	0.34	-14.9
Total R&D appropriations	100.00	100.00	45.3

Source: EUROSTAT

General Advancement of Knowledge is by far the largest category of expenditure accounting for between 60% and 65% of total budgets. Around 45% of the total is allocated to *General University Funds* (GUF) and further 20% is from sources other than GUF. These two categories show contrasting trends, with *GUF* (institutional funding) remaining more or less constant non-GUF (direct project-based funding) decreasing from 21% of total budget to 16% in 2007.

Denmark spends very little on *Defence* (which accounts for less than 1% of the total budget and is in decline). The relative importance of *Health* and *Industrial Production and Technology* has increased and *Agriculture* and *Earth Exploration* has declined.

Structure of funding

Universities are the dominant recipients of public funding of R&D: accounting for more than 90% of the total public sector expenditures. As discussed above the majority of this funding (65%) is channelled as institutional support rather than on a competitive basis. In terms of the modes of funding the Danish system favours generic research (rather than thematic), accounting for 62% of the total expenditures. With regard to the balance between 'R' and 'D', basic research accounts for 44% and Applied research and Experimental development 56% (OECD STI Outlook, 2014)[14].

Policies for Promoting internationalization of Public Sector Research

The RESEARCH2020 catalogue mentions that "excellent research and cooperation with leading international environments" is vital for Danish research. To this end the Ministry of Science, Innovation and Higher Education has initiated a number of collaboration agreements (and other policy measures) to encourage knowledge exchange with knowledge communities outside Europe. One initiative is the establishment of innovation centres in hotspots around the world; in Silicon Valley, Munich, Shanghai, New Delhi/Bangalore, Seoul and São Paulo. These centres facilitate networks and partnerships between Danish and foreign researchers educators and enterprises (Erawatch Country Report Denmark 2013)[15].

Policies for Encouraging University Industry Linkages

An explicit strategy mentioned in the RESEARCH2020 catalogue is "knowledge translated into value", with a focus on technology transfer between companies and universities. The main body responsible for implementing this strategy is the Danish Council for Technology and Innovation. One of the main objectives of this Council is: "Collaboration and dissemination of knowledge between researchers, research and educational institutions, advanced technology groups, knowledge institutions and enterprises". It administers a number of initiatives[16]:

- Innovation Consortia.
- Approved Technological Service.
- Industrial PhD.
- Innovation assistant (Videnpiloter).
- Innovation Networks Denmark.

[14] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en

[15] http://erawatch.jrc.ec.europa.eu/erawatch/export/sites/default/galleries/generic_files/file_0515.pdf

[16] See http://ufm.dk/en/research-and-innovation/councils-and-commissions/the-danish-council-for-technology-and-innovation

Country Report: Finland

Top level priorities of Research Policy

Research policy in Finland is based on the *Action plan for research and innovation policy* (2012)[17] and *Research and Innovation Policy Guidelines for 2011–2015*[18]. The strategic priorities are focused in following areas:

- Promoting the well-being and competitiveness of society
- Enhancing the internationalisation of the Research, Development and Innovation
- Improving the quality and flexibility of the research and innovation system.
- Increasing effectiveness of innovation activities
- Obtaining greater value and new competitive advantages through intangible investment.

Specific Policies

Action plan for research and innovation policy (2012)[1] identifies specific research priority areas in which research will be used to meet global challenges and address social challenges:

- Structural change in the ICT field and national action programme in health technology and pharmaceutical research
- Implementing measures in the areas of cleantech and bioeconomy and in fields such as intelligent construction and security
- Energy, environment and climate strategy

The aim is to ensure that Finland is an attractive innovation environment for companies and research organisations by increasing the number of researchers at the very top of their field, and increasing internationalisation of the system as well as attracting foreign investment.

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for Finland. There has been an increase in overall funding of 12% between 2007 and 2013. As in most EU countries *General Advancement of Knowledge* (GUF and non-GUF) accounts for the largest share of public funding and its importance has increased over time, accounting for nearly 50% of total GBAORD in 2013. *Industrial Production and Technology* is another important category but its share has declined over time. Regarding the three fields related to societal challenges, *Energy* is relatively the most important and its importance has increased

[17] http://www.minedu.fi/export/sites/default/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/erillisraportit/liitteet/TINTO_12.12.2012_eng.pdf
[18] http://www.minedu.fi/export/sites/default/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/julkaisut/liitteet/Review2011-2015.pdf

since 2007. On the other hand public R&D funding in *Health* has declined as has that related to *Environment*.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth
Exploration and exploitation of the earth	1.20	1.39	30.5
Environment	1.63	1.15	-20.8
Exploration and exploitation of space	1.71	2.01	32.0
Transport, telecommunication and other infrastructures	1.66	1.75	18.3
Energy	7.79	8.99	29.7
Industrial production and technology	23.81	17.88	-15.6
Health	6.03	4.84	-9.8
Agriculture	5.81	4.84	-6.5
Education	0.22	0.16	-17.2
Culture, recreation, religion and mass media	0.64	0.77	34.2
Political and social systems, structures and processes	4.63	4.76	15.3
GAK: R&D financed from General University Funds (GUF)	25.80	29.61	29.0
GAK: R&D financed from other sources than GUF	16.67	19.67	32.6
Defence	2.38	2.19	3.6
Total R&D appropriations	100.00	100.00	12.4

Source: EUROSTAT

Structure of funding

Universities received around 65% of total public funding of R&D, with the remaining 35% going to public research institutes. Almost all the funding is addressed to civil objectives rather than defence. Finnish research system gives equal weight to thematic and generic research. Institutional funding and competitive funding are of equal importance (OECD STI Outlook, 2014)[19].

A new funding model for universities was introduced in 2013 with greater emphasis on quality, effectiveness and internationalisation. Public research institutes will also be reformed.

[19] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en

Policies for Promoting Internationalization of Public Sector Research

Internationalisation of science has been a policy objective in Finland for quite some time. *Research and innovation policy guidelines for 2011-2015*[2] emphasises internationalisation is an important factor for improving the quality of scientific research. In order to support focused internationalisation, quantitative foreign funding objectives are to be set for various parts of the science system. The government has implemented a number of programmes to attract foreign talent the public and higher education sectors. Furthermore, Finnish government has increased collaboration and coordination of public agencies and opening up and streamlining of instruments to provide vide more comprehensive support for internationalisation of R&I system (Erawatch Country Report: Finland 2013)[20].

Policies for Encouraging University Industry Linkages

Collaboration between research and business has been actively promoted since 1980s especially by TEKES programmes. More recently the government has established long-lasting public-private partnerships through Strategic Centres for Science, Technology and Innovation (SHOKs). They focus on a number of areas of research relevant to societal challenges: energy, environment, bioeconomy, health and well-being.

[20] http://erawatch.jrc.ec.europa.eu/erawatch/export/sites/default/galleries/generic_files/file_0517.pdf

Country Report: Norway

Top level priorities of Research Policy

The main strategic priorities of research policy in Norway are based on the white paper on research[21] entitled '*Long-term perspectives - knowledge provides opportunity*', together with earlier publication '*In the Vanguard of Research*[22]'.

The priorities are largely demand led and are focused in 3 areas:

- Greater investment in research activity and enhancement the overall quality
- Research responsive more directly to specific social and industrial challenges (e.g. welfare and industrial development, global climate and energy problems)
- Upgrading of Norwegian research national partnerships and international participation.

Specific Policies

The above White paper identifies 5 specific priority areas of research related to global societal challenges:

- environment, climate change, oceans, food safety and energy
- better health, reduced social inequalities in health
- encouraging industrial development in areas relating to food, the marine sector, the maritime sector, tourism, energy, the environment, biotechnology, ICT and new materials/nanotechnology.

To achieve these objectives, the government will implement policies that improve the functioning of the research system, produce high quality research, and that encourage a high degree of internationalisation.

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for Norway. There has been a large increase in funding of research since 2007: 49% in cash terms. A large part of the total (more than 40%) is spent on *General Advancement of Knowledge.* Institutional funding for Universities (GUF) accounts for more than 30% but its relative importance has decreased since 2007. Another important priority is *Health* funding, and this has

[21] https://www.regjeringen.no/contentassets/9f8d4da472c04edf8cabee3fed441b3d/en-gb/pdfs/stm201220130018000engpdfs.pdf

[22] http://www.forskningsradet.no/servlet/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition%3A&blobheadervalue1=+attachment%3B+filename%3D%22Hovedstrategi2009EL20090115engCBEFinal.pdf%22&blobkey=id&blobtable=MungoBlobs&blobwhere=1274505376050&ssbinary=true

increased rapidly over time. Public funds for Environment research have also increased but the relative importance of *Defence* has decreased.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth (2007 to 2013)
Exploration and exploitation of the earth	1.85	1.47	1.3
Environment	2.03	2.62	117.5
Exploration and exploitation of space	2.13	2.01	22.8
Transport, telecommunication and other infrastructures	1.95	1.78	12.1
Energy	2.89	2.71	50.3
Industrial production and technology	8.16	8.17	75.7
Health	10.99	16.25	59.1
Agriculture	8.48	8.66	65.5
Education	0.88	1.04	95.5
Culture, recreation, religion and mass media	1.02	0.96	56.8
Political and social systems, structures and processes	4.37	5.73	75.2
GAK: R&D financed from General University Funds (GUF)	36.25	32.25	43.1
GAK: R&D financed from other sources than GUF	12.63	12.32	34.6
Defence	6.36	4.03	17.5
Total R&D appropriations	100.00	100.00	48.6

Source: EUROSTAT

Structure of funding

Universities received around 60% of total public funding of R&D, with the remaining 40% going to public research institutes. The Norwegian research system gives equal weight to thematic and generic research. Institutional funding accounts for around 60% of the total and competitive funding around 40%. In funding allocations *Applied Research and Development* is favoured over *Basic Research*. The former accounts for around 60% of the total (OECD STI Outlook, 2014)[23].

Policies for Promoting Internationalization of Public Sector Research

Internationalisation remains an overall priority of the government's research and innovation policy. This has resulted in action to join international programmes of research such as the EU Horizon 2020 programme. Norway has signed several bilateral

[23] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en

agreements with third countries. For example the research cooperation with China (CHINOR programme) enables Norwegian researchers to enter into partnerships with Chinese governmental research financing bodies. The thematic priorities are climate change, environment and welfare.

In addition Norway has a number of mobility programmes. For example the YGGDRASIL programme offers grants to highly qualified international PhD students and younger researchers in connection with research visit to Norway. The Leiv Eiriksson mobility programme aims to encourage research collaboration with U.S and Canada.

To encourage bilateral cooperation, the Research Council of Norway also provides national support for existing projects to develop new collaborative research efforts with partners in priority countries: the US, Canada, China, Japan and India (Erawatch Country Report Norway 2013)[24].

Policies for Encouraging University Industry Linkages

Technology transfer and commercialisation have been a long-standing priority of research policy in Norway. A number of policies have been implemented including the Centres for Research based Innovation (SFI) and the Norwegian Centres of Expertise programme (NCE).

[24] http://erawatch.jrc.ec.europa.eu/erawatch/export/sites/default/galleries/generic_files/file_0531.pdf

Country Report: European Union

Top level priorities of Research Policy

The current strategic priorities of research and innovation policy at the European level are based on the EU2020 strategy[25] and within it, the Innovation Union (IU) initiative. The three main pillars of the EU2020 strategy are *smart, sustainable* and *inclusive growth*. According to this strategy, the aim of the IU is to "*re-focus R&D and innovation policy on the challenges facing our society, such as climate change, energy and resource efficiency, health and demographic change".* A key target of the strategy is to increase total R&D expenditures (GERD) to 3% GDP.

Specific Policies

The main instruments of EU-level research and innovation policies are the **Framework Programmes for Research and Technological Development**. These are funding programmes created by the EU to support and foster research in Europe and their specific objectives and actions vary between funding periods. Under FP7 (2007 to 2013), the thematic priorities covered were:

- Health;
- Food, agriculture and fisheries, and biotechnology;
- Information and communications technologies;
- Nanosciences, nanotechnologies, materials and new production technologies;
- Energy;
- Environment (including climate change);
- Transport (including aeronautics);
- Socio-economic sciences and the humanities;
- Space
- Security

In the successor programme, Horizon 2020 (2014 to 2020), funding has been allocated for research and innovation to address the following societal challenges (€29.7 billion):

- Health, demographic change and wellbeing (€7.5 billion);
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bio-economy (€3.9 billion);
- Secure, clean and efficient energy (€5.9 billion);
- Smart, green and integrated transport (€6.3 billion);
- Climate action, environment, resource efficiency and raw materials (€3.1 billion);
- Europe in a changing world - inclusive, innovative and reflective societies (€1.3 billion)

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[25]http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

Another key component of Horizon 2020 is the theme of *Excellent Science* which focuses on basic science and has a budget of €24 billion. The European Research Council (ERC) is in-charge of funds worth €13 billion which are destined for researchers (and teams of researchers) based on scientific excellence of the applications. Under this theme comes funding for *future and emerging technologies* (FET, €2.7 billion), *researcher mobility* (Marie Sklodowska-Curie Action, €6.1 billion) and *large European research infrastructures* (€2.5 billion).

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for the EU as a whole (i.e. weighted average of all EU-28 countries combined). In the period since 2007 there has been a modest in funding of around 6% (in cash terms.

Table 1. Government Funding by Socio-Economic Objectives, 2007 and 2013

	% total 2007	% total 2013	Current price growth (2007 to 2013)
Exploration and exploitation of the earth	1.53	1.96	35.8
Environment	2.63	2.58	3.9
Exploration and exploitation of space	4.62	5.17	18.6
Transport, telecommunication and other infrastructures	2.37	2.70	20.7
Energy	3.12	4.06	37.7
Industrial production and technology	10.14	9.15	-4.4
Health	8.69	8.78	7.1
Agriculture	3.71	3.31	-5.4
Education	0.82	1.21	56.4
Culture, recreation, religion and mass media	1.06	1.08	8.0
Political and social systems, structures and processes	1.98	2.82	50.5
GAK: R&D financed from General University Funds (GUF)	32.87	34.67	11.7
GAK: R&D financed from other sources than GUF	15.14	17.88	25.1
Defence	11.32	4.62	-56.7
Total R&D appropriations	100.00	100.00	5.9

Source: Eurostat

General Advancement of Knowledge is by far the largest category of expenditure accounting for more than 50% of total GBAORD. In 2013 around one-third of the total was allocated to *General University Funds* (GUF) and a further 18% was from sources other than GUF. Both these categories have increased in importance over time. The other important categories for the EU as a whole are *Health* and *Industrial Production and*

Technology. The main trend evident from this table is the decline in the importance of *Defence* R&D expenditures, going from 11% of the total in 2007 to less than 5% in 2013.

Structure of funding

The analysis reported in OECD STI Outlook (2014) shows that for the EU as a whole around two-thirds of government funding goes to Universities and one-third to public research institutes.[26] There has been a slight increase in the relative importance of the former since 2007 (from 62% of the total to 66% in 2013). Nearly 55% of total government expenditures are for generic funds and 45% for thematic research.

Policies for Promoting internationalization of Public Sector Research

EU polices on international research co-operation are driven by the EC communication *Enhancing and focusing EU international cooperation in research and innovation: A strategic approach* issued in 2012.[27] This proposes "to enhance and focus the Union's international cooperation activities in research and innovation by using the dual approach of openness complemented by targeted international cooperation activities, developed on the basis of common interest and mutual benefit, optimal scale and scope, partnership, and synergy". The main elements of this strategy are:

- Horizon 2020 to be fully open to participation from all over the world;
- The European Research Council and Marie Skłodowska-Curie actions to be open to researchers from third countries.
- The Research Infrastructures activity to have a specific focus on international cooperation.

An important consideration is also to tackle global societal challenges, such as food and energy security and climate change through international scientific co-operation.

Policies for Encouraging University Industry Linkage

One of the key elements of the Innovation Union initiative is "to **revolutionise the way public and private sectors work together,** notably through ***Innovation Partnerships*** between the European institutions, national and regional authorities and business".[28] The aim of these partnerships is to tackle specific societal challenges that are shared across the EU and where there is a large new market potential for EU businesses. To date these have focused on the following challenges:

[26] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en
[27] http://ec.europa.eu/research/iscp/pdf/policy/com_2012_497_communication_from_commission_to_inst_en.pdf#view=fit&pagemode=none
[28] http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=intro

- Active and Healthy Aging
- Water
- Agriculture
- Smart Cities
- Raw Materials

Country Report: USA

Top level priorities of Research Policy

The overall framework for research policy is set by the Obama Administration's "*Strategy for American Innovation*"[29]. The main pillar of this strategy in relation to public sector research is to invest in the building blocks of innovation, such as fundamental research, human capital, and infrastructure. The overall aim is to restore American leadership in fundamental research. Additionally the government plans to act as a catalyst for major breakthroughs in national priority areas which are defined as:

a) Unleash a clean energy revolution
b) Support advanced vehicle technologies
c) Drive Innovations in health care technology
d) Harness science and technology to address the "grand challenges" of the 21st Century.

Specific Policies

There are a number of specific policies being pursued in order to fulfil the above goals. Firstly in order to *restore leadership in fundamental research* the US government has substantially increased research funding ($18.3 billion). Secondly the R&D budgets of 3 key science agencies have been doubled: the *National Science Foundation*, the *Department of Energy's Office of Science*, and the *National Institutes of Standards and Technology.* The plan is to provide support for research that is high-risk, multidisciplinary and support early career scientists and engineers. Thirdly there is a declared ambition of investing 3% of GDP in R&D.

In relation to *unleashing the clean energy revolution*, most of the policies are focused on encouraging firms to innovate (sometimes in partnership with the public sector) rather than encouraging public sector research. One specific commitment that involves some basic research is a 10 year $150 billion investment in both fundamental research and development in the following areas: solar, wind, green buildings, efficient lighting, next-generation biofuels, proliferation-resistant nuclear reactors, energy storage, and carbon capture and storage.

Most of the policies that *support advanced vehicle technologies* are aimed at the private sector. An exception is the call to Support the next generation of American Biofuels. The aim is to accelerate the development of clean technologies by harnessing recent advances in synthetic biology.

In relation to the goal of *driving innovations in health care technology*, the plan is to inject $10billion into health research which will be aimed at: identifying genetic changes involved in a number of different types of cancer; discovering causes and treatment of

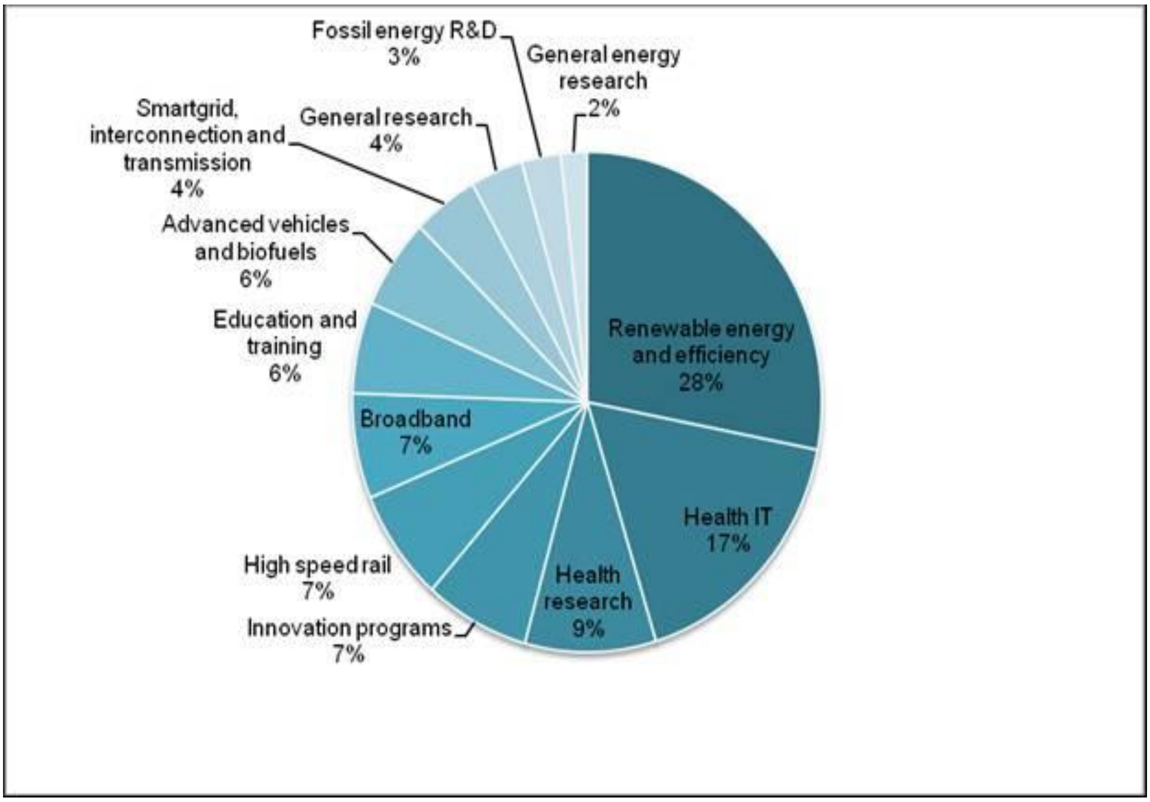
[29] http://www.whitehouse.gov/administration/eop/nec/StrategyforAmericanInnovation

autism, and using DNA sequencing to discover how to prevent and treat heart, lung, and blood diseases.

Finally in order to *harness science and technology to address the "grand challenges" of the 21st Century*, the aim is encourage science, technology and innovation in order to "improve the quality of life and establish the foundation for the industries and jobs of the future". This includes the targeting of very specific areas of science and technology:

- A range of technologies related to Pharmaceuticals: DNA sequencing of cancer; smart anti-cancer therapeutics; early detection of dozens of diseases; nanotechnology that delivers drugs precisely; a universal vaccine for influenza.
- Energy technologies such as solar cells
- Biological systems that can turn sunlight into carbon-neutral fuel
- Automatic, highly accurate and real-time translation between the major languages of the world – greatly lowering the barriers to international commerce and collaboration.

Figure 1-US. Funding Announcement, Recovery Act 2010 (Total over $100 billion)



The Strategy for Innovation is underpinned by the Recovery Act 2010 which contains specific funding allocations as shown in Figure 1-us. Around one-third of the $100 billion allocated to science and technology is focused on the Energy field and one-quarter to Health related areas. The other sizeable category is transport, accounting or 14% of the total. Together these three areas represent nearly three-quarters of the US government priorities.

Trends in Government Budgets

Overall US Budget appropriations have shown a slight decline in the period from 2007 to 2013. The system is also highly concentrated, with *Defence* and *Health* accounting for between 75% and 80% of total funding. These two areas show opposite trends over time with an increase in *Health* spending and a decline in *Defence*. The increasing relative importance of *Health* area is a part of a longer term trend observed over more than 20 years (NSF Science and Engineering Indicators 2014). The two categories with substantial level of funding are *Space* research and directly allocated funds for *General Advancement of Knowledge*.[30] The only other item of note, given the debates on climate change in the US, is the relative unimportance of the environment objective and its decline over time.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth (2007 to 2013)
Exploration and exploitation of the earth	0.68	0.94	34.9
Environment	0.52	0.40	-24.4
Exploration and exploitation of space	7.74	7.94	-0.5
Transport, telecommunication and other infrastructures	1.01	1.12	7.7
Energy	1.35	1.48	6.2
Industrial production and technology	0.34	0.44	24.6
Health	21.90	24.32	7.8
Agriculture	1.64	1.66	-1.6
Education	0.32	0.40	23.6
Culture, recreation, religion and mass media	0.01	0.02	57.5
Political and social systems, structures and processes	0.54	0.92	64.3
General Advancement of Knowledge General University Funds (GUF)	0.00	0.00	--
General Advancement of Knowledge Other Funds	6.14	7.30	15.4
Defence	57.79	53.05	-10.9
Total R&D appropriations	100.00	100.00	-2.9

Source: EUROSTAT

[30] Unlike most EU countries the U.S. federal government does not provide research support through a GUF equivalent, preferring instead to support specific, separately budgeted R&D projects. (NSF Science and Engineering Indicators 2014, p. 4-41.

Structure of funding

Basic research accounted for around one-third of Federal R&D in the period from 2007 to 2011. Relative importance of *Basic* research has declined over this period from 37% in 2007 to 34% in 2011 (NSF Science and Engineering Indicators 2014)[31]. At the same time government expenditures on *Development* have increased from 37% to 43%. Historically, most basic research is conducted at universities and colleges and funded by the federal government.

In terms of the allocation of research funding between Universities and Public sector Research Institutes, 47% goes to Universities and 53% to PRIs. A very large of proportion of public funds is allocated to generic research: 85% compared to 15% for thematic research (OECD STI Outlook, 2014)[32].

Policies for Promoting internationalization of Public Sector Research

The "Strategy for American Innovation" makes no mention of policies for the promotion of internationalization for public sector research. The main body concerned with international co-operation in S&T is *The Office of Science and Technology Cooperation*. The agency is responsible for bi-lateral and multi-lateral S&T agreements, which promote R&D efforts to "improve the human condition, facilitate the exchange of scientific data and results, protect intellectual property rights, and establish partnerships". [33]

Policies for Encouraging University-Industry Linkages

There is very little in the "Strategy for American Innovation" on policies aimed at fostering University-Industry linkages. However in October 2011 the Obama Administration issued a Memorandum on *Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses*[34], which has since become the main basis for policy making. Of course the US has a long history of policies promoting technology transfer and commercialization (see NSF Science and Engineering Indicators 2014, p40-42). However most of the programmes have been in existence since the 1980's and the 1990's. The two more successful initiatives have been reauthorized in 2011 to run through until 2017: the *Small Business Innovation Research* (SBIR) and *Small Business Technology Transfer* (STTR). The main focus of the latter is to support R&D collaboration between SMEs and universities. This programme does not have any thematic focus.

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[31] http://nsf.gov/statistics/seind14/content/etc/nsb1401.pdf
[32] http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en
[33] http://www.state.gov/e/oes/stc/index.htm
[34] http://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali

Country Report: Brazil

Top level priorities of Research Policy

Research policy in Brazil is guided by *The National Strategy for Science, Technology and Innovation (ENCTI) 2012-15*. The declared objectives of *ENCTI* are[35] to: i) close the technological gap with developed economies; ii) support Brazil's leadership in areas of the knowledge economy that take advantage of the country's rich natural resources, such as green innovation, agro-business and other natural-resource-based activities; iii) strengthen the internationalisation of the national research system; iv) foster the development of a green economy; and v) address the country's substantial social and regional inequalities.

These objectives are to be achieved by: (a) the promotion of innovation; (b) improvement of human resources training and capacity-building; and (c) strengthening S&T research and infrastructure. This requires upgrading the innovation regulatory framework and refining and enlarging S&T funding.[36]

In general terms the overall priority of innovation policy in Brazil has shifted from a strong focus on support for science to a much greater emphasis on support for business R&D. This has been accompanied by a greater stress on technology transfer policies.

There is a specific target for Total R&D (GERD) as well as Business R&D (BERD): the former to reach 1.8% of GDP (from 1.16% in 2010) and the latter to reach 0.9% of GDP (from 0.56% in 2010) in the year 2014.

Specific Policies

Majority of the policy targets mentioned in *ENCTI* are aimed at encouraging R&D in firms. A component relevant to public sector R&D is a series of priority programmes aimed at strengthening the national science base and the technological capacity of the Brazilian companies in a number of areas:

- ICT
- Health and Pharmaceuticals
- Oil and Gas
- Defence
- Aerospace
- Nuclear Energy
- Biotechnology and Nanotechnology
- Green Economy (renewable energy, climate change, biodiversity, and oceans and coastal zones)
- STI for Social Development.

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[35] This is largely based on OECD STI Outlook 2014. <http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en>

[36] Erawatch Country Report: Brazil 2012

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for Brazil. In cash terms, total R&D appropriations have increased by 13% in the period from 2007 to 2013.

Table 1. Government Funding by Socio-Economic Objective, 2007 and 2013

	% total 2007	% total 2013	Current price growth
Exploration and exploitation of the earth	0.5	0.2	9.3
Environment	0.8	0.6	11.1
Exploration and exploitation of space	1.1	0.8	-23.5
Transport, telecommunication and other infrastructures	3.8	2.1	58.1
Energy	1.4	0.4	-20.3
Industrial production and technology	5.7	6.6	1.0
Health	7.0	5.3	10.1
Agriculture	9.9	10.2	11.8
Education			
Culture, recreation, religion and mass media			
Political and social systems, structures and processes	0.4	0.0	48.4
GAK: R&D financed from General University Funds (GUF)	58.2	60.9	13.5
GAK: R&D financed from other sources than GUF	10.8	12.0	10.8
Defence	0.5	0.7	53.0
Total R&D appropriations	100.0	100.0	13.0

Source: Coordenação-Geral de Indicadores (CGIN) - ASCAV/SEXEC - Ministério da Ciência, Tecnologia e Inovação (MCTI)

More than two-thirds of the budget is accounted for by *General Advancement of Knowledge* and this proportion has increased from 2007 to 2013. The universities are the largest recipients of government funds, accounting for more than 60% of the total in 2013. Two other areas of increasing relative importance are *Health* and *Agriculture*.

Structure of funding

Not Available

Policies for Promoting internationalization of Public Sector Research

Promotion of international cooperation is one of the strategic priorities announced in *ENCTI*. One of the key programmes focused on this priority is *Science without Borders* which is implemented by Federal Agency for Support and Evaluation of Graduate Education (CAPES) and the National Council for Scientific and Technological Development (CNPq) of Brazil. The main goal of the program is to promote international exchange and mobility. It places scientists and industry personnel from Brazil in international institutions of excellence and encourages highly qualified researchers from abroad to work with local investigators in joint projects. The program also encourages research partnerships between universities and research centres in Brazil and their international counterparts.

In recent years a number of new inter-regional cooperation arrangements have been instigated in order to aim at training researchers building research infrastructure facilities. The most notable are: IBAS (involving Brazil, India, and South Africa); Mercousul, Prosul, SEGIB. Unasul, and ZOPACAS (involving South American partners), PROAFRICA and Portuguese Speaking Nations Community CPLP (involving African countries).[37]

Policies for Encouraging University Industry Linkages

Most policy measures to reinforce the cooperation between universities, research institutes and business firms were launched after the passing of the 2005 innovation law. This law laid down the conditions under which such partnerships could exist. There were provisions to allow private sector firms to use public laboratories for their research. The law obliged research institutes and universities to create technology transfer offices to enable researchers to negotiate contracts and licenses for the research undertaken with the private sector.

There are a number of other programmes that encourage cross-sector mobility of researchers, e.g. PAPPE, the Programme for Support of Research in Enterprise, and SEBRAE, the Brazilian Support Service for Small Enterprises., which facilitate knowledge flows between universities, PRIs and the business sector.[38]

[37] Erawatch Country Report: Brazil 2012

[38] OECD STI Outlook 2014 < http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en>

Country Report: China

Top level priorities of Research Policy

High-level research policy in China is formulated on the basis of two plans: "*The Medium- and Long-term National Plan for Science and Technology Development 2006-2020*" and the "*12th Five-Year-Plan for Science and Technology Development (2011-2015)*". [39,40] The overall guidelines are set out in the former and the implementation outlined in the latter. According to the long-term plan the overall priorities are to (a) promote S&T developments in selected key fields; and (b) strengthen domestic innovation capacity and reduce foreign dependence. This plan also contains explicit mention of societal challenges in environment, energy and healthcare as priorities for S&T policies. The key themes of the 12th plan (the implementation) are rebalancing the economy, ameliorating social inequality and protecting the environment.

This long term plan aims to transform China into an innovative society by 2020. This is to be achieved by increasing national R&D intensity (GERD as a % of GDP) to over 2.2% by 2015 and to 2.5% by 2020. This will require an increase in both public and business R&D.

Specific Policies and funding

Detailed implementation of the above priorities is undertaken by a number of different ministries, the most important of which are Ministry of Science and Technology (MOST) and the Chinese Academy of Sciences (CAS). The most important programmes undertaken by MOST are: the *National Basic Research Programme* ("973 "Programme"); the *National High-Tech Research and Development Programme* ("863" Programme"); and *The R&D Infrastructure and Facility Development Programme.*

The aim of the 973 programme is to fund basic research on major scientific issues in agriculture, energy, information technology, resources and environment, population and health, and materials.[41] The 863 programme is a pre-competitive R&D program involving collaboration between firms and public sector research organizations. *The R&D Infrastructure Programme* aims to strengthen China's S&T capacity by providing a platform for the research community (including both public and private sector) to share the use of state-funded S&T infrastructure.

In terms of funding the 863 programme is the largest with government allocation of €766 million[42] in 2009. In terms of priorities these funds are allocated as follows: ICT (23.5%), manufacturing (15.5%), materials (14.7%), agriculture and biotechnology (9.9%),

[39] English Translation available at: http://sydney.edu.au/global-health/international-networks/National_Outline_for_Medium_and_Long_Term_ST_Development1.doc
[40] http://www.cbichina.org.cn/cbichina/upload/fckeditor/Full%20Translation%20of%20the%2012th%20Five-Year%20Plan.pdf
[41] This section is heavily reliant on Erawatch Country Report 2012 for China
[42] Or 5.115 billion yuan

resources and environment (9.4%). Only slightly smaller is the Infrastructure programme with an allocation of €748 million in 2009. The thematic priorities of this programme (in terms of funds allocated) are: agriculture (19.3%), transportation (14.3%), materials (10.7%), population and health (9.4%), resources (8.6%), information industry and modern services (8.2%), urbanisation and urban development (7.9%), environment (7.5%), manufacturing (5.7%), public security and other social affairs (5.2%), energy (3.2%).

Finally the 973 programme had a budget of €389 million which was allocated as follows: population and health (12.3%), energy (9.2%), nano-technology (9.2%), resources and environment (9.1%), interdisciplinary research (9.1%), agriculture (8.8%), cutting-edge science (8.6%), materials (8.2%), information (7.8%), growth and regeneration (7.0%), and protein engineering (5.9%).

Trends in government budgets

Data on GBAORD is not available for China.

Structure of funding

The only information available on the structure of funding is that majority of government funds on S&T[43] are spent by public research organizations (64% in 2010), with the universities and other higher education institutes playing a minor role (receiving 21% of the total).[44] This also means that institutional block grants to higher education play a minor role, with majority of funds allocated on a competitive basis. At the same time *basic research* accounts for around 22% of total central government expenditures, and *applied research* around 73% (Erawatch Country Report 2012)[45].

Policies for Promoting internationalization of Public Sector Research

As indicated in the 12th Plan, a key priority for China is to expand the level of international S&T cooperation in solving societal challenges. The prioritised fields are energy, environment, new materials, advanced manufacturing, information technology, agriculture, life sciences, aerospace, and marine science. In recent years, China has also increased its participation in large-scale international collaborative projects, such as the EU 7th Framework Programme, and has engaged in annual bilateral dialogues with countries, such as the United States and Germany, on STI co-operation.

China has bilateral cooperation agreements in science and technology with a large number of EU and non-EU countries. These typically have provisions for scientific exchange and research collaboration.

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[43] S&T expenditures include R&D but are broader in scope

[44] http://erawatch.jrc.ec.europa.eu/erawatch/export/sites/default/galleries/generic_files/file_0440.pdf

[45] Sun, Yutao, and Cong Cao. "Demystifying central government R&D spending in China." *Science* 345.6200 (2014): 1006-1008.

A major initiative is the International Science and Technology Cooperation Programme (ISTCP) run by MOST (Ministry of Science and Technology). This scheme funds the participation of Chinese scholars engaged in international research programmes as well as foreign scientists engaged in major national initiatives. The National High-tech R&D Program (863 Program) specifically mentions that special funds are earmarked to support and encourage the implementation of international cooperative projects within its framework.

Policies for Encouraging University Industry Linkages

There is high-level support for promoting University-Industry collaborations. For example in 2012 the government outlined a strategic document, “Further reform of the S&T system and build enterprise-centred innovation system,” which emphasized the strengthening of “Industry-University-Research” linkages. In 2013 MOST began drafting the revision of “The Law of Promoting Technology Transfer”. The new law is expected to reflect the market-based relations between universities and industry in technology transfer.[46]

[46] Erawatch Country Report

Country Report: India

Top level priorities of Research Policy

The current priorities of research policy in India are based on two government documents: *Science, Technology and Innovation Policy, 2013* and the *12th Five Year Plan – Faster, More Inclusive and Sustainable Growth*. [47,48] The overall ambition of the government is to ensure that India is amongst the top 5 scientific superpowers by 2020. The strategic priority is to make sure that science and technology are employed to achieve inclusive, sustainable and rapid growth for the population as a whole. This is to be attained by prioritizing research in critical areas such as agriculture, telecommunications, energy, water management, health and drug discovery, materials, environment and climate change. Further aims are to make careers in science, research and innovation more attractive, and to establish world class R&D infrastructure in selected areas of leading edge science.

A key element of achieving the above targets is to increase total R&D expenditures (GERD) to 2% GDP (from around 0.7% currently). As the government accounts for around two-thirds of total R&D, this will require substantial increases in government expenditures. At the same time the aim is also to increase the amount of R&D undertaken by the private sector. This will be partly achieved by ear-marking between 10% and 15% of public R&D investments exclusively for public-private partnerships (PPPs).

Specific Policies

A key part of the plan is to increase the number of full-time researchers (scientists and engineers) from the current level of 154,000 to 250,000 by introducing policies aimed at providing greater flexibility to the younger generation of scientists and greater mobility between industry, academia and R&D institutions.

The *12th Five Year Plan* also initiated the Grand Challenge Programmes and launched PAN-India missions to address national priorities in Health, Water, Energy, Environment and Food. There is explicit recognition that in order to achieve synergies at the national level there needs to be a co-ordinated effort between different government departments and ministries.

Further the *Plan* signals the creation of new Inter-University Centres (IUCs) and Inter-Institutional Centres (IICs) in chosen areas of Science and Engineering, which will provide access to state-of-the-art facilities. At the same time it announces the creation of high-performance supercomputing facilities computing for applications such as climate modelling, weather prediction, aerospace engineering, computational biology, nuclear applications, and earthquake simulations.

[47] http://dst.gov.in/sti-policy-eng.pdf

[48] http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol1.pdf

Trends in Government Budgets

Table 1 shows the most recent trend in the GBAORD data for India. There has been a large increase research funding between 2005 and 2010: 80% in cash terms.

Table 1. Government Funding by Socio-Economic Objectives, 2005-06 and 2009-10

	% total 2005-6	% total 2009-10	Current price growth 2005 to 2010
Exploration and exploitation of the earth	3.5	3.9	103.2
Environment	1.2	1.1	71.0
Exploration and exploitation of space	12.7	13.7	93.6
Transport, telecommunication and other infrastructures	1.5	1.5	79.4
Energy	7.3	9.0	120.3
Industrial production and technology	7.7	8.4	94.7
Health	4.7	5.2	101.6
Agriculture	19.1	17.7	66.4
Political and social systems, structures and processes	0.4	0.5	136.7
GAK: R&D financed from General University Funds (GUF)	-	-	-
GAK: R&D financed from other sources than GUF	14.1	14.4	83.9
Defence	27.4	24.5	61.1
Total R&D appropriations	100.0	100.0	80.4

Source: Department of Science and Technology: http://www.nstmis-dst.org/SnT-Indicators2011-12.aspx

The largest category of government funding is *Defence*, accounting for around one-quarter of the total but declining in relative terms. Three other areas are also relatively important budget items: *Space*, *Agriculture* and *Basic Research* (directly funded). Together these four categories account for more than 80% of the total. *Energy* and *Health* have grown in relative importance since 2005.

Structure of funding

India's research system is dominated by public sector research organizations.[49] Some of these are national laboratories under the direct control of various government agencies and others are in-house laboratories of public sector enterprises such as steel and railways. Universities play a minor role in the national R&D landscape. This is most clearly evidenced by the proportion of total government R&D that constitutes basic research: in

[49] ERAWATCH country fiche: http://erawatch.jrc.ec.europa.eu/erawatch/opencms/system/modules/com.everis.erawatch.template/pages/exportTypesToHtml.jsp?contentid=35834333-7d29-11df-b939-53862385bcfa&country=India&option=PDF

2010 this was 23%. This means that more than three quarters of all government expenditure is for applied research and experimental development. However the long term trend has been an increase in the share of basic research.

Policies for Promoting internationalization of Public Sector Research

A key priority mentioned in *Science, Technology and Innovation Policy 2013*[1] is Indian participation in the global R&D infrastructure and Big Science. This involves co-operation at the international level in projects such as CERN and International Thermonuclear Experimental Reactor (ITER). It also involves participation in various multi-lateral S&T agreements through UNESCO, UNDP, BIMST-EC; Indian Ocean Rim-EC; Third World Academy of Science.

More specifically the *12th Five Year Plan* mentions investment in developing following major Mega facilities through international co-operation: (i) Laser Interferometer Gravitational Wave Observatory (LIGO); (ii) India-based Neutrino Observatory (INO); (iii) Thirty Meter Telescope (TMT); (iv) Square Kilometre Array (SKA); (v) National Large Solar Telescope and (vi) Next Generation Synchrotron. Other projects include India-based Neutrino Observatory, Thirty Meter Telescope, Square Kilometre Array.

The government also encourages scientific institutions to participate in EU framework programmes in areas such as: clean energy, energy efficiency and renewable energy, computational materials, food and nutrition research and water technologies. India became the fourth largest international partner under 7th EU framework.

Policies for Encouraging University Industry Linkages

A top level STI policy priority is to "build partnership with identified players of the National Innovation System to build the scientific, technological and human resource niches for the country". This will be achieved by earmarking government funds for partnerships between public sector research organizations and private firms for achieving social and public good.

A number of government departments have launched research programmes to forge science and industry links. Some of these are:

- Industrial R&D Promotion Programme (http://dsir.csir.res.in/webdsir/#files/tpdup/irdpp/irdpp.html)
- Technology Development and Innovation Programme (http://www.dsir.gov.in/tpdup/irdpp/irdpp.htm);
- Technology Development and Demonstration Programme (http://www.dsir.gov.in/tpdup/tddp/tddp.htm);
- Technopreneur Promotion Programme (http://dsir.gov.in/tpdup/tepp/tepp.htm);

- Technology Management Programme (http://www.dsir.gov.in/tpdup/tmp/tmp.htm);
- International Technology Transfer Programme (http://www.dsir.gov.in/tpdup/ittp/ittp.htm);
- Technology Development & Utilization Programme for Women (http://www.dsir.gov.in/tpdup/tdupw/tdupw.htm)

IV. Assessment

This report set out to answer a number of questions of interest to research policy by undertaking comparisons between the Nordic countries and a set of international counterparts. The first was the extent to which government spending on public sector R&D has changed over the recent years. The second was the extent to which policies related to grand societal challenges have risen in prominence. The third set of questions focused on the differences in the structure of public sector research. The analysis is based on systematic data collected by the OECD, EUROSTAT and UNESCO, together with country reports on Science Technology and Innovation policies produced by ERAWATCH and the OECD, and high level national strategy documents. The main findings of our analysis are summarized in the two-part table below.

In terms of funding the countries can be divided into three groups. This first comprises Sweden, Denmark, Norway, India and China, which have experienced high growth in their public R&D. By far the highest growth has been in the case of China, followed by India (albeit from a low base). For the second group of countries, growth of public R&D has been modest: Finland, Brazil and the EU-28. While in these countries expenditures increased at a high rate in the period up to 2007/2008 there has been a decline since then. The only country in our sample where expenditures have declined is the USA, where the largest fall was in the period from 2001 to 2008. Since then there has been a modest increase. The budgetary data show a contrasting trend, whereby the USA experienced an increase from 2001 to 2007 followed by a decline up to 2013.

All countries under consideration give prominence to grand societal challenges as high level priorities for innovation in their mission statements. Most also have specific commitments to funding scientific research related to such challenges. However the analysis of government budgets shows a different picture. Taking as an example the largest spending country, the USA, what we observe is that the Obama Administration's "*Strategy for American Innovation"* mentions the need to harness science and technology to address the "grand challenges" of the 21st Century as one of the 4 national priorities. However the analysis of the of the US budgetary information shows that *defence* remains of the key priorities, accounting for more than 50% of the total US government budget for R&D. The only societal challenge that is of high relative importance is *health*. On the other hand *energy* and *environment* are of much lower priority, with the latter declining in terms of the share of funds allocated. As shown in the summary table below this pattern is prevalent in most of the countries in our sample.

There are some differences amongst countries in terms of their main priority as shown by the analysis of budgetary information. For the 4 Nordic countries, the EU-28 and Brazil, the largest share of government budget is spent on *general advance of knowledge*. For USA and India the main priorities are *defence* and *space*.

Universities are the main recipients of public funds for R&D in the 4 Nordic countries and the EU-28. In Denmark and Sweden they account for more than 80% of total resources.

By contrast in the USA, India and China, public research institutes are relatively more important. In the case of the India and China by far the largest proportion of government funds are channelled through PRIs.

There are differences across countries in the balance of funding between *basic* and *applied* research and *development*. For the USA and India *applied* research and *development* are relatively more important and for Norway and China *applied research* is more prominent. Denmark accords equal priority to both and for Sweden most funds are directed to *basic* research.

Finally for almost all countries, policies that promote international collaboration of public sector research and encourage linkages between public sector research and business firms are of great importance. They are both mentioned specifically in high-level documents that underlie policy making.

Summary of the Main Findings

	EU	**Sweden**	**Denmark**	**Finland**	**Norway**
Expenditures	Modest growth	High growth	High growth	Modest Growth	High growth
Budget (GBAORD)	Modest Growth	High growth	High growth	High Growth	High growth
Societal challenges mentioned in high level policy documents	Yes	Yes	Yes	Yes	Yes
Specific commitments to funding R&D related to societal challenges	Yes	Yes	Yes	Yes	Yes
Relative importance of societal challenges in budget	Health a big priority and increasing; Energy and Environment small	Energy, Health and Environment are relatively small but increasing	Health a big priority and increasing; Energy modest and increasing	Energy a big priority and increasing; Health and Environment small and declining	Health a big priority and increasing; Energy and Environment small
Top Priority	General Advancement of Knowledge (> 50% of total)	General Advancement of Knowledge (70% of total)	General Advancement of Knowledge (60% of total)	General Advancement of Knowledge (50% of total)	General Advancement of Knowledge (45% of total)
Universities vs PRIs	Universities (66%)	Universities (85%)	Universities (90%)	Universities (70%)	Universities (65%)
Balance of Basic versus applied		Basic	Equal		Applied Research
International Collaboration	High level priority	High level priority	High level priority	High level priority	High level priority
University Industry Linkages	High level priority	High level priority	High level priority	No mention in High level documents	High level priority

Summary of the Main Findings

	USA	**Brazil**	**China**	**India**
Expenditures	Decline	Modest Growth	High growth	High growth
Budget (GBAORD)	Modest Growth (Decline since 2007)	High Growth		High growth
Societal challenges mentioned in high level policy documents	Yes	Yes	Yes	Yes
Specific commitments to funding R&D related to societal challenges	Yes	Yes	Yes	Yes
Relative importance of societal challenges in budget	Health a big priority and increasing	Health a priority but declining; Energy and Environment small and declining	N/A	Energy a big priority ; Health and environment smaller priorities
Top Priority	Defence (more than 50% of total)	General Advancement of Knowledge (70% of total)	N/A	Defence and Space account for 40% of total
Universities vs PRIs	Equal	N/A	PRIs (64% of total)	PRIs
Balance of Basic versus applied	Applied Research and Development	N/A	Applied Research	Applied Research and Development
International Collaboration	No mention in High level documents	High level priority	High level priority	High level priority
University Industry Linkages	No mention in High level documents	High level priority	High level priority	High level priority

Annex 1. Sources of Charts and Tables

Chart 1a. Growth rate of National R&D Expenditures (at constant prices)

Eurostat: Total intramural R&D expenditure (GERD) by sectors of performance in national currencies [rd_e_gerdtot]:

http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do;jsessionid=5Hvmis0kYbNdggrR8SjWilUKugGrylGN6jhpO7fAWgjVrODo5cne!1990887461

GDP deflators for obtained from the OECD Main Science and Technology Indicators database (MSTI).

Missing data for US for 2013.

Chart 1b. Growth rate of National R&D Expenditures (at constant prices)

R&D data for China from Eurostat and OECD as above; Brazil and India from UNESCO http://data.uis.unesco.org/Index.aspx?queryid=74),

GDP deflators from World Bank.

Missing data for 2013 for India and Brazil

Chart 2. Trends in GERD as a % of GDP 2000 to 2013

Denmark, Finland, Norway, Sweden, EU-28, USA and China from Eurostat research and development expenditure, by sectors of performance (tsc00001):

http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsc00001&plugin=1

Brazil and India from UNESCO Science, Technology and Innovation Statistics:

http://data.uis.unesco.org/?queryid=74

Missing data for 2013 for USA, India and Brazil

Chart 3. Growth rates of Government expenditures on National R&D

Denmark, Finland, Norway, Sweden, EU-28, USA and China from Eurostat research and development expenditure, by sectors of performance (tsc00001) database:

http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsc00031&language=en

Missing data for Denmark, Sweden and Norway (for alternate years from 2002), are interpolated using stata ipolate function.

Brazil and India from UNESCO as above (chart 1b)

Growth rates calculated by authors.

Chart 4. Government financed GERD as % of GDP

EUROSTAT and UNESCO as above (Chart 3)

Tables 1 and 2

As Charts 3 and 4

Charts 5. Trend in Defence as a % of Total GBAORD 2005 to 2013

Denmark, Finland, Norway, Sweden, EU-28 and USA from Eurostat database http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=gba_nabsfin07&lang=en;

Brazil from:
http://www.mct.gov.br/index.php/content/view/9134/Brasil_Dispendios_publicos_em_pesquisa_e_desenvolvimento_P_D_por_objetivo_socioeconomico.html

India from

https://data.gov.in/catalog/expenditure-research-and-development-objectives#web_catalog_tabs_block_10 .

Percentages calculated by authors

Chart 6. Trend in GUF as a % of Civil GBAORD 2005 to 2013

As above

Chart 7. Trend in Health as a % of Civil GBAORD 2005 to 2013

As above

Chart 8. Trend in Energy as a % of Civil GBAORD 2005 to 2013

As above

Chart 9. Trend in Environment as a % of Civil GBAORD 2005 to 2013

As above

Annex 2. Definition of Socio-economic objectives (NABS 2007)

1. Exploration and exploitation of the Earth

This category covers research with objectives related to the exploration of the Earth's crust and mantle, seas, oceans and atmosphere, and research on their exploitation. It also includes climatic and meteorological research, polar exploration and hydrology. It does not include:

– Soil improvement and land use (2 below).

– Research on pollution (3 below).

– Fishing (6 below).

2. Infrastructure and general planning of land use

This covers research on infrastructure and land development, including research on the construction of buildings. More generally, this covers all research relating to the general planning of land use.

This includes research into protection against harmful effects in town and country planning but not research into other types of pollution (3 below).

3. Control and care of the environment

This covers research into the control of pollution, aimed at the identification and analysis of the sources of pollution and their causes, and all pollutants, including their dispersal in the environment and the effects on man, species (fauna, flora, micro-organisms) and the biosphere. Development of monitoring facilities for the measurement of all kinds of pollution is included. The same is valid for the elimination and prevention of all forms of pollution in all types of environment.

4. Protection and improvement of human health

This covers research aimed at protecting, promoting and restoring human health, broadly interpreted to include health aspects of nutrition and food hygiene. It ranges from preventive medicine, including all aspects of medical and surgical treatment, both for individuals and groups, and the provision of hospital and home care, to social medicine and paediatric and geriatric research.

5. Production, distribution and rational utilisation of energy

This covers research into the production, storage, transportation, distribution and rational use of all forms of energy. It also includes research on processes designed to increase the efficiency of energy production and distribution, and the study of energy conservation.

It does not include:

– Research relating to prospecting (1 above).

– Research into vehicle and engine propulsion (7 below).

6. Agricultural production and technology

This covers all research on the promotion of agriculture, forestry, fisheries and foodstuff production. It includes: research on chemical fertilisers, biocides, biological pest control and the mechanisation of agriculture; research on the impact of agricultural and forestry activities on the environment; research in the field of developing food productivity and technology. It does not include:

– Research on the reduction of pollution (3 above).

– Research into the development of rural areas, the construction and planning of buildings, the improvement of rural rest and recreation amenities and agricultural water supply (2 above).

– Research on energy measures (5 above).

– Research for the food industry (7 below).

7. Industrial production and technology

This covers research on the improvement of industrial production and technology. It includes research on industrial products and their manufacturing processes, except where they form an integral part of the pursuit of other objectives (e.g. defence, space, energy, agriculture).

8. Social structures and relationships

This covers research on social objectives, as analysed in particular by social and human sciences, which have no obvious connection with other categories. It includes quantitative, qualitative, organisational and forecasting aspects of social problems.

9. Exploration and exploitation of space

This category covers all civil space research and technology. Corresponding research in the defence field is classified in 13 below. Although civil space research is not in general concerned with particular objectives, it frequently has a specific goal, such as the increase of general knowledge (e.g. astronomy), or relates to particular applications (e.g. telecommunications satellites).

10. Research financed from general university funds

When reporting GBAORD by "purpose", this class should include, by convention, all R&D financed from general purpose grants from ministries of education, although in some countries many of these programmes may be relevant to other objectives. This convention has been adopted because of the problem of obtaining suitable data and thus of comparability. Member countries should provide the most detailed breakdown possible of the “contents” of this class by field of science and technology and, where they are able to do so, by objectives.

11. Non-oriented research

This covers all those appropriations or outlays which are earmarked for R&D but which cannot be attributed to an objective.

12. Other civil research

This covers civil research which cannot be classified to any other category.

13. Defence

This category covers research (and development) for military purposes. It also includes basic research and nuclear and space research financed by ministries of defence. Civil research financed by ministries of defence, for example in the fields of meteorology, telecommunications and health, should be classified in the relevant category above.