GOING FOR SMART GROWTH

MAKING RESEARCH INNOVATION WORK FOR BULGARIA

THE WORLD BANK

January 2012

Report No. 66263-BG

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Making Research and Innovation Work for Bulgaria

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THE WORLD BANK
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Washington, D.C.

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Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Manufactured in the Republic of Bulgaria
First printing: January, 2012

Report No. 66263-BG

Cover design by *Boris Balabanov*

Printed on 100 %   Recycled Paper
Text body - *CyclusPrint* - *90 gr.*
Cover - *CyclusPrint* - *300 gr,*

BULGARIA - GOVERNMENT FISCAL YEAR

1 January – 31 December

CURRENCY AND EQUIVALENT UNITS

(Exchange rate effective January 3, 2012)
Currency Unit = Bulgarian Lev (BGN)
EUR 1 = 1.95583
US$ 1 = 1.50287

WEIGHTS AND MEASURES

Metric System

ABBREVIATIONS AND ACRONYMS

ARC Fund	Applied Research and Communications Fund
ALLEA	All European Academies
BAS	Bulgarian Academy of Science
BASSCOM	Bulgarian Association of Software Companies
BEEPS	Business Environment Enterprise Survey
BSMEPA	Bulgarian Small and Medium Enterprises Promotion Agency
CGP	Competitive Grant Program
CIP	Competitiveness and Innovation Framework Programme
CMMI	Capability Maturity Model Integration
EC	European Commission
ECA	Europe and Central Asia
ECSHD	Human Development Sector
ECSPF	Europe and Central Asia Private & Financial Sectors Development Sector
EFPIA	European Federation of Pharmaceutical Industries and Associations
EPO	European Patent Office
ERA	European Research Area
ESF	European Science Foundation
EU	European Union
EXPY	Measure of Export Sophistication
FDI	Foreign Direct Investment
FP7	Seventh Framework Programme for Research and Technological Development
GDP	Gross Domestic Product
HDNED	Education Group of The World Bank's Human Development Network
ICT	Information and Communications Technology
IPR	Intellectual Property Rights
IT	Information Technology
JEREMIE	Joint European Resources for Micro to Medium Enterprises
NBER	National Bureau of Economic Research
MEET	Bulgaria's Ministry of Economy, Energy and Tourism
MEYS	Bulgaria's Ministry of Education, Youth and Science
MNEs	Multinational Enterprises
MTEF	Medium-term Expenditure Framework

NEMESIS	New Econometric Model of Evaluation by Sectoral Interdependency and Supply
NGO	Non-Governmental Organization
NIF	Bulgaria's National Innovation Fund
NIH	U.S. National Institutes of Health
NSF	Bulgaria's National Science Fund
NRP	National Reform Program
OCS	Israel's Office of the Chief Scientist
OECD	Organization for Economic Co-operation and Development
OP	Operational Programme
PRMED	World Bank's Economic Policy and Debt Department
RDI	Research and Development Institute
R&D	Research and Development
SAP	System Analysis and Program Development Corporation
SEBRA	System for Electronic Budget Payments
SMEs	Small-and-Medium-Sized Enterprises
SOEs	State-Owned Enterprises
STI	Science, Technology, and Innovation
TA	Technical Assistance
TIP	Technological Incubators Programme
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USPTO	United States Patent and Trademark Office
UVD	Unit Value Distance Comparison
VC	Venture Capital
VCP	VMware Certified Professionals
WEF	World Economic Forum

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ACKNOWLEDGEMENTS

This policy note has been prepared as part of the programmatic analytical and advisory activities coordinated by the Europe and Central Asia Region (ECA) Finance and Private Sector Development Department (ECSPF) of the World Bank. The team preparing the policy note was led by John Gabriel Goddard (Senior Economist) and included Evgeni Evgeniev (Private Sector Development Specialist), Yana Ukhaneva (Consultant) and Sorin Krammer (Assistant Professor, University of Groningen). The team appreciates the valuable contributions from the Applied Research and Communications (ARC) Fund, which was commissioned to produce several technical notes that assess budgetary spending and public policies in the areas of research and innovation; the ARC Fund team was coordinated by Ruslan Stefanov and included Teodora Georgieva, Zoya Damianova and Todor Galev. This activity was coordinated with colleagues in ECA's Human Development Department (ECSHD), particularly Alberto Rodriguez (Sector Manager), Plamen Danchev (Human Development Economist) and Peter Pojarski (Senior Operations Officer). Hilary Gopnik provided vital editorial support. The Bulgarian the Baltic Countries), Markus Repnik (Country Manager for Bulgaria), Florian Fichtl (former Country Manager for Bulgaria), Gerardo Corrochano (Sector Director, ECSPF and Director of the Innovation, Technology, and Entrepreneurship Global Practice) and Lalit Raina (Sector Manager, ECSPF).

The team would like to thank the Government of Bulgaria for the cooperation and support extended during the preparation of this policy note, and express its appreciation for guidance received from counterparts under the leadership of H.E. Traicho Traikov, Minister of Economy, Energy and Tourism and H.E. Sergei Ignatov, Minister of Education, Youth and Science.

The team appreciates the inputs provided by the peer reviewers of this policy note, Silvia Viceconte (Policy Co-ordinator, Europe 2020 Strategy, EC), Athanasios Sofos (Program Manager, DG Regional Policy, EC), Benedikt Herrmann (Innovation Policy Officer, DG Research, EC), Alfred Watkins (World Bank S&T Program Coordinator, HDNED) and Mark Dutz (Senior Economist, PRMED). The team also thanks the following for their comments: Ana Mihaylova (Senior Advisor to the Executive Director, EDS19), Jean-Louis Racine (Science, Technology and Innovation Specialist, ECSPF), John Daniel Pollner (Lead Financial Officer, ECSPF), Paulo Guilherme Correa (Lead Economist, ECSPF), Stella Ilieva (Senior Economist, ECSPE), Rosalinda Quintanilla (Lead Economist, ECSPE), Sylvia Stoynova (Operations Officer) and Ivelina Taushanova (Communications Officer), all from the World Bank.

The team is thankful to Paul David (Professor Emeritus of Economics, Stanford and Oxford Universities; Professor of Innovation and Competition in the Digital Economy, Ecole Polytechnique), and Itzhak Goldberg (Visiting Researcher, EC Joint Research Center, Seville) for their valuable inputs. The World Bank team is also appreciative of the feedback received from participants at the *Competitiveness through Research and Innovation: Strategies, Policies and Incentives* Forum held on June 21, 2010 in Sofia, Bulgaria.

EXECUTIVE SUMMARY

Context and Objectives

Bulgaria's competitiveness challenge is to "grow smart", which means making research and innovation one of the major drivers of economic growth. Bulgaria's competitiveness has improved in recent years, but not strongly enough to catch up with EU peers (see Table 1) nor quickly enough to keep pace with emerging countries in Asia and Latin America. Bulgaria's exports increased in absolute and in per capita terms throughout the last decade, and by 2008 they represented nearly 60 percent of its GDP, but the export basket continues to be dominated by products from traditional and mature industries. Today, only 3 percent of exports are high-technology products, substantially below the EU-27 average (16 percent). Innovation could help industries in which Bulgaria has a comparative advantage to move up the value chain and expand the country's high-tech export base.

Table 1: Bulgaria's standing in international rankings of competitiveness

	Global Competitiveness Report 2011-2012	Doing Business 2012	Innovation Union Scoreboard 2010	WEF Lisbon Review 2010
Finland	4	11	4	2
Italy	43	87	19	25
Hungary	48	51	24	21
Turkey	59	71	33	n/a
Romania	77	72	28	26
Bulgaria	74 (out of 142)	59 (out of 183)	32 (out of 34)	27 (out of 27)
Croatia	76	80	25	n/a

Policies that intensify Research and Development (R&D) investments are seen as one way in which to stimulate Bulgaria's economic growth, high-tech exports and competitiveness. Investments in research and innovation are seen as core contributors to Bulgaria's global competitiveness in the National Reform Program (NRP) 2011–2015. Indeed, the Government of Bulgaria (GoB) has committed to meeting a target of R&D/GDP of 1.5 percent by 2020, three times the current level. A large share of the new investments is expected to come from enterprises. But while greater R&D levels are important, to deliver the anticipated impact it is also important to upgrade relevant institutions, policies and legislation.

This policy note contributes to the GoB's efforts by providing a detailed assessment of Bulgaria's innovative capacity and offering policy recommendations to increase the impact of research and innovation. This note is one of the central outputs of the programmatic analytical and advisory support requested by the Government of Bulgaria, and coordinated by the Ministry of Education, Youth, and Science (MEYS) and the Ministry of Economy, Energy and Tourism (MEET). The recommendations have been greatly enriched by policy discussions with the MEYS and the MEET, as well as consultations with universities, research institutes, think tanks and the business community.

Part I of the policy note provides an assessment of Bulgaria's innovation capacity in the public and private spheres. Specifically, the note examines: (i) recent trends in Bulgaria's export performance, benchmarking Bulgaria relative to comparator countries; (ii) the characteristics of innovation activities in Bulgaria's private sector, as seen by enterprise surveys; (iii) developments in technological invention and scientific production, by analyzing the statistics about patents granted in the US Patent and Trademark Office (USPTO) and the European Patent Office (EPO) as well as data on scientific publications.[1]

Part II provides recommendations that could facilitate the implementation of the NRP and the Scientific Research Strategy, including sectoral analysis to guide innovation policy in priority industries. The recommendations are divided into the following areas: (i) attaining the 1.5 percent R&D/ GPD target under the Europe 2020 Strategy; (ii) strengthening the institutional and policy framework for research and innovation; (iii) achieving better results from national funding instruments—the National Innovation Fund and the National Science Fund; (iv) increasing absorption of EU funds targeting innovation; (v) developing targeted innovation policies and instruments for priority sectors.

Key Challenges

There is an urgent need to reverse the erosion of Bulgaria's technological and scientific competences through more strategic support of research and innovation. The evidence presented in this policy note shows that innovative outputs plunged post-1990 followed by a slow recovery. Bulgaria's patenting and scientific publication track record does not compare well with most European countries, although there are encouraging signs when it comes to patenting activity, which is currently on the rise, propelled by R&D-intensive foreign investments. International experience shows that the enterprise sector will need to be an active partner in developing innovative ideas and products. The most innovative countries such as Germany, Finland, and Sweden have the highest share of private spending, with about 65 percent of total R&D funded by private enterprise. At 30:70, the ratio of private to public R&D in Bulgaria is unfavorable compared to these countries.

Raising the R&D-intensity of the economy is one of the main challenges ahead. A substantial increase in R&D investments would be needed to meet the target of R&D/GDP of 1.5 percent by 2020, since Bulgaria currently has R&D spending of 0.48 percent of GDP (compared to 1.85 percent in the EU-27 and 0.7 percent in ECA). Prior to the downturn, there were increases in the volume of R&D spending, but they were at a slower rate than GDP growth. Due to the downturn, and its impact on the capacity of the State budget, there have been two consecutive years of real declines in public spending on R&D. At the same time, private R&D remains weak compared to the EU as a whole.

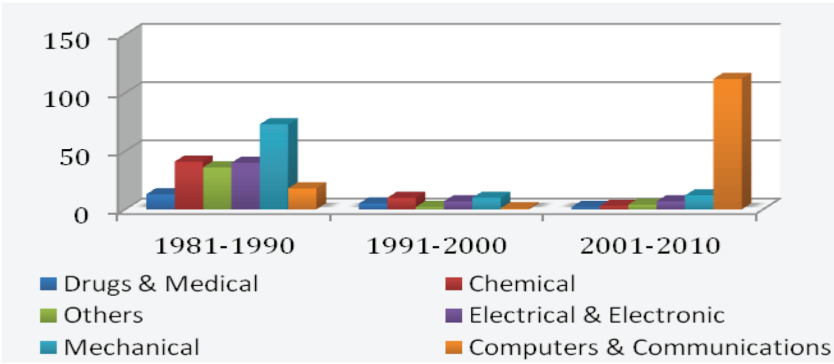
Enterprise surveys suggest that Bulgarian firms are actively upgrading their product lines, but only a minority are innovating or investing in long-term R&D. The 2008 Business Environment Enterprise Survey (BEEPS) shows that almost 55 percent of companies in Bulgaria upgraded an existing product line or service in the last three years and 40 percent introduced a new product. However, only 28 percent of firms invested in R&D during this time. An in-depth analysis of Bulgarian companies suggests that larger companies innovate more, and that innovating firms that also export are much larger than average. The propensity to export is higher for innovative firms with foreign ownership. One in four firms in the exporting-innovating group has significant foreign direct investment (FDI), compared to one in fifteen firms in the non-exporting innovating group.

Expanding demand-side policies to stimulate private innovation is critical given the potential impact on economic growth and employment. BEEPS data indicates that innovative companies in Bulgaria tend to grow faster, whether measured by annual sales or employment. Our analysis shows that annual sales for innovating firms grew 26 percent per year in the pre-crisis period (2005–07), about one and a half times the growth rate for non-innovating firms. The difference is even greater when it comes to employment growth: innovating firms experienced 8 percent annual growth in their number of employees compared to a flat workforce in non-innovating firms. Other recent studies also find that innovative firms create more jobs than their non-innovating counterparts (Dutz et al. 2011).

[1] While the report mainly focuses on frontier (*new-to-the-world*) innovation, Bulgaria as well as all countries stand to gain from catch-up innovation, namely policies to better diffuse existing global knowledge and stimulate firms to absorb and adapt that knowledge (*new-to-the- rm* innovation), including not only product and process innovations, but also organizational (including management upgrading) and marketing innovations.

Encouraging greater international collaboration, in particular partnerships between local researchers and R&D teams working in Multinational Enterprises (MNEs), could boost the supply of new technologies. Bulgaria experienced a big drop in innovations protected by patents since 1990, especially in mature fields connected to traditional industries. But in the last three years the trend has reversed (Figure 1). Most new patents granted to Bulgarians by USPTO are related to high-tech industries, especially computers and communications. This positive performance is driven by collaboration with multinationals from Western Europe, the United States, and Japan. To stimulate technological development, the government could boost international R&D collaboration with MNEs. This will provide an opportunity for Bulgarian researchers and companies to connect with lead inventors and corporate R&D at the world technology frontier.

Figure 1: Patents granted to Bulgarian inventors declined substantially post-1990, but have seen an uptick thanks to innovative activities in the IT sector



Source: Authors' calculations using the NBER patent dataset and USPTO online search patent database.
Note: Only patents with a Bulgarian first-inventor are included.

Strengthening the scientific base is critical to maintaining the flow of new knowledge and skilled R&D personnel. Bulgaria's public research infrastructure is hampered by governance gaps, investment shortfalls, and an exodus of young talent. As a result scientific production is not growing as fast as it could and only a modest share of scientific research has a significant impact. It will need a concerted effort to upgrade the research units and bring talented young people back to work in them. Additionally, the current funding environment does not sufficiently encourage researchers and research organizations to increase the quality and impact of their research.

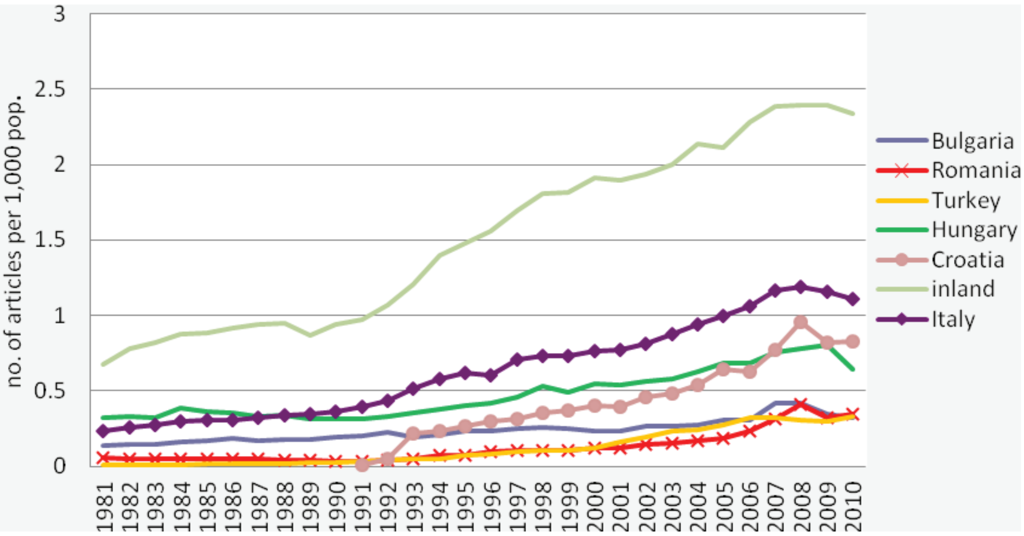
Scientific production would need to grow at a faster rate for Bulgaria to improve its global position. Measured on a per capita basis, Bulgaria's scientific production is on a par with Romania and Turkey but lags behind the OECD and other countries in the region (Figure 2). Between 2001 and 2009, Bulgarians published over 21,000 papers included in bibliometric databases, as compared to 18,685 in 1991–2000 and 14,839 in 1981–1990. This translates into an 8 percent annual increase, similar to Finland (4 percent), Italy (7 percent), Hungary (8 percent) and Poland (5 percent) but below Romania (29 percent), Croatia (18 percent), and Turkey (14 percent). Overall, Bulgaria's contribution to the world pool of publications decreased from 0.19 percent in 1996 to 0.14 in 2008.

The challenge for reinforcing the science base is not just publishing more but making a greater impact with each publication. Only a modest share of scientific research produced in Bulgaria has a significant impact in terms of knowledge creation and diffusion, as proxied by citations.[2]According to

[2] This index does not weight the number of coauthors involved or the composition of the scientific portfolio of countries and differences in terms of citing propensity between fields. The impact of Bulgarian papers on the international scientific community can also be analyzed using the "New Hot Papers" section in ISI Thomson. This list includes all articles worldwide that have received the largest number of citations, based on a certain threshold that is specific to the discipline. This list is very dynamic and changes every quarter. In March 2010, the top-five Bulgarian "Hot Papers" includes papers in the general field of medicine, physics, chemistry, and geosciences. Most "hot papers" are the result of an international effort with many co-authors.

the H-measure[3] for scientific impact, Bulgaria has a score of 97 (this means that Bulgarian researchers published 97 papers with 97 citations or more in 1996–2008), similar to Romania and Croatia, but below Turkey, Hungary, and Poland. Finland scores almost 300 for the H-index while Italy tops the comparators with 432.

Figure 2: More publications are being produced by Bulgaria's researchers, but this has yet to happen at a pace that increases Bulgaria's global position in science



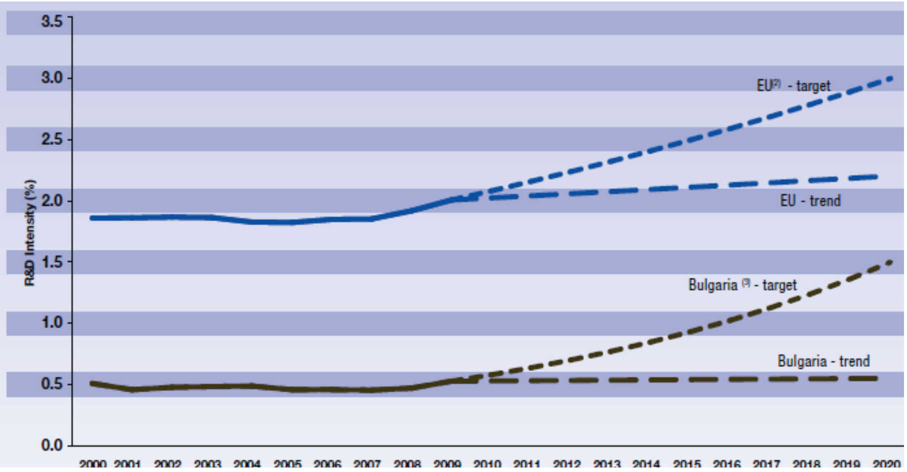
Source: Authors' calculations based on Web of Science, March 2011.

Key Recommendations

To meet the national target of 1.5 percent R&D/GPD by 2020, the Government of Bulgaria would need to greatly increase absorption of EU funds and boost public R&D spending, consistent with the capacity of the State budget. Business-as-usual will not deliver the needed increase in R&D investments. The projections prepared for the *Innovation Union Competitiveness Report 2011* show that R&D intensity would remain flat if the trends observed from 2000 to 2009 continue (Figure 3). The government estimates that meeting this target will require absorption of €539.2 million from the Operational Program "Development of the Competitiveness of the Bulgarian Economy" (OP Competitiveness) 2007–2013 funds. Implementation has improved but would need to be faster still to fully utilize the resources by the end of the programming cycle. Regarding public spending, the NRP states that 0.8 percent of the planned total budgetary expenditures will be allocated to science in 2011, which is equivalent to 0.3 percent of GDP. This would be a considerable increase over previous levels.

[3] It is possible to measure the scientific productivity and impact of a country's publications through the H-index developed by Hirsch (2005). This equals *h* if a country publishes *h* papers each of which has been cited by others at least *h* times in the considered time frame.

Figure 3: Bulgaria's R&D Intensity Projections, 2000–2020



Source: Innovation Union Competitiveness 2011 Report, based on data from the EC's DG Research and Innovation and Eurostat.

Shifting resources from core institutional funding toward competitive funding would raise the efficiency of public expenditures in R&D. The challenge is not just increasing public R&D, but improving the quality of public expenditure. International experience shows that competitive funding is better at promoting excellence in research and increasing collaboration among research institutions as well as with foreign researchers and firms. In the case of scientific research, only a small share (less than 10 percent of total subsidies) has been allocated through the National Science Fund for competitive support to projects. Most state subsidies have been provided to universities and the Bulgarian Academy of Sciences as institutional funding. As more resources become available, increasing this share could provide important incentives for high-quality research.

Improving the articulation of the institutional framework would help Bulgaria to fully exploit the opportunities provided by EU funds. The strategies and legal framework for scientific research have been developed independently of those for innovation, and the financing instruments are designed and administered by different bodies; there are two separate Operational Programs supporting scientific research and innovation in Bulgaria, OP Competitiveness and OP Human Resources. These programs are not effectively coordinated, and they have different implementation authorities and instruments. To maximize the impact of these programs, it would be useful to strengthen the links between support instruments and progressively consolidate the implementing bodies.

The new Scientific Research Strategy is a step in the right direction. The new Scientific Research Strategy identifies the challenges that Bulgaria needs to tackle to strengthen its overall scientific performance as well as the direct contribution of research for innovation and economic growth. International best practice points to the usefulness of setting up a body (for example, in the form of an inter-governmental council) that monitors the execution of the Strategy after it is adopted and invites stakeholders to regular consultations. It is important that the proposed National Innovation Strategy is fully synchronized with the Scientific Research Strategy, which implies a clear sequence of interventions that will be implemented and connections between the support mechanisms.

In addition to improving the overall institutional framework, there is a need to enhance the organization and governance of the public research organizations. In Bulgaria, as in other post-transition countries, the scientific productivity and impact of the public organizations that perform the bulk of the R&D is hampered by outdated institutional and governance models. A recent report (World Bank, 2011) looking into the effectiveness of public R&D institutes (RDIs) concluded that the challenge is to better define the core mission of each RDI (e.g., basic research, education, R&D services, etc.) and depending on this mission, introduce incentive frameworks to systematically improve performance as well as non-budgetary sources of financing. Two options that could help in the medium-term are: introducing a system-wide evaluation of research organizations that can foster internal reforms; providing budgetary resources to researchers and/or research units that make measurable improvements in impact metrics and generate external private funding.

National instruments are the only source of funding early stage R&D, and therefore play a critical role in Bulgaria's innovation system. National instruments, specifically the National Science Fund (NSF) and the National Innovation Fund (NIF), grew substantially after 2005, but they have experienced budget cuts in 2009 and 2010. As a result, the NSF held no new competitive calls in 2010, and since 2008 the NIF has mainly funded pre-existing contracts and tendered no calls for new research proposals. In the short-term, it would be important to: assess the capacity and impact of these national grant schemes and to consider changes in their design based on international best practice; work closely with beneficiaries to sustain the quality of proposals and enlarge the project pipeline. In the medium-term, merging the NSF and NIF into one agency that supports research and innovation projects would be one option to improve coordination and build specialized capacity to design, administer and evaluate innovation support public policies and instruments.

Strengthening implementation capacity and allocating funds to instruments that facilitate absorption could speed up disbursements of EU funds for research and innovation. Speeding up implementation is seen as a priority in order to fully utilize OP Competitiveness resources by the end of the programming cycle. At the ministerial level, the coordination of EU funds has been strengthened through the establishment of a Minister for EU Funds. However, capacity to implement innovation programs remains uneven. In the short-term, it would be useful to: reinforce capacity by hiring experts with the right profile, and develop new IT systems and interactive tools to help potential beneficiaries improve the quality of their project proposals. Another short-term option that seems to receive support, both internally and externally, is to channel OP Competitiveness funds to large projects, like the development of Technology Parks. In the medium-term, creating a dedicated OP for Research and Innovation for the 2014–2020 programming cycle could make the support more strategic and facilitate implementation.

To facilitate the implementation of the NRP and the Scientific Research Strategy there is also a need to develop targeted innovation policies and instruments for priority sectors. An assessment of two of the priority sectors identified by MEET and the Scientific Research Strategy, pharmaceuticals and IT, shows that there are specific obstacles that hinder their development. Targeted policies that support technology absorption and innovation would help these strategic industries achieve their potential.

The pharmaceutical and IT industries are major recipients of FDI, generating skilled jobs and exports, but there is a need to support their further development. Specific obstacles for the development of the pharmaceuticals industry in Bulgaria include: administrative hurdles that delay manufacturing of new generics, informal market competition from countries outside the EU, a lack of homegrown innovation and limited uptake of funding instruments for innovation. The IT industry has experienced robust growth in the last ten years, with significant FDI by global IT companies, but it needs support to become a global center of excellence. Our analysis shows that specific obstacles for future expansion are: shortages of highly-skilled IT labor, the regulatory burden for IT firms, and imbalances in the overall IT infrastructure.

This policy note offers recommendations for accelerating the development of Bulgaria's pharmaceutical and IT industries and increasing the R&D-intensity of these industries. In the short-term, support could be targeted to: training more highly-qualified specialists through a close partnership with lead firms that offer training to higher education institutions and schools; establishing grants to retain young Bulgarian scientists in these priority areas and attract international experts who can revitalize the research agenda and improve the quality of training; and improving the business environment for the pharmaceuticals and IT industries. In the medium-term, it would be critical to: scale-up the NSF and NIF with new funding windows for pharmaceuticals and IT; and continue improving the business environment for the pharmaceuticals and IT industries.

SUMMARY OF KEY POLICY RECOMMENDATIONS

KEY ISSUE	RECOMMENDATIONS	TIMELINE
Bulgaria's export basket has not improved its ranking of quality or sophistication for the past decade	• Refocus the FDI attraction strategy toward investment in export-oriented sectors with higher-value added products and in R&D-intensive industries	Short-term
	• Work with private sector to remove specific investment bottlenecks faced by exporters—especially skills and infrastructure	Medium-term
Few firms in Bulgaria invest in R&D, often because of constraints in access to finance	• Expand demand-side innovation policies, specifically by scaling-up funding in EU and national instruments that co-finance private R&D and technology commercialization	Short-term
Bulgaria's patenting and scientific publication track record does not compare well with EU countries	• Develop instruments to foster international collaboration with other EU scientists and with R&D units of MNEs	Short-term
Bulgaria's R&D spending of 0.49% of GDP is substantially lower than national target of 1.5 percent R&D/GPD by 2020	• Increase absorption of available EU funds and raise public R&D spending	Short-term
	• Shift public R&D spending from core institutional funding toward competitive funding	
	• Increase the volume of matching grants to leverage private R&D investment	
	• Adopt counter-cyclical R&D spending policies and instruments in the medium-term expenditure framework (MTEF)	Medium-term
	• Introduce an R&D Satellite Account for more active monitoring of R&D expenditures	
Funding and support mechanisms for research and innovation are fragmented in different ministries, with little integration between implementing agencies or Operational Programmes	• Develop synchronized strategies on research and innovation up to 2020, including clear mechanisms to monitor the implementation of specific action plans	Short-term
	• Introduce a system-wide evaluation of research organizations, as a way to promote efficiency-enhancing reforms in their organization and governance.	Medium-term
	• Provide additional budgetary resources to research units that make measurable improvements in impact metrics and generate external funding from private sources. • Establish a competitive grant program for high-impact researchers.	

KEY ISSUE	RECOMMENDATIONS	TIMELINE
The main national funding instruments for research and innovation do not operate as efficiently as they could.	• Prepare an evaluation to assess the results achieved by these instruments and to recommend changes in their design based on international best practice.	Short-term
	• Work closely with beneficiaries to sustain the quality of proposals and enlarge the project pipeline.	
	• Consider merging the administration of the NSF and NIF into a single specialized agency that has much better capacity.	Medium-term
EU funding, primarily through the OP Competiveness program, is the main source of financing for innovation in Bulgaria, but absorption has been slow	• Improve administrative capacity and incentive structure for the calls for proposals in OP Competitiveness	Short-term
	• Develop IT systems and support tools for businesses to improve the quality of the project applications for competitive grants	
	• Develop a rating system for consultants that work with beneficiaries of OP Competitiveness to promote improvements in the quality of external support	
	• Channel some of the existing EU funds to larger-scale projects such as technology parks	
	• Improve the EU-funded instruments and schemes for the framework period 2014–2020, for example, by creating a dedicated OP for Research and Innovation	Medium-term
New support policies and instruments are needed to develop the innovative potential of the pharmaceuticals and IT industries	• Train more highly-qualified specialists in these industries through a close partnership with lead firms that offer training in higher education and schools	Short-term
	• Establish grants to retain young Bulgarian scientists and attract international experts in these priority industries	
	• Support the development of R&D centers in partnership with international pharmaceutical and IT companies	
	• Scale-up the NSF and NIF with new funding windows for priority sectors such as pharmaceuticals and IT	Medium-term
	• Improve the business environment for the pharmaceuticals and IT industries.	

GOING FOR SMART GROWTH
Making Research and Innovation Work for Bulgaria

INTRODUCTION

Research and innovation can help Bulgaria to move up the value chain in industries that enjoy a comparative advantage as well as to increase the share of high-tech exports, reinforcing the country's competitiveness. Bulgaria's competitiveness has improved in recent years, but not quickly enough to catch up with EU peers, nor to keep pace with emerging countries in Asia and Latin America. Developing dynamic knowledge-based productive sectors would strengthen competitiveness and facilitate the convergence process to EU income levels. R&D-intensive industries like IT have high capacity and could easily build more links with local research institutions. Scientific research would need to be more closely linked with businesses, by developing R&D commercialization, through active patenting and licensing, entrepreneurial spinoffs and contract research.

Bulgaria's transition was characterized by considerable macroeconomic turbulence and structural transformation, during which export-oriented industries generally declined. In 1990, industry generated 50 percent of GDP and 43 percent of employment; by the time the economic crisis of the late 1990s subsided in 2001, the position of industry had fallen to 18 percent of GDP and 23 percent of employment, where it has remained since.[4] While other countries in Europe and Central Asia (ECA) forged ahead, Bulgaria's exports-to-GDP ratio stagnated, and its high-tech export industries such as computer manufacturing all but disappeared in the face of price and trade liberalization and rapid technological change. This left the export basket exposed to severe price and quality competition from emerging country imports.

The reallocation of productive resources and large FDI inflows generated economic growth but contributed little to upgrading of skills and technological capacities. Low-skilled manufacturing, service, and construction sectors took the lead in generating employment and economic growth, pushed by a surge in financial FDI. This was a common trend in Central and Eastern Europe, but countries like Hungary and Poland simultaneously enjoyed a manufacturing renaissance brought about by the entry of MNEs into industries like car manufacturing. Besides large companies, however, sustained growth also requires the emergence of an entrepreneurial culture and the right career incentives for young people. Start-ups and small-and-medium sized enterprises (SMEs) need to be supported by a favorable business environment.

The burst of growth in 2005–2008 lifted welfare levels, but also widened the salary gap between the private and public sectors, making teaching and research careers less attractive. Private sector salaries increased in absolute and relative terms compared to the EU average, but wages increased less in manufacturing, in-house R&D positions mostly disappeared after privatization, and salaries in public research organizations stagnated in real terms. This has been associated with a fall in total R&D personnel, which now stands at 17,000, as well as steady emigration of talented young people: almost one in ten people born in Bulgaria live in OECD countries.[5] Although this policy note does not directly assess education, the recruitment and retention of the highly trained staff necessary to meet R&D goals is heavily dependent on access to high quality education. The survey of enterprises in Part I finds that innovative companies that export their products hire significantly more employees with university degrees than other groups of companies.

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[4] For details, see National Statistical Institute at http://www.nsi.bg/index_en.htm.

[5] Statistics about scientific personnel are available on the Eurostat website; and migration data is from the OECD International Migration Database. The emigration rate is a high 7–8 percent for people with secondary and tertiary education.

Box 1: Personal Viewpoint–Young Bulgarian Researcher

After finishing my doctorate at a prestigious university abroad, I decided to pursue a career in one of the public research institutes in my home country, Bulgaria. The first two years of my engagement were difficult because the institute's funding was cut and with the low salaries (€200, monthly average), I could barely pay the bills. Our research team won a highly-competitive project funded by the EC's Seventh Framework Programme for Research and Technological Development (FP7) that would enable us to interact with researchers throughout Europe. The implementation of the project required our institute to provide funding in advance, which would be reimbursed later. Because of inadequate funding at our institute and weak planning, we had to cancel the project. As a result, I have decided to quit my job at the institute and seek job opportunities abroad.

Source: Interview by the authors.

There is an urgent need to reverse the erosion of Bulgaria's technological and scientific competences through more strategic support of research and innovation. The evidence presented in this policy note shows that innovative outputs plunged post-1990 followed by a slow recovery. Patenting and publication metrics indicate deterioration in core innovation areas in which Bulgaria excelled before 1990, the exceptions being the pharmaceutical and Information and Communication Technology (ICT) areas. Recently, there have been improvements in these statistics, indicating that basic science and applied innovation capabilities are regaining strength. But private demand for domestic innovations remains very weak; when the demand is there, the companies tend to source their technologies off-the-shelf from reputable international providers. It is important to scale-up the public financing instruments that can help public-sector research to get commercialized, in order to expand the economic impact of science.

Severe cuts to public R&D spending in response to budget consolidation have curtailed support programs for research and innovation. As a result of the economic downturn, public spending on R&D in Bulgaria declined for two consecutive years in 2009 and 2010. Because of these cuts, the National Science Fund (NSF) held no significant competitive calls for proposals in 2010 and the National Innovation Fund (NIF) has held no calls for proposals since 2008. Bulgaria currently has R&D spending of 0.48 percent of GDP vs. 1.85 percent in the EU-27 and 0.7 percent in ECA. Declining public R&D spending, and low private R&D,[6] are major causes of Bulgaria's lackluster track record of publications, patenting, and technology licensing as well as the small share of high-tech exports in the country's export basket.

Higher and more consistent public and private R&D investments could rekindle Bulgaria's innovative potential and thereby strengthen its competitiveness. Some emerging high-tech countries such as Korea have established anti-cyclical R&D spending policies, and Bulgaria could consider introducing such a policy into its expenditure framework. By spending more on innovation when the economy is in a decline, Bulgaria could boost productivity when it is needed most. Data from recent enterprise surveys, presented below, indicates that Bulgaria's enterprises are actively upgrading their product lines, but they are not financing long-term R&D. A predictable funding process would help ensure longer-term investments and could produce significant benefits for the economy and employment. One modeling exercise found that if the R&D spending target of 3 percent of GDP is realized as per the Europe 2020 Strategy, then 5.4 percentage points of GDP (€795 billion) could be generated by 2025, creating 3.7 million jobs (Zagame 2010, p. 7). Different studies show that innovative firms create more jobs than their non-innovating counterparts (Dutz et al. 2011).

Research and innovation are a top policy priority within the EC, creating growing opportunities for external financing, especially through earmarked Structural Funds. The Lisbon Agenda formulated in March 2000, and the Europe 2020 Strategy place innovation at the forefront of economic growth strategies and call for stepping-up R&D investments in a big way. The EU Structural Funds,

[6] Bulgarian firms contribute 34 percent of national R&D compared to 55 percent in the EU.

particularly the Competitiveness and Human Resource Development Programs, can provide funding leverage for Bulgaria's commitment to increase R&D spending and support firm innovation and technology absorption, as well as raise the skills capacity of Bulgarian researchers. Further funding opportunities exist in the EU, but as they are allocated competitively, it is imperative to raise the quality and quantity of domestic proposals and to put in place the necessary co-financing from national sources.

However, funding increases on its own will not have the desired impact without upgrading relevant institutions, policies and legislation. Bulgaria's institutional and legal framework for innovation needs to be adjusted to the new EU policy environment and the realities of the post-crisis economy. The National Reform Program 2011–2015 embraces the Europe 2020 Strategy and translates it into more concrete national targets. This shows that there is government-wide recognition about the need to advance this policy agenda. In parallel, the Ministry of Education, Youth and Science has prepared a National Scientific R&D 2020 Strategy, which lays the groundwork for institutional strengthening and inter-ministerial coordination. The Ministry of Economy, Energy and Tourism is drafting a National Innovation Law and is planning to redirect remaining EU funds toward building technology parks in priority industries. These are welcome developments, but more will be needed to enhance the implementation results of public support programs. Past evaluations underline the need to tackle weaknesses in Science, Technology, and Innovation (STI) policy that led to the creation of overlapping programs with limited coherence and poor rationalization of resources.

The public research infrastructure needs to be revamped, as it is hampered by governance gaps, investment shortfalls, and an exodus of young talent. The traditionally strong ties during socialist times between industry, R&D institutes, and the Bulgarian Academy of Sciences had their roots in capital-intensive industries that relied on strong engineering and scientific know-how for their competitiveness. These industries lost their markets in the Eastern bloc in the transition period, their sales and R&D dropped abruptly, and the connections with research institutes and universities were cut off. Two decades later, responding to this structural shift is still a challenge. It will need a concerted effort to reorganize public research institutes accompanied by injections of public funds to renovate research labs and bring talented young people back to work in them.

International experience shows that public action is a necessary condition for innovation initiatives to succeed, but not a sufficient one, so making enterprises an active partner is critical. The most innovative countries such as Germany, Finland, and Sweden have the highest share of private R&D spending, with about 65 percent of total R&D funded by the private sector. At 30:70, the ratio of private to public R&D in Bulgaria is unfavorable compared to these countries. The Government of Bulgaria has publicly recognized the importance of the private sector in boosting scientific and innovation performance and meeting national R&D targets, but the instruments that have been tried and tested so far have not achieved a transformational change. This suggests that a serious evaluation is needed to identify what has worked and what has not. Based on this, matching grants and other support mechanisms in Bulgaria would need to be redesigned and scaled-up.

This policy note provides a detailed assessment of Bulgaria's innovative capacity and offers policy recommendations to increase the impact of science and innovation. This note is one of the central outputs of a programmatic analytical and advisory activity coordinated by the Ministry of Education, Youth, and Science (MEYS) and the Ministry of Economy, Energy and Tourism (MEET). The policy note draws on the findings of an analysis of Bulgaria's innovative capacity and technical notes commissioned from the ARC Fund,7 as well as written reports prepared for the government during the course of this activity. The recommendations have been greatly enriched by policy discussions with the MEYS and the MEET, as well as consultations with universities, research institutes and the business community.

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[7] ARC Fund (2010) Technical note 1: Innovation policy & public spending; Technical note 2: Capacity to absorb EU funds; Technical note 3: Review of national innovation instruments; Technical note 4: Framework to assess BAS restructuring.

Part I of the policy note provides an assessment of Bulgaria's innovation capacity in the public and private spheres. Specifically, the note examines: (i) recent trends in Bulgaria's export performance, benchmarking Bulgaria relative to comparator countries; (ii) the characteristics of innovation activities in Bulgaria's private sector, as seen by enterprise surveys; (iii) developments in technological invention and scientific production, by analyzing the statistics about patents granted in the US Patent and Trademark Office (USPTO) and the European Patent Office (EPO) as well as data on scientific publications.[8]

Part II provides recommendations that could facilitate the implementation of the NRP and the Scientific Research Strategy, including sectoral analysis to guide innovation policy in priority industries. The recommendations are divided into the following areas: (i) attaining the 1.5 percent R&D/GPD target under the Europe 2020 Strategy; (ii) strengthening the institutional and policy framework for research and innovation; (iii) achieving better results from national funding instruments—the National Innovation Fund and the National Science Fund; (iv) increasing absorption of EU funds targeting innovation; (v) developing targeted innovation policies and instruments for priority sectors.

[8] While the report mainly focuses on frontier (*new-to-the-world*) innovation, Bulgaria as well as all countries stand to gain from catch-up innovation, namely policies to better diffuse existing global knowledge and stimulate firms to absorb and adapt that knowledge (*new-to-the- rm* innovation), including not only product and process innovations, but also organizational (including management upgrading) and marketing innovations.

PART I. ASSESSMENT OF BULGARIA'S INNOVATIVE CAPACITY

Bulgaria's competitiveness has improved, but not strongly enough to catch-up with EU peers nor quickly enough to keep pace with emerging countries. In the Global Competitiveness Report 2011–2012, Bulgaria's level of competitiveness is ranked 74th out of 142 countries compared to position 72nd (out of 125 countries) five years earlier. Of all the dimensions measured in this Report, innovation has the bottom score. The Doing Business Report 2012 ranks Bulgaria higher, placing it 59th out of 183 economies in terms of the quality of its business environment. The Innovation Union Scoreboard 2010 and the WEF Lisbon Review 2010 placed Bulgaria last among EU countries (Table 2).[9] While none of these indices is perfect, each provides a useful competitiveness metric.

Table 2: Bulgaria's standing in international rankings of competitiveness

	Global Competitiveness Report 2011-2012	Doing Business 2012	Innovation Union Scoreboard 2010	WEF Lisbon Review 2010
Finland	4	11	4	2
Italy	43	87	19	25
Hungary	48	51	24	21
Turkey	59	71	33	n/a
Romania	77	72	28	26
Bulgaria	**74 (out of 142)**	**59 (out of 183)**	**32 (out of 34)**	**27 (out of 27)**
Croatia	76	80	25	n/a

To advance Bulgaria's competitiveness position, and move up in the global and European rankings, there is a need for new strategies that can make innovation a driver of exports, job creation and growth. As demonstrated in the NRP 2011–2015, there is a consensus in Bulgaria that "business as usual" is unlikely to generate sufficient growth to dent unemployment and attain income convergence with the EU: a proactive and more strategic approach is needed. Reforms to further improve the business environment should be coupled with measures to stimulate adoption of new foreign technologies and development of in-house R&D capabilities, building on the existing scientific and technological strengths of the economy.

I.A. Sophistication and technological intensity of Bulgaria's exports

Bulgaria's export basket has not improved its ranking of quality or sophistication for the past decade. Future growth in the economy and employment will depend on harnessing innovation to create higher value-added exports.

Short-term action:

- Refocus the FDI attraction strategy toward investment in export-oriented sectors with higher-value added products and in R&D-intensive industries

Medium-term action:

- Work with private sector to remove specific investment bottlenecks faced by exporters—especially skills and infrastructure

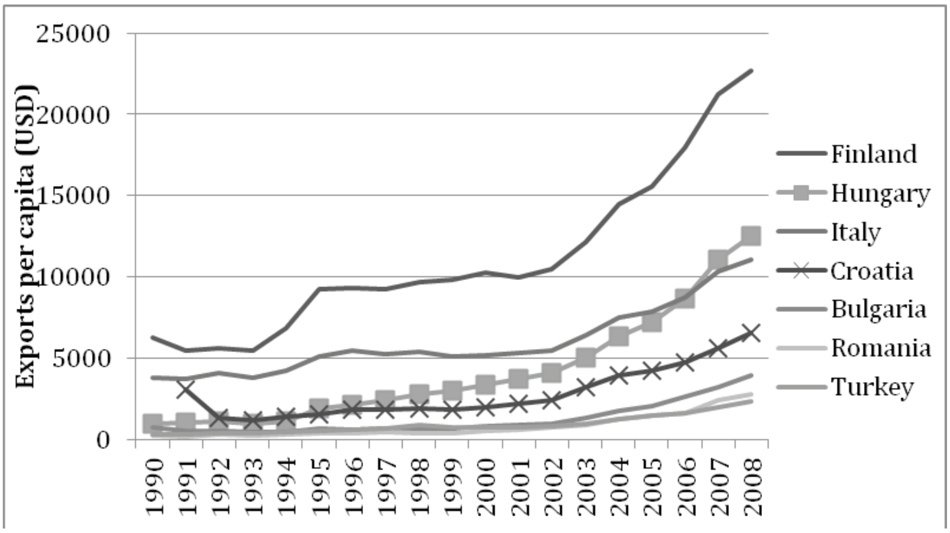
Policymakers in Bulgaria agree that exports need to play a more central role in the country's growth to strengthen the recovery and avoid future boom-bust cycles. In a context of fiscal adjustment and weak domestic demand as households and firms deleverage, exports present an opportunity for sustained growth. The experience of Germany and many emerging countries in Asia

[9] For further information, see the Global Competitiveness Report 2011–2012, Doing Business 2012, Innovation Union Scoreboard 2010, The Lisbon Review 2010

shows that when growth is anchored on exports, it is possible for the economy to have a faster V-shaped recovery after a downturn and increase potential output growth.

Throughout the last decade, Bulgaria's exports increased in absolute and in per capita terms, but this growth lags behind regional comparators and there is a persistent trade deficit. Exports have increased significantly in the last decade. By 2008 they were an important component of the Bulgarian economy representing nearly 60 percent of its GDP (Figure 4). However, this performance has to be seen in a comparative basis: past export growth situates Bulgaria in the middle of the transition countries, but lagging behind regional export champions like Hungary, despite starting from similar export levels in the early 1990s. In 2008, Bulgaria had US$3,958 exports per capita, higher than Romania (US$2,781) and Turkey (US$2,378), but below Croatia (US$6,553), Hungary (US$12,549), Italy (US$11,100) or Finland (US$22,664). A bleak indicator from the point of view of competitiveness is that the country's trade balance remains negative and is negative for most of its top-ten export products.

Figure 4: Bulgaria's exports per capita in a regional context: 1990–2008



Source: World Development Indicators (2009).
Note: Total Exports in current US$ divided by population.

To intensify its export growth, Bulgarian firms are starting to diversify their markets and are targeting high-growth regions. Bulgarian exports are aimed at the EU market (Greece, Germany, Italy, and Romania), neighboring countries (Turkey and Serbia), and large countries—Russia, USA, China, Saudi Arabia, India, and Pakistan (Table 3: Main Export Destinations for Bulgaria (2008)3). Export growth to key EU markets, particularly Greece and Romania, will be held back while these countries recover from financial and fiscal crises. Consequently, the market openings will be in regions experiencing robust domestic demand—Russia and former CIS, Turkey, and Persian Gulf countries.

As a way to support this effort, the Government of Bulgaria has taken active steps to establish closer partnerships with emerging economies and improve trade-enabling transport corridors. The Bulgarian Prime Minister met the Chinese Prime Minister in 2010 to discuss how Chinese investors could participate in Bulgaria's infrastructure sector including harbors, airports, and railways, as well as in IT, industrial parks, locomotive and car manufacturing. Bulgaria is also disbursing EU and national funds to remove trade bottlenecks related to transport infrastructure, customs, and logistics. These investments will be critical for Bulgaria's geographical diversification. Currently, Bulgaria ranks 63 out of 155 countries in the WB Logistics Performance Index, on par with the ECA region, but below regional export leaders such as the Czech Republic (ranked 26) and Turkey (ranked 39).

Table 3: Main Export Destinations for Bulgaria (2008)

Partner	Trade Indicators				
	Exports USD mil.	Trade balance USD mil.	Share in Bulgaria's exports	Growth 2004–08	Growth partner's imports 2004–08
Greece	2,230	272	9.90%	23%	15%
Germany	2,045	-2,361	9.10%	21%	14%
Turkey	1,979	-80	8.80%	21%	20%
Italy	1,887	-1,058	8.40%	11%	12%
Romania	1,631	-448	7.30%	43%	27%
World	22,478	-11,295	100.00%	23%	15%

Source: Authors' calculations, based on UN COMTRADE, 2010.

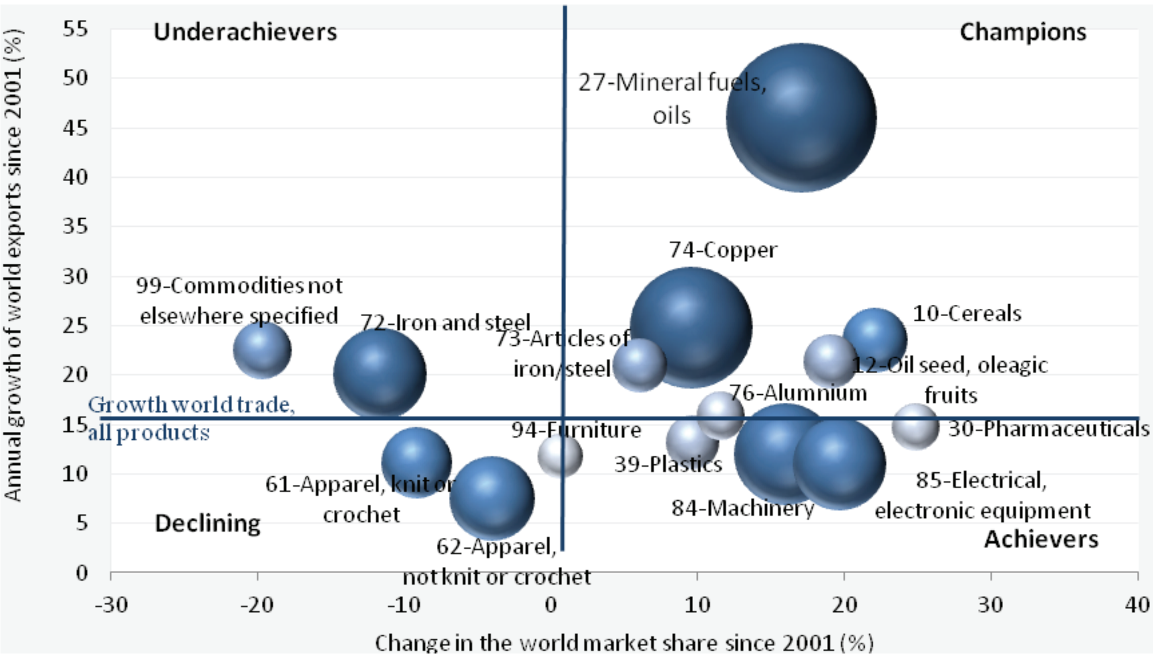
But if past trends persist, Bulgaria's export basket will continue to be dominated by traditional exports. Figure 5 reviews the recent performance of Bulgaria's 15 leading export product groups (at the 2-digit level) by comparing the national change in world market share to the growth of international demand for goods.10 The two blue lines (change in the world market share=0, and annual growth of all exports=18 percent between 2001 and 2008) divide the chart into four quadrants that characterize the evolution of Bulgarian exports.[11]

- The upper-right quadrant (***Champions***) includes products that enjoy both fast growth worldwide and good performance by Bulgaria; among them, we find mineral fuels and oils, copper, cereals, and agricultural by-products as well as articles from iron and steel.
- Products in the upper-left quadrant (***Underachievers)*** are those in which there has been a high demand worldwide, but Bulgaria underperforms the rest of the world, in that it is steadily losing market share; the iron and steel industry stands out.
- Products with dim perspectives for future exports include garments and furniture, which occupy the lower-left quadrant (***Declining***). These products are facing fierce competition from countries like China and India, and increases in labor costs that reduce their international competitiveness.
- Finally, products in the lower-right quadrant (***Achievers)*** are gaining world market share but have yet to see stellar export growth. Several industries with higher technological content, which have a good chance of becoming champions of Bulgarian exports, are in this group: pharmaceuticals, machinery, electrical equipment, and chemical intermediate products (aluminum, plastics).

[10] For concrete policy applications, this analysis can be refined to the product level (4-digit or more).

[11] The reasoning behind this model is similar to the portfolio models used in marketing, such as the Boston Consulting Group matrix.

Figure 5: Dynamic exports profile of Bulgaria, 2001–2008



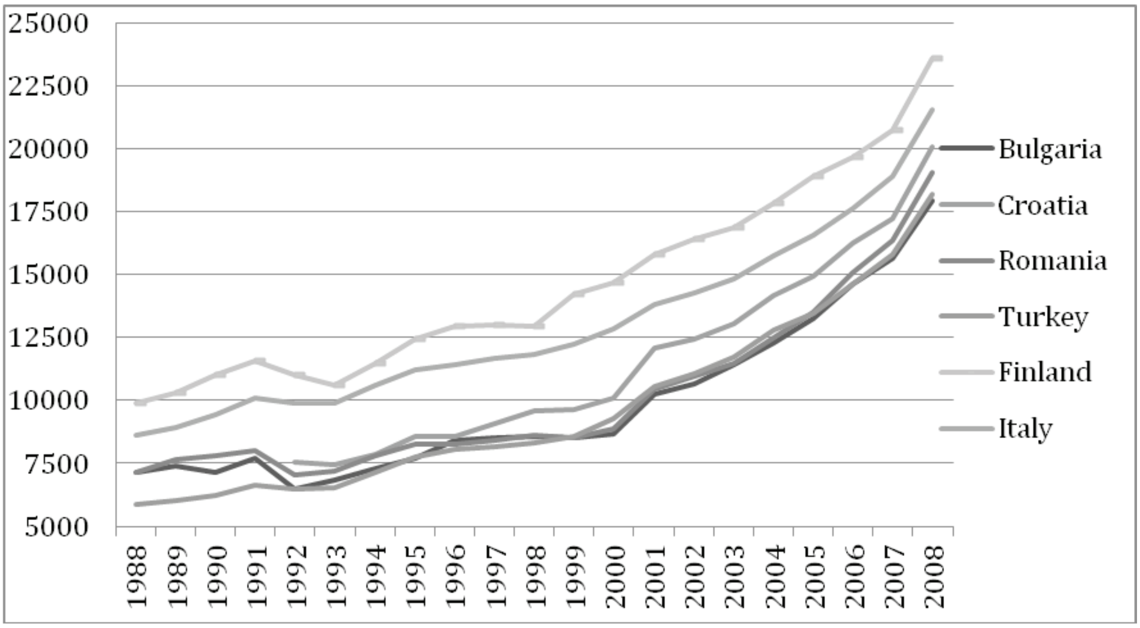
Source: Authors' calculations, based on UN COMTRADE, 2010.
Note: The area of the circles corresponds to the export size in $US mln.; the top 15 exports are represented.

In the medium to long term, diversification into higher value-added goods and services and R&D-intensive industries will be an indispensible ingredient to sustain exports. So far Bulgaria's robust export growth was built on the back of foreign investments that increased capacity and efficiency in traditional manufacturing industries, at a time when commodity prices increased. This translated into double-digit growth of exports of petroleum products, metals (copper, iron, zinc), cables and iron products, chemicals, cereals, apparel, and refrigerators, among others. These commodities are typical of the structure of Bulgarian exports, which are heavily oriented toward traditional and mature industries that take advantage of low labor and energy costs. However, in order to sustain export growth, more focus needs to be placed on manufacturing higher value-added goods and providing services that will generate more revenue for the local economy, and high-tech industries that are R&D-intensive.

Bulgaria faces a challenge to increase the sophistication of its export basket, as measured by established methodologies. To assess the competitiveness of Bulgarian exports, indicators of the quality and sophistication of a country's export basket were calculated for Bulgaria and comparator countries—see Box A. 1 in Annex 1 for details. The indicators for *unit value distance*—reflecting room for improvement in quality and price of exports—show that Bulgaria's export basket has made virtually no progress between 1990 and 2008. Bulgaria's rankings (71th in 1990; 86th in 2000; 67th in 2008) have not improved much; significant progress was made by Hungary, and Turkey, while Italy and Croatia have lost some edge. Bulgaria has an average position in terms of the level of sophistication of its exports as measured by the EXPY indicator, with moderate improvements over time that are in line with Turkey, Romania, and Serbia, but below Central European nations and global top exporters (Figure 6).[12]

[12] This ranking according to sophistication levels is consistent with the OECD classification of sectors into low and high technology, with a few exceptions. Apparel and furniture are two examples of relatively low-tech products that still are produced intensively by firms in developed nations, driven by strong specialization and consumer preferences that give rise to market niches, and therefore these products get higher PRODY measures. A weakness of the sophistication indicator is that it is sensitive to the prices of commodities. Specifically, the recent demand for oil and other natural resources, which led to a spike in their prices, caused an increase in their measure of "sophistication."

Figure 6: Evolution of Export Sophistication (EXPY): Bulgaria and Selected Comparators (1988–2008)



Source: Authors' calculations, based on UN COMTRADE.

The low sophistication of the export basket is linked to the low share of high-technology exports. At 3 percent, the share of high-technology goods is substantially below the EU-27 average (16 percent) and in the lower tier compared to the rest of Eastern Europe (Czech Republic-13 percent; Hungary-20 percent; Croatia-7 percent; Romania-4 percent; Poland- 3 percent). In fact, among the top-ten exports (at 2-digit level classification) only electrical equipment and boilers and machinery have a high-tech component.[13] More sophisticated manufactured goods are represented in the second tier of exported products (ranked 10-20): this includes glassware, optical apparatus, pharmaceuticals, chemicals, and plastics.

To reverse this trend, the government and industry would need to work together to promote more investment and R&D in medium- and high-tech product niches. Economic studies suggest that industrial diversification precedes export diversification (Cadot et al. 2007) because diversified economies are better equipped to take advantage of the export opportunities in the global market. The experience of export champions such as Korea and Malaysia suggests that diversification and exporting opportunities were advanced through technology absorption and innovation, but that this process was neither automatic nor without cost. Government intervention to bring in foreign expertise through FDI and address market failures that depress private innovation played a catalytic role.

In addition to horizontal measures[14] to attract export-oriented FDI, the government could introduce more impactful innovation policies and instruments targeting high-potential sectors. Attracting export-oriented FDI—and ideally FDI that is R&D-intensive, can support Bulgaria's efforts to reach Europe 2020 and NRP targets and would be a good avenue to increase the share of medium- and high-tech exports (see Box 2 for details). But in addition to offering horizontal measures such as tax incentives, there is a need to remove specific bottlenecks faced by high-potential industries—including skills and infrastructure. A sectoral approach, which sets out a clear innovation policy in each industry, including reforms and public investments to resolve bottlenecks, could anchor the

[13] Aerospace, computers, office machinery, electronics, instruments, pharmaceuticals, electrical machinery and armament are considered high-technology manufacturing industries by Eurostat and OECD; for details about this classification, see http://www.oecd.org/dataoecd/43/41/48350231.pdf.

[14] Horizontal measures benefit all investors in a non-selective way, in contrast to sector-specific measures.

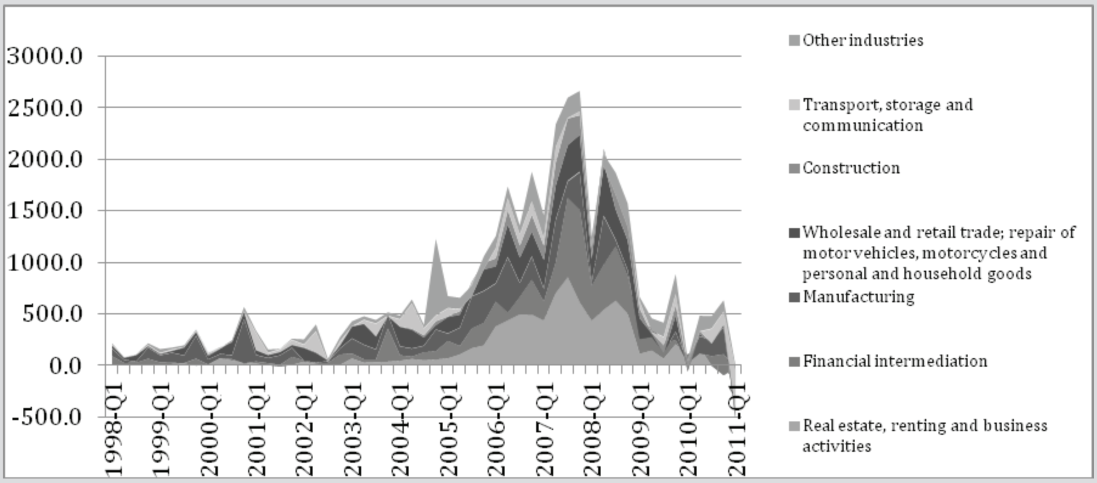
medium-to-long term expectations of domestic and foreign investors, tipping the balance in favor of Bulgaria as a destination for R&D-intensive FDI. Part II of the policy note provides recommendations for sectoral innovation policy in two export-oriented industries, pharmaceuticals and IT.

Box 2: Technology Absorption Through FDI in Bulgaria

FDI can be an important channel for technology absorption and modernization of local technologies. Foreign companies bring new knowledge and technology upgrades, replace obsolete equipment, and often change the management structure. Multiple economic studies have found that fully or partially owned foreign subsidiaries are on average more productive than local counterparts. They also point to positive spillovers from the entry by foreign owned subsidiaries, as local companies can connect to global supply chains, creating a channel for knowledge transfers (Goldberg et al, 2008).

Bulgaria was able to create a competitive investment climate, which attracted an impressive volume of FDI in 2003-2008, but only a small share was in export-oriented industries. In the boom period, Bulgaria, like other ECA countries, benefited from large inflows of FDI. The inflows have returned to more normal levels: from a peak of 30 percent of GDP in 2008, FDI inflows reverted to 4 percent of GDP in 2010.* Bulgaria benefits from its location in Europe, low corporate taxes, a stable political situation, investment grade rating (BBB), strong technical and engineering education and low wages in EU terms. But the bulk of FDI went to financial institutions and to construction and real estate projects. One example of a successful FDI project in high value-added industries is Johnson Controls, which entered the Bulgarian market in 2001. The company currently employs about 500 people in project support, hardware design and software solutions to global automotive producers.

Quarterly FDI inflows to Bulgaria, by industry (EUR mln.)



Source: Bulgarian National Bank.

The government has emphasized the importance of increasing FDI in priority sectors for successful economic development. The "Vision 2020" Strategy identifies the key industries and industry clusters for targeted FDI for which Bulgaria has a comparative advantage, which include agri-food, healthcare, transport & logistics, transport equipment and machine building, IT and outsourcing, chemical, electronics and electrical—this assessment is consistent with the analysis of exports presented above. It estimates that investments in these sectors could contribute up to 33 percent to Bulgaria's output in 2020. To get there, the Strategy calls for the creation of incentives for investors, such as subsidies and support for training of employees and improvement of skills.

** For further information about the reasons behind the FDI boom and why this led to macroeconomic imbalances that are now unwinding, see the IMF Article IV Consultation for 2008 and 2010, as well as the IMF Selected Issues papers.*

I.B. Bulgaria's private innovation—insights from enterprise surveys

Bulgarian firms that innovate grow one and a half times faster than non-innovating firms and create more jobs. But one in five firms report that they don't have access to the external finance they need to make long-term R&D investments.

Short-term action:

- Expand demand-side innovation policies, specifically by scaling-up funding in EU and national instruments that co-finance private R&D and technology commercialization.

Private R&D and the overall innovative capacity of enterprises are among the most vital components of a nation's innovation system. According to a review of the economic literature by the US Congressional Budget Office, the contribution of R&D to productivity growth is in the order of 0.20–0.30 based on micro-econometric methods and 0.1 based on studies that use country-level data (CBO 2005). The report underlines the value of private R&D investments for growth. This is because in addition to privately appropriated benefits, R&D investments by one firm can help *other* firms in the industry to increase their productivity due to knowledge spillovers, and there are many types of cross-border spillovers. But for spillovers to materialize, the recipient firms need to have a minimal innovative capacity—e.g., qualified staff and laboratories—so they can absorb and apply this knowledge.

Data from recent enterprise surveys indicates that Bulgaria's enterprises are actively upgrading their product lines, but they are not financing long-term R&D. According to the most recent BEEPS,[15] almost 55 percent of companies upgraded an existing product line or service in the last three years and 40 percent introduced a new product. The rate of product upgrading compares favorably with other EU countries. However, the survey also shows that a minority of firms invest in R&D. This is consistent with the low level of private R&D for the country as a whole (0.15 percent of GDP). The implication is that process-focused innovation and specialized upgrading of traditional product lines is perceived to have a higher short-run payoff than diversification of the company's products. This can explain why export growth continues to be concentrated in traditional low-tech products.

A core of Bulgarian companies has superior innovative capacity, simultaneously carrying out multiple technology-related activities. More than 40 percent of companies in Bulgaria undertake two or more types of technology upgrading and innovation. This trend is consistent over time: companies that upgrade existing products or services are also more likely to introduce new ones.

Table 4: Comparison of selected economies on the intensity of private innovation

Country	Introduced new product or service	Upgraded an existing product line or service	Conduct R&D	Number of companies
Bulgaria	40%	55%	28%	283
Croatia	61%	72%	49%	157
Hungary	38%	71%	11%	290
Romania	43%	48%	19%	523
Turkey	44%	57%	23%	1126

Source: BEEPS, 2008.

[15] The results are based on the data collected by the *Business Environment Enterprise Survey (BEEPS)*, conducted in the fourth quarter of 2008 in all ECA countries by the World Bank and EBRD. The survey covers companies operating in various manufacturing and services sectors. Where possible we compare our results with the results of the Community Innovation Survey conducted by Eurostat in 2004-2006. To give a sense of the dynamics of private innovation in recent years, we compare our findings with the results of the Enterprise surveys conducted in 2002 and 2005. The three main indicators of technology upgrading and innovation obtained by the BEEPS come from asking the managers of Bulgarian firms whether their establishment: introduced any new products or services in the last three years; upgraded an existing product line or service in the last three years; spent a positive amount on R&D activities, either in-house or in cooperation with other companies in the most recent fiscal year.

The key result from our analysis is that innovative firms in Bulgaria have much stronger sales and employment dynamics than other firms, which underscores their potential for propelling economic growth and job creation. To deepen our understanding of the characteristics of innovative companies, we split the 2008 BEEPS sample into innovative and non-innovative groups, depending on whether or not they introduced a new product in the last three years, and further subdivided the group of innovative companies into those that export and those that do not (see Table 5). Even for a small sample of 286 companies, this breakdown points to statistically significant differences between groups.[16] In particular, innovating firms in the BEEPS sample grew much faster, whether measured by annual sales or employment. Annual sales for innovating firms grew 26 percent annually in the pre-crisis period 2005–07, about one and a half times the growth rate of non-innovating firms. The difference is even greater for employment growth: innovating firms experienced 8 percent annual growth in the number of employees compared to a flat workforce in non-innovating firms.

An analysis of rates of innovation and exporting of Bulgarian companies highlights the importance of firm size, location, and FDI:[17]

- **Firms in the innovating group are larger than average, and the innovating firms that export are even larger.** The correlation between rates of innovation and the size of the company is even stronger when comparing the exporting innovative companies to those that do not export. On average, companies in the exporting innovative group have double the number of employees, and include many more large firms with 250+ employees.
- **More firms in the innovating group are located close to Sofia—and this concentration is even stronger for innovating firms that export.** Innovating firms are much more likely than non-innovating firms to be located in Sofia—the economic center of the country—where FDI inflows and public R&D capacity are concentrated. 67 percent of exporting innovative companies is located in Sofia, whereas non-exporting innovative companies are more widely dispersed.
- **The propensity to export is higher for innovative firms with foreign ownership.** One in four firms in the exporting innovative group has significant FDI, compared to one in fifteen firms in the non-exporting innovative group. This suggests that there is a core of innovative MNEs in Bulgaria that are export-oriented.
- **The amount of time a firm has been established does not appear to be a significant factor, with an average of about 12–13 years.** This suggests that innovation and exporting are not associated specifically with either younger entrepreneurial companies or older incumbents. The fact that only a handful of start-up companies are represented in the innovative group simply reflects the low number of start-ups in the BEEPS sample.

In combination, these results reflect the positive feedbacks that can exist between innovation, sales growth, job creation, and export potential. The foregoing results are consistent with a "Schumpeterian"[18] perspective of industrial growth and innovation, whereby large firms that are internationally connected via FDI deploy resources to increase their innovative capacity, leading to a technological comparative advantage that opens up export opportunities. Additionally, it suggests that exports are a channel through which firms in open economies acquire foreign knowledge about technologies and products.

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[16] All the main results from the statistical analysis were confirmed using econometrics. These results are presented in Annex 2. The econometric analysis adapts the model set out in Goldberg et al (2008).

[17] These findings are broadly in line with the Community Innovation Survey (CIS). The CIS 2006 revealed a strong correlation between company size and innovation intensity. It also indicates that about one quarter of innovating companies operate predominantly in the Bulgarian market, and only slightly more than 10 percent export their production to other countries. The sectors with the largest share of innovative companies include the IT industry and financial intermediation, which are not covered in the BEEPS. The percentage of innovative enterprises in the CIS is lower than in BEEPS. This could be because of sample differences or because the Community Innovation Survey was conducted in 2006, whereas the BEEPS gathered the data in 2008, at the peak of the business cycle.

[18] In *Capitalism, Socialism and Democracy*, the Austrian economist Joseph Schumpeter discussed the role that large firms can play in generating innovations on account of their profitability and privileged access to finance.

Table 5: Characteristics of each group of enterprises

	Non-innovating firms	Innovating firms	Non-exporting innovating firms	Exporting innovating firms
Average annual sales growth rate over 2005–07	16.4%	25.8%	27.8%	20%
Average growth rate of employees over 2005–07	0.25%	8.1%	8.7%	6.1%
Average age of companies in years	12.7	12.7	12.8	12.5
Share of new companies (less than 4 years old)	5.2%	2.4%	2.9%	0.8%
Average number of employees	25	35	28	61
Share of SMEs (up to 250 employees)	94%	93%	96%	83%
Percent of companies located in Sofia	11.2%	44.4%	37.5%	67%
Percent of companies with at least 25% foreign ownership	8.2%	11.8%	6.8%	27.6%
Number of companies:	165	121	91	30

Source: Authors' calculations, based on BEEPS 2008 data.
Note: Shaded cells show statistically significant differences, dark grey at 1% level, grey at 5% level, light grey at 10% of significance.

Understanding which firms are innovating is critical for policy design, in particular for selecting the appropriate support instruments. Different factors shape the private decisions to innovate. Economic studies point to the importance of: (i) internal drivers such as previous R&D history, the rate of technological adoption, and the quality of the workforce and management; and (ii) external, demand-side drivers such as the intensity of domestic and foreign competition and the sophistication of consumers, in addition to environmental constraints such as access to finance, the business environment, the underlying innovation infrastructure, and government policies. Our analysis helps to disentangle these factors.

Innovating firms in Bulgaria tend to have more advanced capabilities, including experience with R&D projects, adopting ICT and standards, and hiring skilled personnel. As shown in Table 6, all the variables we used as a proxy of a firm's internal capabilities differ significantly depending on whether companies innovate and export:

- **Experience with R&D projects is a distinctive characteristic of Bulgarian innovative companies.** This underscores the importance of government incentives for in-house R&D, and of mainstreaming R&D investment into companies' growth strategies. Companies cannot rely only on learning-by-doing; long-established firms will exhaust the productivity gains that come from experience in production and need to actively search for new sources of competitive advantage. R&D can accelerate this search process.

- **Innovating firms tend to be early adopters of Information and Communication Technologies (ICT).** Over 60 percent of innovating firms have invested in a corporate website and almost 100 percent of export-oriented innovating firms have set up websites to market their products and services.

- **Internationally-recognized quality certification is highly correlated with innovation.** This is particularly true for export-oriented innovators, reflecting the importance of international certifications such as ISO as a way to achieve—and to signal—high production standards and quality and gain access to global value chains.

- **Exporting innovators hire significantly more employees with university degrees than other groups of companies.** This is consistent with the view that Bulgarian exporters can attract workers with better qualifications through higher salaries, and this sustains higher labor productivity.
- **Innovative companies face sharper skills shortages.** Managers' perceptions about the adequacy of workforce education suggest that skills are a binding constraint for one in three innovating firms.

Table 6: Developing advanced internal capabilities is a common characteristic of innovative companies, especially those that are export-oriented

	Non-innovating firms	Innovating firms	Non-exporting innovating companies	Exporting innovating companies
Percent of companies that conducted R&D	8.9%	56.1%	59%	45%
Percent of companies that have a website	41.8%	58%	47.5%	92.2%
Percent of companies with internationally-recognized quality certification	16.5%	31.7%	19.4%	72%
Average percent of employees with university degree	22.3%	28.5%	24.6%	42.5%
Inadequately educated workforce is an obstacle to current operations (percentage of firms)	15.1%	31.1%	33.2%	23.9%

Source: Authors' calculations, based on BEEPS 2008 data.
Note: Shaded cells show statistically significant differences, dark grey at 1% level, grey at 5% level, light grey at 10% of significance.

In addition, firms that innovate tend to face competitive pressures. Our analysis underlines the importance of competitive pressures as a determinant of innovation (see Table 7). In Bulgaria, managers in all types of companies identify domestic competition as an important factor that affects the firms' decision to develop new products, services, and markets. Foreign competition affects a smaller share of firms, but is a significant factor for innovating companies and especially those that are export-oriented. Other studies have found that countries with competition-friendly business environments (including access to credit) have more young firms that are able to innovate (Dutz et al. 2011).

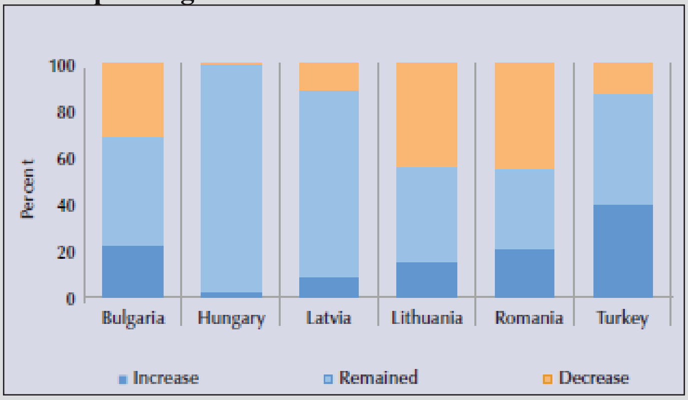
Access to finance is a binding constraint to innovation for many Bulgarian firms. About one in five companies surveyed in BEEPS face external financing constraints. The CIS also found that factors related to finance can be major obstacles for innovation.[19] During the recent economic crisis, it became more difficult for enterprises to secure bank loans to match public funding. The combination of financial constraints and falling demand led many Bulgarian companies to cut their R&D spending (See, Box 3).

[19] The CIS asked companies to classify the factors that hamper enterprise innovation activities by degree of their importance. The main obstacles to the enterprise operations reported by the CIS in Bulgaria are the high cost of innovations (4.8% of firms), the lack of funds within the enterprise (4%), the lack of sources outside of the company (3.1%), market power of the established companies (2.4%) and lack of qualified workforce (2.2%).

Box 3: R&D Decisions During the Crisis: Firm-Level Evidence for Selected Economies

It is widely believed that R&D spending is pro-cyclical because it is mainly financed from cash flow, which contracts in recessions, and because firms face difficulties tapping into external funding sources to support their investments in general and their R&D spending in particular. A recent study conducted by the World Bank showed that R&D spending declined in some countries of the ECA region in 2009, confirming the pro-cyclical bias of R&D. However, the same data revealed that firms in Turkey and Hungary increased their R&D efforts during the recent economic slowdown, which could suggest that firms in these countries are maintaining an anti-cyclical R&D path to ramp up productivity growth and get a comparative advantage.

R&D Spending in 2009



Further analysis of correlations between R&D decisions and pre-crisis firm characteristics shows that export-oriented firms and firms with quality certification were more likely to increase their R&D efforts in 2009. The results also indicated that large firms were more inclined to reduce R&D efforts during the crisis when compared to small firms. Finally, firms that had access to credit before the crisis were more likely to reduce their R&D efforts during the economic downturn.

Source: Correa and Iootty 2011.

Only a small fraction of Bulgarian firms have received a grant from the State or the EU, which suggests available incentives are not extensive enough to mitigate the financing constraints. Less than one in twenty companies in the BEEPS has been awarded a grant. The fact that the share is approximately the same for innovating and non-innovating companies suggests that the support schemes available are not having a large impact on innovation. To increase the impact, it is necessary to expand demand-side innovation policies through matching grants and venture capital (VC) funds, to co-finance private R&D and technology commercialization, and to promote entrepreneurial innovation and the adoption of international quality certification and ICT. This is discussed in more detail in Part II.

Box 4: Personal Viewpoint–A Bulgarian Entrepreneur

As a former scientist with two decades of experience, I decided to set up a business in Bulgaria. My business has potential to grow because the company is selling an innovative product, patented by the Bulgarian Patent Office. My staff and I became very optimistic when we heard about the launching of a program by the MEET to support the development of new products, funded from EU Structural Funds. We applied to get funding and we were approved. But our first interactions with the bureaucracy were far from efficient, as we were overburdened with documentation in each of the stages of the project and we experienced payment delays, although our reports were in impeccable condition. Fortunately these issues improved in recent years. Now we are looking to export in the EU, and to do so we want to file a patent at the European Patent Office (EPO). However, the patenting costs are €20,000–30,000 and this represents a huge financial burden for my company. For now at least there is no support for innovative SMEs to obtain patents at EPO or at the USPTO.

Source: Interview by the authors.

Table 7: External Drivers of Innovation

	Non-innovating firms	Innovating firms	Non-exporting innovating companies	Exporting innovating companies
Percent of companies for which pressure from domestic competitors affects innovation decision	52.6%	61.2%	63.8%	53.1%
Percent of companies for which pressure from foreign competitors affects innovation decisions	21.8%	41.9%	35.6%	61%
Percent of companies that export their production	11.4%	23.5%		
Percent of companies for which pressure from customers affects innovation decisions	58.9%	62.8%	65.4%	54.6%
Percent of companies for which access to finance is an obstacle to its operations	15.8%	19%	18.6%	20.5%
Top 3 elements of the business environment, which represent the biggest obstacle faced by the firm	-Access to finance -Practices of informal competitors -Tax rates	-Political instability -Inadequately educated workforce -Corruption	-Corruption -Political instability -Inadequately educated workforce	-Political instability -Practices of informal competitors -Crime, theft, disorder
Percent of companies that received subsidies from the government or EU over the last 3 years	4.2%	3.7%	1.8%	9.7%

Source: Authors' calculations, based on BEEPS 2008 data.
Note: Shaded cells show statistically significant differences, dark grey at 1% level, grey at 5% level, light grey at 10% of significance.

The results from enterprise surveys can help to better design the support programs to stimulate private innovation. The insights in this section could help to structure innovation support from the government, as instruments like tax credits are more suitable for large companies whereas business incubators and matching grants are better at incentivizing start-ups and SMEs. In Part II of this policy note, which offers recommendations to improve existing support instruments, we explore this in the context of specific incentives that are offered today using national and EU resources. A critical policy design issue is determining the selection criteria for awarding public financing. A poor selection of beneficiaries will significantly reduce the impact of the subsidies. The factors that are associated with innovation point to criteria that could help to filter companies based on their track record, so that the firms with the most potential for innovation are supported.

I.C. Benchmarking Bulgaria's performance with new technological inventions and scientific production

Bulgaria's patenting and scientific publication track record does not compare well with most European countries but patenting activity is on the rise, signaling a possible turning point in the impact of technological innovation.

Short-term action:

- Develop instruments to foster international collaboration with other EU scientists and with R&D units of MNEs.

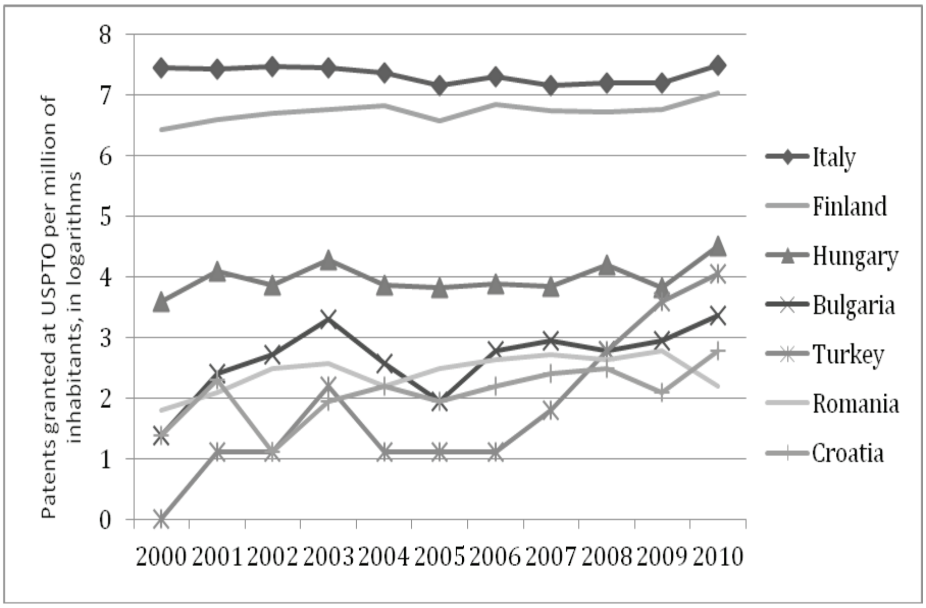
This section uses statistics for patents and publications to benchmark Bulgaria's performance in new technological invention and scientific research. The capacity of a country to generate cutting-edge technology and science is an intangible asset that is very hard to measure. As a result, economists turn to measures of innovation outputs like patents and publications, which have become standard indicators that can be used to evaluate developments over time and make country comparisons. We use the statistics about patents granted to Bulgarians by the USPTO and applications to the EPO to track the new technologies developed in Bulgaria and rely on patent citations to analyze the impact of these technologies.[20] We analyze the number of publications by Bulgarian researchers in international journals and citations to these papers to track scientific production over time and within specific disciplines and organizations.

Bulgaria's patenting track record does not compare well with most European countries. Bulgaria averages 0.85 patents per million inhabitants in the last two decades, which is above Romania (0.24) and Turkey (0.19), but below advanced transition countries such as Hungary (5.16) and Croatia (3.08) and far from Western European nations (Italy, 27.81; Finland, 137.11) (see Figure 7).[21] The patenting gap has its origins in the 1990s, when Bulgaria's international patenting plummeted. Bulgaria's top-performing patenting classes were connected to traditional industries with mature technologies, such as metallurgy, chemicals, industrial heating and medicaments. Today, companies in these industries prefer to upgrade product lines by purchasing foreign capital goods rather than developing in-house technologies. Figure 8 presents a breakdown of Bulgarian patents granted in the USPTO into six generic fields, as per the classification by Hall, Jaffe, and Trajtenberg (2001).

[20] The two sources of data we draw on have the advantage of providing comparable data across countries. Due to the significant costs involved and the perceived future value of the invention, only the best Bulgarian innovations will apply for a patent abroad. As a result, there is a downward bias for developing countries when analyzing their international patenting rates. To check the robustness of our conclusions and get a better perspective on these issues, we compare the results with statistics from the Bulgarian Patent Office—this source provides a broader picture of the technologies that are developed in the Bulgarian economy, however, national patenting rates tend to be noisier measures and are not useful for cross-country comparisons.

[21] Similar results and rankings emerge in EPO data on patent applications.

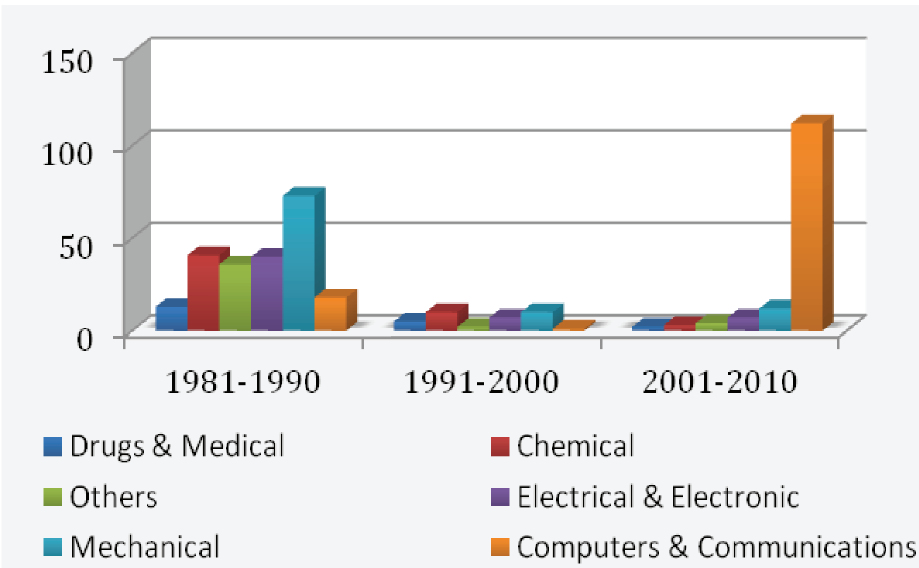
Figure 7: Patents granted by USPTO to inventors in Bulgaria and comparator countries: 2000–2010



Source: USPTO, data on utility patents, accessed in March 2011.

Patenting activity is now on the rise, propelled by R&D-intensive FDI in the IT industry. Most new patents granted to Bulgarians by USPTO are related to high-tech industries, especially computers and communications. The current patenting performance is dominated by new fields: communication and navigation technology, data processing, computers, software and memory and miscellaneous categories (defense, engines). The rise in the number of patents is a result of new R&D facilities by MNEs in the IT industry, which are active in cloud computing and other cutting-edge software development areas. This diversification into new technological areas that are more relevant in the current global economic environment is an important development and should be nurtured. In Part II.E we discuss policy options to support the IT sector.

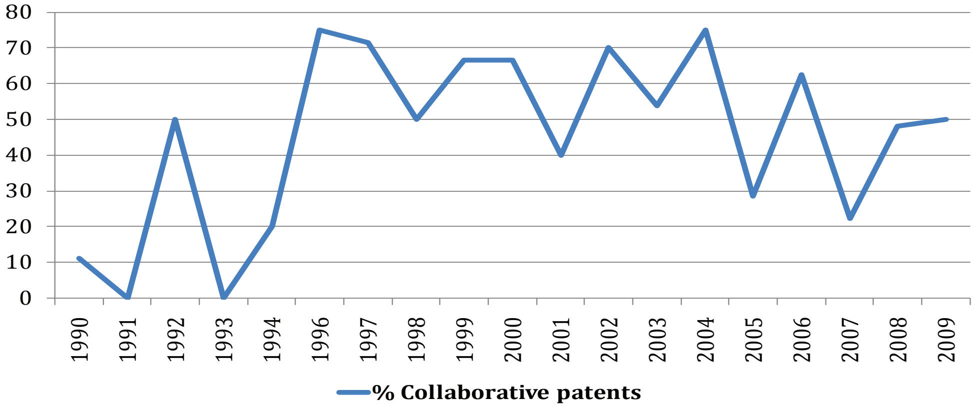
Figure 8: Patents granted to Bulgarian inventors declined substantially post-1990, but have seen an uptick thanks to the innovative activities of IT companies



Source: Authors' calculations using the NBER patent dataset and USPTO online search patent database.
Note: These numbers refer exclusively to inventions with a Bulgarian first-inventor.

Measures to foster international collaboration, in particular R&D partnerships between local inventors and teams from MNEs, could stimulate new technological development. Prior to 1990, patents were mostly generated by all-Bulgarian teams of inventors, either working in public R&D institutes or at large state-owned enterprises (SOEs). Collaboration with foreign researchers and firms picked up in the late 1990s and has increased ever since (Figure 9). Nowadays these co-inventions count for more than half of the country's patents at USPTO. The internationalization of innovation activities presents an opportunity for countries to connect with lead inventors and corporate R&D at the world technology frontier. Most of these collaborations occur with researchers and firms from Western Europe (Germany, Sweden, Belgium), the USA, and Japan.[22] Conversely, there is almost no collaboration with Eastern Europe, except for a few patents co-authored with Russian inventors.

Figure 9: More international co-invention, especially with private partners



Source: Authors' calculations based on patents granted at USPTO.

Scientific production is growing, but not fast enough for Bulgaria to improve its global position. Measured on a per capita basis, Bulgaria's scientific production is on a par with Romania and Turkey but lags behind the leaders in our comparison group (Finland and Italy) and Central Eastern countries (Croatia and Hungary) (Figure 10: More publications are being produced by Bulgaria's researchers, but this has yet to happen at a pace that increases Bulgaria's global position in science10). Between 2001 and 2009, Bulgarians published over 21,000 papers included in bibliometric databases,[23] as compared to 18,685 in 1991–2000 and 14,839 in 1981–1990. This translates into an 8 percent annual growth in terms of published scientific work, similar to Finland (4 percent), Italy (7 percent), Hungary (8 percent) and Poland (5 percent) but below Romania (29 percent), Croatia (18 percent) and Turkey (14 percent). Overall, Bulgaria's contribution to the world pool of publications decreased from 0.19 percent in 1996 to 0.14 in 2008.

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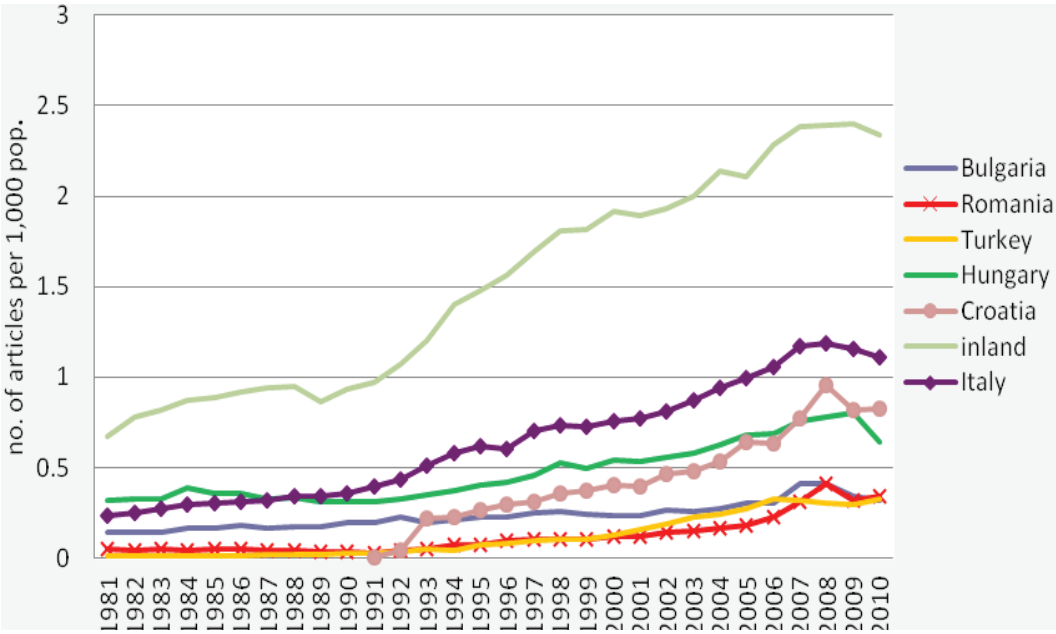
[22] World Bank (2008) finds that more than half of US patents in Eastern European transition economies stem from international teams of inventors. For example, US, Japanese or European based multinationals outweigh domestic companies in the top 10 Russian generators of patents. Similarly, we find that collaboration for Bulgaria in terms of innovation (or co-invention) has surged since 1990. As a rule, the emergence of new players, some of them important multinationals with a global presence (GE, Samsung, Sun, Nokia), as assignees of Eastern European patents is not surprising (Krammer 2009).

[23] In order to get an overall picture of the Bulgarian scientific landscape, all indicators were calculated using several bibliometric databases, namely Web of Science and Essential Science Indicators, both owned by Thomson Scientific (Philadelphia, PA) and Scopus from Elsevier. ISI's Web of Science and Essential Science Indicators do not monitor any Bulgarian journals while Scopus covers several such publications. However, due to the low number and relative quality of the Bulgarian journals, the analysis will focus mainly of ISI's databases for international comparisons and performance assessments. Due to the process of aggregative database update, there is data truncation, and between 8 and 12 percent of the observations are usually not reported for the last available year (in this case 2009).

Figure 10: More publications are being produced by Bulgaria's researchers, but this has yet to happen at a pace that increases Bulgaria's global position in science



Source: Authors' calculations based on Web of Science, March 2011.

Bulgaria's challenge is not just publishing more in international journals but also developing research with a greater impact. According to the H-measure[24] for scientific impact, Bulgaria has a score of 97 (this means that Bulgarian researchers published 97 papers with 97 citations or more in 1996–2008), similar to Romania and Croatia, but below Turkey, Hungary, and Poland. Finland scores almost 300 for the H-index while Italy tops the comparators with 432. Only a modest share of scientific research produced in Bulgaria has a significant impact in terms of knowledge creation and diffusion, as proxied by citations.[25]

The scientific fields in which Bulgaria excelled pre-1990 continue to play a leading role. The scientific strengths of Bulgarian publications lie in the fields of physics (optics, applied, condensed matter and multidisciplinary), chemistry, and engineering (materials science, electrical and electronics). The most significant increases are in optics and electrical and electronic engineering, while the most notable decrease occurred in multidisciplinary sciences. Overall, Bulgaria's pure science and engineering remains the main source of international publications.[26]

Scientific productivity is highest in the main institutions in Sofia, particularly the Bulgarian Academy of Sciences and the University of Sofia „St. Kliment Ohridski". As in most countries, scientific production is highly concentrated in terms of institutions and geography: the top-five

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[24] It is possible to measure the scientific productivity and impact of a country's publications through the H-index developed by Hirsch (2005).This equals *h* if a country publishes *h* papers each of which has been cited by others at least *h* times in the considered time frame.

[25] This index does not weight the number of coauthors involved or the composition of the scientific portfolio of countries and differences in terms of citing propensity between fields. The impact of Bulgarian papers on the international scientific community can also be analyzed using the "New Hot Papers" section in ISI Thomson. This list includes all articles worldwide that have received the largest number of citations, based on a certain threshold that is specific to the discipline. This list is very dynamic and changes every quarter. In March 2010, the top-five Bulgarian "Hot Papers" includes papers in the general field of medicine, physics, chemistry, and geosciences. Most "hot papers" are the result of an international effort with many co-authors.

[26] The specialization patterns were calculated based on an index that measures the ratio of the country's world share of publications in a given discipline to the world share in all disciplines. The specialization of comparator countries reveals both similarities and differences with Bulgaria. Romania's scientific strengths are very similar and reside mainly in chemical engineering (2.55), chemistry (2.03) and mathematics (2.61). Croatia tends to do well in social sciences (2.68), agricultural and biosciences (1.52) and environmental sciences (1.34). Hungary has a larger pool of strong fields ranging from arts and humanities (1.21) to neuroscience (2.56), mathematics (2.17) and veterinary medicine (1.66). Turkey is very strong in dentistry (2.92), energy (1.58) and veterinary (2.23). Finland has an advantage in neuroscience (1.22), business and management (1.36), economics (1.15), environmental science (1.90), computer science (1.50) and decision science (1.69). Italy tends to do better in decision science (1.33) and dentistry (1.34).

institutions—all of which are in Sofia—produced almost three quarters of the country's total publications. The Bulgarian Academy of Sciences remains the most prolific institution with half the Bulgarian publications in ISI recorded journals (see Table 8). Other prominent institutions are the University of Sofia, the Sofia Medical University and the University of Chemistry, Technology and Metallurgy. Outside the capital, smaller contributors include the Medical University of Varna, the University of Plovdiv "Paisii Hilendarski" and the Institute of Forage Crops in Pleven.

Table 8: Top Bulgarian institutions in terms of publications (1981–2009)

Main institutional contributors	1981–1990			1991–2000			2001–2009		
	Rank	Total	%	Rank	Total	%	Rank	Total	%
Bulgarian Academy of Sciences	1	7,977	53.8	1	9,744	52.2	1	10,473	49.1
University of Sofia	2	2,062	13.9	2	3,052	16.3	2	2,737	12.8
Medical University Sofia	3	1,214	8.2	3	626	3.4	3	1,671	7.8
Univ. Chem. Tech. & Metallurgy	4	514	3.5	5	236	1.3	4	846	4
Technical University Sofia	5	188	1.3	4	261	1.4	5	560	2.6
Total (all institutions)	14,839			18,685			21,340		

Source: Authors' calculations, Web of Science (accessed March, 2010).

International research collaboration with other EU researchers has increased. Bulgaria's share of publications co-authored with foreign researchers increased from 16 percent in 1981–1990 to 35 percent in the 1990s transition period, and over 50 percent in the last ten years. The co-authors mostly reside in Western Europe (Germany, France, and Italy) and the USA, although recent trends have seen an increase in partnerships with other EU countries (Belgium, Spain, and Poland). After a large drop in 1990, there is now increasing co-authorship with Russian scientists.27 These are positive developments, as bibliometric studies find that publications with international co-authors have significantly more visibility and impact (measured by citations) (Figg et al. 2006; Ma and Guan 2005; Inzelt et al. 2009). Since the magnitude of this effect depends on the partnering country and discipline (Glänzel et al. 1999), it is encouraging that Bulgarian scientists collaborate with scientists from leading EU countries.

[27] According to SCOPUS data, increases in terms of international cooperation have been similar for Finland (from 33 percent to 49 percent) and Italy (from 30 to 41 percent) while the rest of the comparator countries have been less impressive in this respect (on average 1 to 5 percent between 1996 and 2008).

PART II. POLICY RECOMMENDATIONS

The Government of Bulgaria is prioritizing new policies that can raise the country's innovative capacity and increase the impact of innovation on economic growth. In the Convergence Program 2011–2014 and the National Reform Program (NRP) 2011–2015, the Government has set out a broad range of growth-enhancing structural reforms. The fact that research and innovation are perceived as an integral component of Bulgaria's business environment and central to its competitiveness and growth agenda is important, as this policy area was previously regarded as isolated and contributing little to growth.

Timely implementation of the NRPs will be critical for Bulgaria and all other EU countries to meet their commitments under the Europe 2020 Strategy. In its *Progress Report on Europe 2020 Strategy*, the EC recommends member states to: take active steps to increase public investment in research, innovation and education; present a coherent plan for reforming research and innovation systems, based on an analysis of individual strengths and weaknesses; and gear their reforms to removing obstacles to the growth of innovative companies, including by improving framework conditions and access to finance. The compilation of all provisional national targets by DG Research indicates an aggregated level of around 2.7 percent of GDP, below the expected target of 3 percent GDP invested in R&D. Ambitious national targets and a focus on long-term reforms will be needed for the EU to attain the headline targets by 2020.

Bulgaria's NRP defines concrete targets, measures and indicators to strengthen innovation in the public and private sectors. One of the four NRP national targets is to raise investment in R&D to 1.5 percent of GDP by 2020, similar to current levels of R&D in the UK and Norway. Attaining the R&D target would enhance growth and employment[29], but the government's contribution needs to be consistent with the capacity of the State budget. The main measures to be implemented are listed in the NRP's action plan:

- Adopting a new "National Strategy for Development of Scientific Research 2020" to improve the R&D policy framework, identify priority fields, introduce financial instruments, and strengthen monitoring and evaluation.
- Passing legislation on innovation to improve the financial framework for promotion of innovation.
- Creating a €30 million Growth Capital Fund (€25.5 million from the Joint European Resources for Micro to Medium Enterprises (JEREMIE) funds and €4.5 million from the budget) to provide investment capital to 12+ high-growth companies.
- Establishing support programs for companies and research organizations to participate in the European EUREKA initiative, so that at least 10 new projects are awarded.
- Financing about 50 new R&D projects and technical feasibility studies each year through the National Innovation Fund, with a €38 million budget envelope in 2011–15.
- Supporting about 70 new R&D projects in Bulgarian enterprises by drawing on €25.5 million in EU funds and €4.5 million from the national budget.

[29] Preliminary estimates suggest that the effects of more and better R&D expenditures on GDP and export growth are significant (Soete, 2010). The forecasts of the NEMESIS (New Econometric Model of Evaluation by Sectoral Interdependency and Supply) model are that the financial crisis created a long-term structural gap in the EU's GDP of on average some 9 percent, and because this has a larger impact on R&D intensive sectors, it would reduce the R&D intensity of the European economy. A concerted effort to increase R&D intensity to 3 percent for the EU as a whole, as envisioned in the Europe 2020 Strategy, would improve growth prospects significantly, cutting 43 percent of the GDP gap resulting from the crisis by 2025. The modeling exercise implies that "for the years 2020 and 2025, respectively 3 and 5.4 percentage points of GDP (i.e. €398 and €795 billion) will be generated thanks to the new 3 percent objective, including 2.7 and 3.7 million extra jobs" (Zagame 2010, p. 7).

The Strategy for Development of Scientific Research proposed in the NRP has already been adopted by the Council of Ministers (CoM) and later by the parliament. The Scientific Research Strategy sets measurable targets and indicators so the country can achieve "a moderate innovator" status by 2020 as measured by the Innovation Union Scoreboard (for instance, this is the current position of Poland, Hungary and the Czech Republic).[30] The strategy was developed by the MEYS in close consultation with stakeholders. It was adopted by the CoM in June 2011 and few months later by the parliament. The strategy's success hinges on the performance of the proposed initiatives to strengthen R&D spending, innovation infrastructure, and human potential.

Part II of this policy note provides recommendations for facilitating the implementation of the NRP and the Scientific Research Strategy, as well as other initiatives that are underway. The recommendations are divided into the following areas:

- attaining the 1.5 percent R&D/GPD target under the Europe 2020 Strategy;
- strengthening the institutional framework for research and innovation;
- achieving better results from national funding instruments—the National Innovation Fund and the National Science Fund;
- increasing absorption of EU funds targeting research and innovation and involvement in EU initiatives; and
- developing targeted innovation policies and instruments for priority sectors.

II. A. Attaining the 1.5 percent R&D of GDP target under the Europe 2020 Strategy

To meet the national target of 1.5 percent R&D/GPD by 2020, Bulgaria needs to substantially increase absorption of EU funds, raise public spending, and increase the efficiency of its national funding instruments.

Short-term actions:

- Increase absorption of EU funds and raise public spending
- Shift public R&D spending from core institutional funding toward competitive funding to improve the quality of public expenditure and amplify results.
- Increase the volume of matching grants to leverage private R&D investment

Medium-term actions:

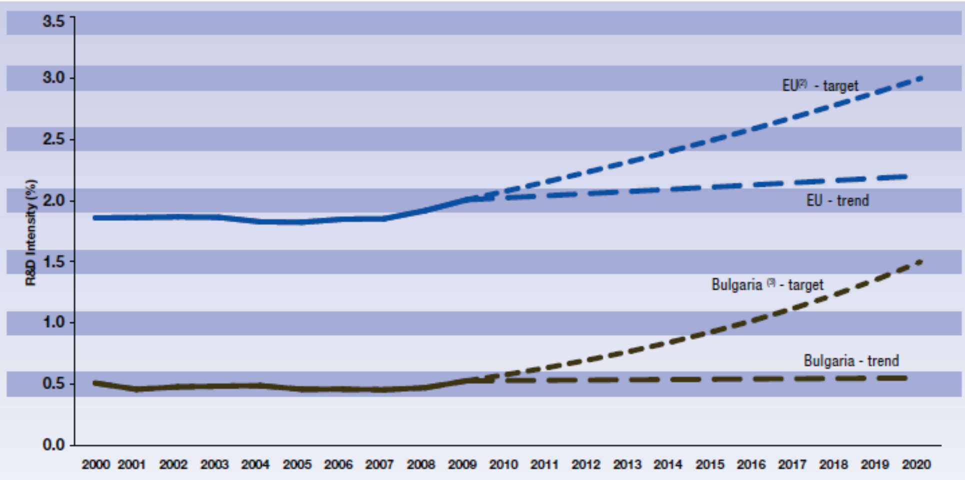
- Introduce counter-cyclical R&D spending policies and instruments in the medium-term expenditure framework (MTEF)
- Introduction of an R&D Satellite Account for more active monitoring of R&D expenditures

To meet the national target of 1.5 percent R&D/GPD by 2020, the Government of Bulgaria would need to greatly increase absorption of EU funds and boost public R&D spending, consistent with the capacity of the State budget. Business-as-usual will not deliver the needed increase in R&D investments. The projections prepared for the *Innovation Union Competitiveness Report 2011*

[30] The starting point of the strategy is that there are several challenges that need to be dealt with. *Economic challenges*: Bulgaria significantly lags behind other EU members in terms of economic development; there is a relatively higher share of agricultural sector; GDP per capita is lower than in the rest of the EU; exports are mainly in traditional and labor-intensive industries. *Innovative development and competitiveness challenges:* low share of high-tech exports; low innovation capacity in terms of registered patents; low and falling R&D investments; unfavorable ratio of R&D spending between public and private sector; unfavorable expense structure in the public sector and the lack of resource concentration; artificial separation of science from higher education, inefficient use of existing national and EU instruments. *Human resource challenges:* aging profile of scientists; no young scientists; worsened quality of education; large share of R&D employees work in public sector. *Internationalization challenges:* low level of participation in EU programs such as the Competitiveness and Innovation Framework Programme (CIP); the Information and Communications Technology (ICT) policy support program and others.

show that R&D intensity would remain flat if the trends observed from 2000 to 2009 continue (Figure 11). The government estimates that meeting this target will require absorption of €539.2 million from the Operational Program "Development of the Competitiveness of the Bulgarian Economy" (OP Competitiveness) 2007–2013 funds by 2015. By May 2011, OP Competitiveness had contracted 36 percent of the total funds, and paid 21 percent. Implementation has improved in the last year but is still not fast enough to fully utilize the resources by the end of the programming cycle. Regarding public spending, the NRP states that 0.8 percent of the planned total budgetary expenditures will be allocated to science in 2011, which is equivalent to 0.3 percent of GDP. This would be a considerable increase over previous levels.

Figure 11: Bulgaria's R&D Intensity Projections, 2000–2020



Source: Innovation Union Competitiveness 2011 Report, based on data from the EC's DG Research and Innovation and Eurostat.

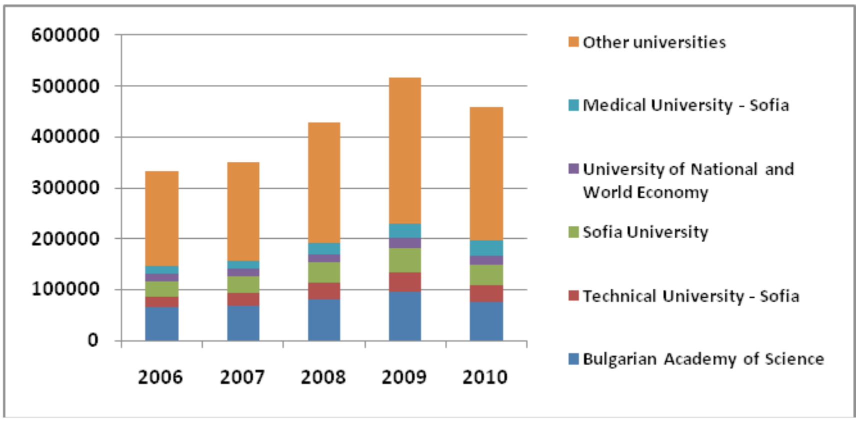
Introducing counter-cyclical R&D spending policies and instruments would help to achieve this target. Due to the downturn in 2009–2010, there have been two consecutive years of nominal and real declines in public R&D spending. The National Innovation Fund received BGN 4 million from the national budget for innovation projects in 2010, a sharp decline over previous years. Emerging high-tech countries such as Korea have established anti-cyclical R&D spending policies, which have proven to be very successful in assuring the continuity of scientific and innovation activities. Bulgaria could consider introducing a policy similar to Korea into its mid-term expenditure framework (MTEF).

More active monitoring of R&D spending would be facilitated by the rapid introduction of an R&D Satellite Account, as envisioned in new European System of Accounts regulations. R&D satellite accounts are already compiled in several OECD and EU countries, as a tool to better understand the importance of R&D to economic growth and international competitiveness. The European System of Accounts plans for all EU countries to develop R&D satellite accounts, adopting a consistent treatment for R&D as a type of fixed capital formation. This will facilitate comparisons across countries and is likely to raise the estimates of private R&D. Bulgaria's National Statistical Institute could partner with agencies in Finland or other advanced EU countries that are piloting the methodologies to introduce a satellite account early on.

To raise the efficiency of public expenditures in R&D, it would be helpful to start shifting resources from core institutional funding toward competitive funding. The challenge is not just increasing public R&D, but improving the quality of public expenditure. International experience shows that competitive funding is better at promoting excellence in research and increasing collaboration among research institutions as well as with foreign researchers and firms. In the case of scientific research, only a small share (less than 10 percent of total subsidies) has been allocated through the NSF for competitive support to projects. Most state subsidies have been provided to universities and the

Bulgarian Academy of Sciences as institutional funding (Figure 12) and the main portion of this subsidy is spent on salaries and social security, with a small share for capital investments. State subsidies for universities are allocated on the basis of the number of students and the evaluation received from the accreditation review. As more resources become available, increasing this share could provide important incentives for high-quality research.

Figure 12: Total state subsidies for universities and the BAS (in 000 BGN)



Source: Law on State Budget.

Increasing the volume of matching grants would help to leverage private R&D investments. At 30:70, the ratio of private to public R&D is unfavorable in Bulgaria compared to other EU countries; the most innovative countries such as Germany, Finland, and Sweden display the highest share of private spending (in these countries, around 65 percent of total R&D is funded by enterprises). To leverage private R&D, the volumes disbursed through the National Innovation Fund and competitive funds from EU resources would need to increase substantially. As discussed in World Bank (2011), matching grants have proved to be an effective instrument for leveraging private sector innovation. For an example of the instruments and results, see Box 5 on Israel's experience.

Box 5: How Israel Promotes Innovation, and How Bulgaria Could Apply this Experience

The Office of the Chief Scientist (OCS) within the Ministry of Industry, Trade and Labor stands at the heart of Israel's R&D support schemes. Its main activity is to support industrial R&D through a range of domestic and international support programs. The annual budget of the OCS has been stable and growing, reaching $350 million in 2010. Industrial R&D expenditures in Israel grew at double-digits since the inception of the OCS and today Israel is recognized for its high-tech exports and VC industry.

The main program to incentivize industrial R&D is a competitive matching grant scheme that provides up to 50 percent of a project's R&D budget. The program selects projects according to their merit across all branches of industry. It is considered an international best practice because of the high demand from the private sector, the policy design, and the provision of repayment terms that are industry friendly yet bring considerable resources back to the public sector. Specifically, successful projects are required to repay 3–5 percent of their sales in royalties, up to the dollar-linked amount of the grant.

The Technological Incubators program (TIP) was introduced in 1990 to assist immigrant scientists and engineers from transition countries to develop ideas while being (self) employed in the short term, and potentially creating new high-tech companies and more jobs in the mid-to-long term. Currently 24 incubators are operating, out of which 15 are located in peripheral areas, with about 200 projects in the TIP at any given time. TIP's experience suggests that:

- Great care should go into choosing a manager with private-sector experience.
- Incubators need to have a close relationship to universities.
- Strong public support for seed finance is vital but may decrease as projects mature.
- A sufficient percent of the shares should remain in the property of the entrepreneurs to keep them motivated and strongly involved.
- Evaluations of the projects should be performed by an expert network.

In addition, the OCS established the Yozma Venture Capital (VC) program in 1993. At that point the conditions for the creation of a VC industry were in place, in terms of technological capabilities and project pipeline. Yozma's experience suggests that when creating a VC industry the following factors should be taken into consideration:

- The state should be a passive investor.
- It is best to involve foreign partners—this may lead to recruitment of very experienced venture capitalists.
- It is important to make sure that public funds are controlled by different management companies to avoid monopolization of the funds.
- Incentives that motivate funds to be more profitable in case of success appear to be more effective than incentives that limit the investors' losses in case of bad investments.

Overall, the Israeli experience demonstrates that well-designed interventions can have a transformational effect if they help to build technological capabilities in the private and public sector. For this to happen, there needs to be a sequence of interventions that starts by nurturing early stage technological development and moves progressively to stages where large-scale R&D and VC are relevant.

Source: World Bank (2011).

II.B. Strengthening the institutional framework for research and innovation

Funding and support mechanisms for research and innovation in Bulgaria are fragmented in different ministries with little integration between implementing agencies or Operational Programmes.

Short-term action:

- Develop synchronized strategies on research and innovation up to 2020, including clear mechanisms to monitor the implementation of specific action plans.

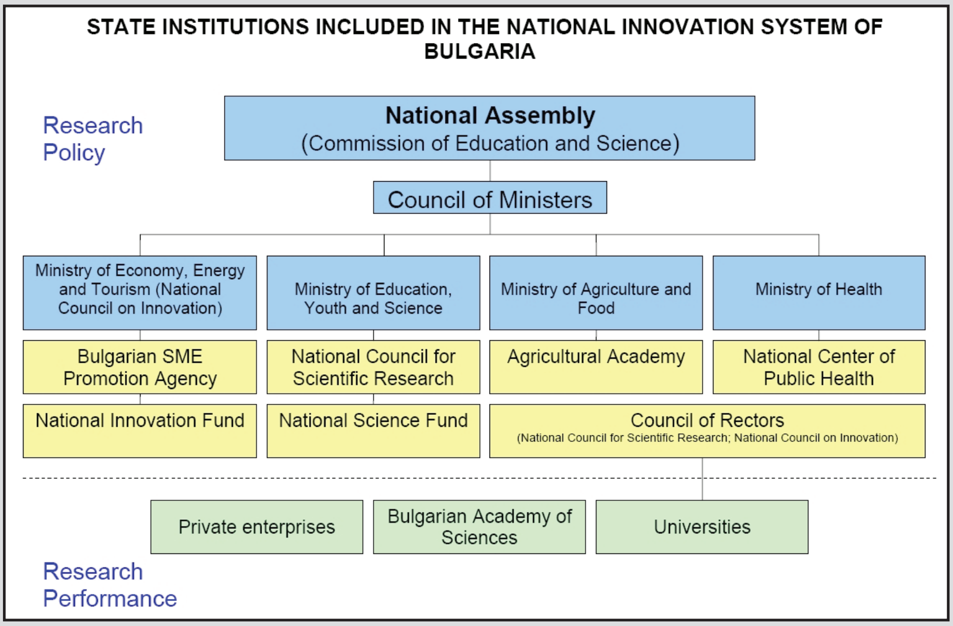
Medium-term actions:

- Introduce a system-wide evaluation of research organizations, as a way to promote efficiency-enhancing reforms in their organization and governance.
- Provide additional budgetary resources to the research units that make measurable improvements in impact metrics and generate external funding from private sources.
- Establish a competitive grant program for high-impact researchers.

Public policy on research and innovation in Bulgaria is designed and implemented by multiple ministries and agencies, which has led to fragmentation and coordination problems. The MEYS and the MEET lead major reforms and programs in the research and innovation areas (see Box 6). On the whole, the strategies and legal framework for scientific research have been developed independently of the strategies and legal framework for innovation, and the financing instruments are designed and administered by different bodies. As in other countries, this fragmentation of responsibilities has made it difficult to develop an integrated STI strategy, and it has resulted in problems such as running programs with overlapping objectives, limited coherence, and a poor rationalization of resources.

Improving the articulation of the institutional framework would help Bulgaria to fully exploit the opportunities provided by EU funds. There are two separate Operational Programmes supporting research and innovation in Bulgaria: OP Competitiveness under the responsibility of the MEET; and OP Human Resources, for which the Ministry of Labor and Social Policy is the managing authority and MEYS is one of the three intermediary bodies. These programs are not effectively coordinated, and they have different implementation authorities and instruments. To maximize the impact of these programs, it would be useful to strengthen the links between support instruments and progressively consolidate the implementing bodies.

Box 6: Overview of the state institutions in Bulgaria's innovation system



The *MEET* is responsible for the formulation of innovation policy and strategy in the business sector. The *National Council for Innovation* is a consultative body to the MEET and includes representatives from the business sector, academia, the scientific community, and nongovernmental organizations. The *Bulgarian SME Promotion Agency (BSMEPA)*, which reports to the MEET, prepared and now implements the measures of the *National Innovation Strategy*, including the administration of the *National Innovation Fund* established in 2005.
The *MEYS* is responsible for national research policy. The *National Council for Scientific Research* is the coordinating body for research policy and is comprised of representatives from ministries and scientific organizations. The *National Council for Scientific Research* participates in the preparation of and approves the *National Strategy for Research and Development*, and defines funding priorities for the *National Science Fund*, established by the MEYS in 1990.

Other ministries play a supporting role in innovation policy. The *Ministry of Agriculture and Food* hosts the Agricultural Academy, which incorporates all scientific and research units in the field of agriculture and plays a role in the implementation of research policy. Similarly, the *Ministry of Health* oversees the National Centre of Public Health Protection, a public performer of medical research and health risk analysis (The Ministry of Health oversees seven National Medical Research Centers). The *Ministry of Defense* manages an R&D program and collaborates with the Ministry of Education, Youth and Science to align research priorities with the country's defense needs and capabilities.

Source: ERAWATCH, Structure of the Research System in Bulgaria, 2010.

The new Scientific Research Strategy is a step in the right direction, but now it is important to synchronize this with the proposed National Innovation Strategy. The new Scientific Research Strategy identifies the challenges that Bulgaria needs to tackle to strengthen its overall scientific performance as well as the direct contribution of research for innovation and economic growth. Box 7 presents an overview of the objectives of the Strategy and its Action Plan. In light of the Europe 2020 Strategy, a new National Innovation Strategy is also being prepared, with the MEET in the lead. The Innovation Strategy will support industries that have high potential for innovation. To be effective, these two strategies should be fully synchronized, which implies that there is a clear sequence of interventions to be implemented and close connections between the support mechanisms.

Box 7: National Scientific Research Strategy for Bulgaria

The Scientific Research Strategy recognizes that there are several pre-conditions for Bulgaria to attain the full benefits of integration into the European Research Area (ERA), namely improving the institutional and policy framework, increasing R&D investments to 1.5 percent of GDP, and strengthening the capacity of public research organizations and private companies. In view of this, the objectives of the strategy are to encourage:

- *Concentration of public resources and investment in priority scientific areas:* National instruments like the National Science Fund and the National Innovation Fund are expected to play a central role in allocating funding to projects on a competitive basis. EU funds will play an essential role in incentivizing R&D by business.
- *Support for the scientific infrastructure:* To address the large investment gap in public research organizations, the Strategy proposes to direct EU funds into refurbishing laboratories, upgrading scientific instruments and funding to purchase materials.
- *Strong inclusion of the private sector:* Develop effective coordination mechanisms like national technological platforms, which can merge scientific and industrial interests.
- *Mobility of human capital, knowledge, and technologies:* the Strategy proposed actions to encourage younger generations to continue their university education, such as scholarships for doctoral students and increased mobility with foreign research centers and universities.

The **Action Plan** for the period 2011–2013 identifies the following measures:

(i) A new model for financing will be introduced, which will translate into a better balance of institutional and competitive program financing. Longer-term scientific programs in priority areas will also be introduced, which will be subject to regular evaluation by external experts.

(ii) Scientific research will be prioritized in five areas that will concentrate 70 percent of the national R&D financing. This is expected to create a critical mass of intellectual potential and scientific infrastructure.

(iii) The conditions for scientific careers will be improved through professional development, qualification, and specialization of scientists.

(iv) Bulgarian science will be better integrated in the European Research Area (ERA) through support offered to the Bulgarian scientific community to take part in the European Community initiatives. Participation through projects in the South East European ERA-NET Plus is one possible avenue.

(v) The knowledge triangle (education, research and innovation) will be strengthened through improvements to institutional coordination, development of schemes for start-ups, encouragement of business angels, support for SMEs to better absorb technologies, and increased private-sector financing of R&D.

(vi) Scientific infrastructure will be improved through the establishment of regional partnerships that can be integrated with large European scientific infrastructures.

(vii) An assessment system for scientific research will be introduced.

(viii) The social dimensions of science will be reinforced through such measures as national scientific awards and support for publication in high-impact journals.

To strengthen the commitment to the new strategies, it could be useful to set up a single body to monitor the execution of these action plans. The Action Plan for the Scientific Research Strategy specifies the public authorities that are responsible for the implementation of each measure and it lists indicators that will be measured and reported by 2014. The Innovation Strategy will also specify concrete actions and indicators that need to be monitored over time. International best practice points to the usefulness of setting up a body (for example, in the form of an inter-governmental council) that monitors the execution of the Strategy after it is adopted and invites stakeholders to regular consultations. As of yet, no proposal for the establishment of a council or use of an existing body to undertake this function has been discussed, although it is mentioned in previous strategic documents. This role could be performed by a single high-level body that merges the National Council for Scientific Research and the National Innovation Council, or by institutionalizing a certain number of joint sessions of the two Councils.

In addition to improving the overall institutional framework, there is a need to enhance the organization and governance of the public research organizations. In Bulgaria, as in other post-transition countries, the scientific productivity and impact of the public organizations that perform the bulk of the R&D is hampered by outdated institutional and governance models. A recent report (World Bank, 2011) identifies the main issues that limit the effectiveness of R&D institutes (RDIs) based on 21 case studies in Croatia, Lithuania, Poland, the Russian Federation, Serbia, Turkey, and Ukraine (see Figure 13). The report concluded that the challenge facing RDIs is to better define their core mission (e.g., basic research, education, R&D services, etc.) and depending on this mission, introduce incentive frameworks to systematically improve performance as well as non-budgetary sources of financing. As we discussed in Part I, the Bulgarian Academy of Sciences and top research universities have a good track record when it comes to basic research, and they also play a leading role in higher education, but they are generally isolated from knowledge commercialization activities.

Figure 13: Chain of Events Leading to Ineffective R&D Institutes

Source: World Bank (2011).

The Bulgarian Academy of Sciences (BAS) commissioned an evaluation of its research performance in 2008, which underlined the urgent need to carry out reforms. In 2008, the BAS contracted the European Science Foundation (ESF) and the All European Academies (ALLEA) to conduct an independent evaluation of its research performance covering a five-year period from 2004 to 2008. The results in the evaluation report (ESF/ALLEA 2008) are that:

• Many BAS institutes perform valuable research following international standards and there are cases where research groups operate at the forefront worldwide.[31]

[31] Including the Institute of Nuclear Research and Nuclear Energy, Institute of Electrochemistry and Energy systems, Institute of Polymers, Central Laboratory of Photoprocesses, Institute of Molecular Biology, Institute of Microbiology, National Institute of Meteorology and Hydrology, Geophysical Institute, Central Laboratory of Mineralogy and Crystallography, and National Institute of Archaeology with Museum.

- The relatively good results are based on investments made prior to 1990 and cannot be sustained without considerable effort and extra funding. Currently, the generation of additional income by institutes takes precedence over the development and implementation of sustainable research policies.

- The creation of international advisory councils for the institutes or for their field of research could be a way to strengthen policymaking.

- A lack of papers published abroad (particularly in peer reviewed journals) and the maintenance of sub-standard in-house journals in some institutes is problematic.

- The overall financial situation negatively impacts the training and development of young researchers. As a result, many BAS scientists take on a considerable teaching load on top of their research work to augment their income.

Based on this assessment, the BAS started a reorganization that aims to improve the institutes' scientific productivity. The academy's 72 institutes have been merged into 42 institutes, and new procedures for periodic institutional attestation of research institutes and scientists were prepared and approved. Nine thematic panels and advisory bodies were also established to improve the overall governance of the institutions. It is too early to judge whether the reorganization has succeeded, but in any case it should be seen as the first round of reforms, and the next round could focus on developing deeper collaboration with research groups in universities (including joint initiatives to upgrade the research infrastructure) and fostering knowledge commercialization and interactions with enterprises.

While the ESF/ALLEA review was useful in spurring reorganization at the BAS, it raised the need for a more comprehensive independent review of the entire research system. This review of the universities and BAS research institutions should be conducted by an independent, international group of experts with the aim of transparency and impartiality. This review would include provisions to ensure future evaluation and monitoring of the research system in Bulgaria. The outcome of the evaluation would be used by MEYS to determine future funding and to create a plan to improve, merge or close non-productive groups. Universities have specific challenges in developing research capabilities, which would need to be addressed (see Box 8).

Box 8: Challenges in Allocating and Using STI Funding in Universities

Some common challenges in allocating and using STI funding in universities outlined in interviews with the rectors of major universities are:

- The minimum of 10 percent of budgets going to STI, as outlined in the Law on Higher Education,* is not fulfilled. Trying to reach the 10 percent means cutting the budget for salaries and other essentials, which is not feasible.
- The annual state subsidies for universities are based on a formula that includes such factors as the number of students and planned capital expenditures but that does not include STI spending needs. Salaries, with the exception of sabbatical leaves for research, should not be considered STI spending.
- The funding for STI often goes to supplying the bare minimum universities need to conduct everyday business such as the purchase of computers and stationery. STI spending should instead only include:
  - Salaries covering the actual hours spent in research
  - Direct research costs such as analysis, data gathering and purchase, software, machinery, and lab consumables.
- Overly complex accounting principles slow down the implementation of projects and do not make a clear distinction between STI spending and other types of spending. Accounting and/or managerial systems need to be implemented that separate expenses used directly for STI and expenses used for the normal functioning of the universities. Such systems will also permit administrators to quantify the cost of scientific output.
- Rules for state subsidies require that public procurement procedures are used for any capital expenditures including equipment and construction. Projects can be significantly slowed down by this requirement. These public procurement laws apply to all university projects even if the funding comes from private companies, which can be a significant disincentive to private investment in university-based research.
- A reliable 3-year projection for STI funding from the government would help universities in planning and setting priorities and strategies. Under current conditions, STI budgets can be, and often are, cut after they have been approved, making planning difficult.
- Subsidies are provided to universities in monthly installments that total less than 100 percent of the annual subsidy, with the remaining 5–10 percent being released only at the end of the year. This creates two problems: the installments do not correspond to actual spending timetables (due to frontloading, subcontracting, etc.) and the 5–10 percent of the subsidy provided in December cannot be used in the same year. As a result it is transferred to the following year, leading to a cut in the state subsidy for the following year.
- Universities that are part of the System for Electronic Budget Payments (SEBRA) are subject to special limits of what they can and cannot use out of their accounts.[2] This limits these universities' financial flexibility.

* *Article 91 (7)*

** *SEBRA is an information system for surveillance and management of payments made by the participating public sector enterprises within limits previously set. It also serves the payments made by budget spending units included in the Single Account System of the Ministry of Finance.*

The Government could incentivize future reforms by making funding increases to research institutes conditional on measurable improvements in impact metrics. In general, the impact of Bulgaria's science infrastructure remains below relevant comparators in the EU. New funding policies that allocate fresh resources to institutions that demonstrate measurable increases in the impact of their research would create an environment in which management of the institutes is encouraged to increase the quality of research, rather than the headcount of full-time researchers or students. An example of how this system might work is the Research Assessment Exercise that takes place in the UK every five years. In the past, this assessment relied on expert panels, but the new Research Excellence Framework to be completed in 2014 will carry out a systematic benchmarking of research units relying on impact metrics similar to those we analyzed in Part I.

In parallel, funding could be directed to the most prolific researchers, thereby making research careers more attractive and encouraging increasing productivity and impact. The Government could improve career development opportunities by establishing a competitive grant program for high-impact researchers that includes distinctions and "performance-pay". An example is Mexico's National Researchers System (SNI), a program administered by the National Council for Science and Technology (CONACyT) since 1984 that awards grants based on the scientific outputs of individual researchers.[32] Financial incentives are granted to affiliated researchers based on a periodic peer review process of their outputs. The incentives are non-taxable complements to the regular remuneration granted according to the category and level of the researcher, amounting from three times Mexico' minimum wage (approximately €200 per month) to 14 times the minimum wage (approximately €958 per month).

External funding from private sources and EC programmes secured by Bulgarian research institutions has the potential to increase further if reforms are continued. External funding has increased over time and should continue to increase if there is a strong drive to establish R&D contracts with industry and compete for FP7 programs. The following measures could help to achieve this goal: revisions in the evaluation and promotion schemes to reward applied research with a high potential for commercialization; improved IPR rules to support work with businesses; creation of a central technology transfer office to support R&D commercialization opportunities; and co-financing from national sources to facilitate participation in EC programs.

An incentive scheme in which the public sector matches the payments from private businesses to research institutions could also be a useful approach. This kind of program would ensure that contributions to industry by government-funded researchers will be rewarded without jeopardizing their public funding and would encourage more explicit and transparent knowledge transfer between sectors. An international example is the Fraunhofer Institute, which has a performance-based funding scheme that aims to keep industry to institutional funding in a certain range in order to balance basic and market-oriented R&D. The institutes receive 0.4 euro of funding for each euro raised from industry; but this falls to 0.1 euro if industry revenues are outside the 35-55% range.

A better governance framework for higher education, including pooling of resources and facilities between universities and the BAS, is also needed. There are problems with the university governance, including quality assurance and financing, which continue to negatively affect the quality of higher education and limit the role of universities in scientific research. Below-market wages, a lack of interest by faculty and students in scientific research, and brain drain are partly attributable to the institutional rigidities of the tertiary sector (see Box 9). The Scientific Research Strategy recognizes that universities and research organizations do not cooperate sufficiently. There is potential for pooling resources so that the research centers within universities are adequately equipped with human and technological resources for quality research. More needs to be done to integrate BAS researchers and academic staff into purely educational activities of universities; so far this is done sporadically at the level of PhD programs of universities, but this could also be done at earlier stages (BA and MA programs).

[32] The outputs include: publication of articles, books, book chapters; the introduction of patents, development of new technologies, innovation and technology transfer; supervision of graduate and post-graduate students; teaching at graduate and post-graduate level; and training of researchers and research groups. For further information, see http://www.conacyt.mx/en/Pages/default.aspx.

Box 9: Personal Viewpoint – CEO of a Large IT Company

For seven years, I worked for a large IT company in Silicon Valley in California, USA. When I received an offer from my company to develop a subsidiary in Bulgaria, my family and I jumped at the opportunity to return home. Besides my position as the CEO, I run several educational IT programs with two Bulgarian universities. Along with my staff we offer knowledge and skills on a voluntary basis. By preparing top notch IT engineers, we are able to support the higher education system in Bulgaria, which is gradually turning into a global IT hub. In my communication with professors, I hear a lot of positive feedback about our educational IT programs, but I see resistance on the part of university management to launch new programs. I believe that Bulgaria can become internationally competitive, but there needs to be strong public incentives for universities and public research institutes to collaborate with private businesses.

Source: Interview by the authors.

II. C. Achieving better results from national funding instruments

The main national funding instruments for research and innovation, the National Science Fund and the National Innovation Fund do not operate as efficiently as they could.

Short-term action:

- Prepare an evaluation to assess the results achieved by these instruments and to recommend changes in their design based on international best practice.
- Work closely with beneficiaries to sustain the quality of proposals and enlarge the project pipeline.

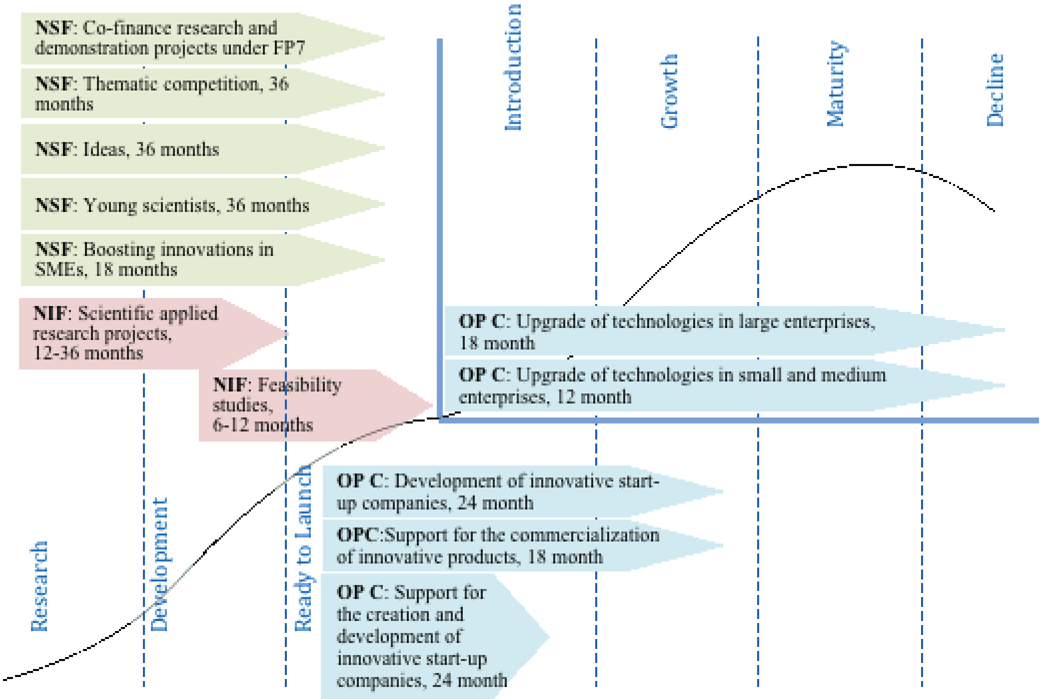
Medium-term action:

- Consider merging the administration of the NSF and NIF into a single specialized agency that has much better capacity.

The two main public financial instruments to support research and innovation are the National Science Fund and the National Innovation Fund. The main funding instrument to support public and private scientific research is the NSF, which is overseen by the National Council for Scientific Research at the MEYS. The NSF specific schemes to support the national research potential include support to young researchers, research infrastructure, and preparation of research projects. The main government instrument offering direct financial support for business R&D is the NIF, which co-finances applied research and encourages joint project implementation by firms and research organizations. The NIF is administered by the Bulgarian Small and Medium Enterprises Promotion Agency at the MEET.

Because these national instruments are the only source of funding for early stage R&D, they play a critical role in creating a project pipeline for other support programs. As shown in Figure 14: Position of the National Science Fund and National Innovation Fund along the Science to Market Axis14, the NSF and the NIF are the main source available for funding early stage R&D, whereas the EU funding instruments under OP Competitiveness provide funding for later stages of the R&D commercialization process. The NSF is focused mainly on the first stages of fundamental and applied research, and the NIF is the interface that links applied research to commercialization of R&D.

Figure 14: Position of the National Science Fund and National Innovation Fund along the Science to Market Axis



Source: ARC Fund 2010 Technical Note, commissioned by World Bank.

The NSF has been in operation since 1990, but a significant increase in funding was provided in 2005–2009. The funding of NSF was increased from BGN 15 million annually in 2006–2007 to BGN 60 mln. for 2008 and BGN 80 mln. for 2009. The grants are allocated on a competitive basis to scientists or teams of scientists from Bulgaria that apply to competitive calls announced by the fund. The evaluation of research projects and programs is generally performed by independent foreign evaluators with guidelines on objectivity, competence, and conflict of interests. In 2009, 51 research units of BAS, 8 institutes of the Agricultural Academy and 26 universities received funding from 15 competitions.

Since its inception in 2005, NIF held five competitive calls for proposals that distributed BGN 61 mln. The National Innovation Fund (NIF) was created as an element of the Innovation Strategy of Bulgaria in 2005 to stimulate innovative activities of Bulgarian businesses. The Fund provides matching grants for (i) feasibility studies and (ii) applied R&D projects that develop new or improved products and services. The maximum subsidy is BGN 50,000 for feasibility studies and BGN 500,000 for R&D projects. 381 projects, or 56.4 percent of all projects that submitted applications, were approved to receive a subsidy. The enterprises that were awarded funding are concentrated in high-tech industries: ICT (22 percent), biotechnologies (8 percent), machine-building (7 percent), chemical technologies (7 percent) and instrumentation engineering (7 percent). The fund does not support absorption of technology.[33]

Due to the overall fiscal adjustment in Bulgaria, the budgets of the NSF and NIF were severely cut in 2009-2010, leaving no room for new calls for proposals. The funding of most projects was significantly reduced, the advance payments of a large number of projects were delayed, and the NSF held no new calls for research proposals. The funding of BGN 50 million in 2010 is allocated to be spent on ongoing EU-supported projects and national projects for which contracts were signed in

[33] The NIF does not support e.g. investment projects, which are focused on purchase of machines, equipment, materials, buildings etc.; development of a product or service which is ready for the market; etc.

2008 and 2009. This budget cut has impaired the continuity of scientific activities. After 2008, the NIF also operated only in respect to previously signed contracts, and no additional calls for proposals were made.

Box 10: Personal Viewpoint—Senior Bulgarian Researcher

I have a teaching position at one of the top universities in Bulgaria where I lead several research projects financed with EU funds as well as private businesses. I involve doctoral students in these projects, as it gives them access to international knowledge. It also motivates the students to stay in Bulgaria and continue their research work, as they receive bonuses on top of their low monthly stipends. Because winning international research projects is difficult, we need a strong national funding instrument to help build a solid research community. Right now the National Science Fund (NSF) does not have the resources to promote sustainable change. For Bulgarian scientists to be an equal partner in the European Research Area, a stronger commitment from Bulgarian policymakers would be needed.

Source: Interview by the authors.

Before fresh resources are allocated, it is important to assess the strengths and weaknesses of these instruments, and take measures to strengthen their future performance. The Scientific Research Strategy points out that unpredictable funding and lack of coordination between the two instruments limit the results seen to date. Another major challenge is increasing the project pipeline, given the weak capacity of many beneficiaries (companies as well as research and educational institutions). An assessment carried out by the ARC Fund based on data from the granting process and discussion with beneficiaries reveals a number of specific strengths and weaknesses in the operation of the NSF and NIF (see Table 9 and Table 10).

Table 9: Taking Stock of the Strengths and Weaknesses of the NSF

Strengths	Weaknesses
• Established institution with a solid history and strong support base. Activities have been subject to international evaluation. • Awareness of the importance of program-based competitive funding and an increase of funds for scientific research granted on a competitive basis. • Active leverage of European Framework Programmes through specialized mechanisms to support scientists in their preparation and implementation of such projects. • Introduction of thematic and infrastructural competitions, making it possible to concentrate resources in areas of high value for economy and society. • Specialized scholarship programs for young researchers and qualification schemes for established scientists. • Support for strengthening research capacity in universities.	• No mid- or long-term budget planning. • NSF priorities could be better linked to solving social and economic problems, and could be better coordinated with the National Strategy of Scientific Research and EU Framework Programmes. • Reviewers prepare generic, unspecific project reviews that do not provide clear assessment of the qualities of the project. • The criteria for objectivity and avoidance of conflict of interests are not properly observed (e.g., members of the commissions to the NSF are involved in the implementation of some projects). • Patents and other IPR which are developed as a result of NSF funding are not sufficiently protected. • No regular evaluation of programmatic impact.

Source: ARC Fund Technical Note (2010) commissioned by the World Bank.

Table 10: Taking Stock of the Strengths and Weaknesses of the NIF

Strengths	Weaknesses
• NIF supports a pipeline of 381 projects from different sectors of the economy, both high-tech and traditional, which have leveraged BGN 30 million in matching private R&D. • A legal framework for the management and operation of the fund has been established. NIF has been certified by the relevant national and European bodies. • The establishment of consortia among enterprises, universities and research organizations strengthens the link between researchers and businesses and promotes trust between the partners. • The funding process helps develop the capacity of Bulgarian enterprises to plan and implement projects. • The co-funding and reporting requirements force the enterprises to report their actual financial status and improve compliance with social security payments.	• There is a lack of procedure for determining the priorities of the Fund as well as one for reporting these priorities during project evaluation. • The NIF is not an autonomous legal entity. As such it is unable to manage its own resources or to co-finance approved European projects. • The management of NIF's financial resources is on an annual basis, while some contracts have a three-year duration. • Only a small number of the projects are based on previous research projects. There is no link between NIF and NSF. • As of 2008, NIF has been operating only with the contracts that were signed in previous years. • There is no evaluation of the results of projects that have been subsidized by the Fund after their conclusion.

Source: ARC Fund 2010 Technical Note, commissioned by the World Bank.

Preparing an evaluation for the grants awarded to date under both the NSF and the NIF is an immediate priority. The evaluations of NSF and NIF have been focused on procedural assessments and not evaluations of the performance and impact of the grants. The emphasis has been on reporting and authenticating project costs rather than monitoring the results. Although many of the recent calls for proposals included international peer review in the granting process, there has been no evaluation of the results obtained by the projects. Before the Bulgarian government channels increasing amounts of public funds to these programs, it is important to undertake independent evaluations of results. The lessons from similar programs in the USA and Israel provide useful pointers about the elements the evaluation should focus (Box 11).

Box 11: Lessons Learned from OECD Countries that Support Commercial Innovation

OECD countries have been experimenting for decades with several instruments to support commercial innovation, among which the US SBIR program and Israel's MAGNET and Yozma programs stand out because of their scale and perceived success. Many ECA countries, especially new EU member states and accession candidates, already operate variations of these schemes, but these have often encountered implementation problems such as those we identify in Bulgaria. Three principles emerge from OECD experience in effective program design:

First, it is essential to evaluate the *institutional environment.* The design of new instruments needs to account for the existing institutional environment, with an emphasis on weighing the benefits and potential for effective restructuring of existing instruments against the advantages of creating new institutions and instruments from scratch. An optimal instrument design should include the following key elements:

- The administration and funding decisions are located in independent institutions
- The funding decision is made by an independent investment committee
- The investment policy and decision processes are instituted and supervised by a supervisory board consisting of representatives of different government institutions and international advisors
- Technical assessments of the project proposals are based on external peer reviews involving international experts where possible

Second, it is vital to provide *additionality.* Government interventions need to be carefully designed so that they do not crowd out private investment and funding sources. Although financial market failures can be identified, especially in the early stages of innovation, the smaller the distance of the innovative process from the market and the higher the probability of market success, the higher the probability of financing from mainstream financial intermediaries. It can be argued that the important principle of matching may prevent or at least mitigate crowding out. Projects closer to commercial application should be funded by venture capital or other private sources. As much as possible interventions should be designed to promote private risk taking and stimulate the private risk-capital market.

Third, it is critical to pursue *neutrality*. The program should not try to steer the grants (or other instruments) in any predetermined direction, but rather should try to deploy them in such a way as to maximize spillovers or social returns. The success of R&D support programs in Finland and in Israel is in large measure attributed to the fact that the policies implemented were largely neutral in that sense. There were still instances of targeting, but the thrust of the policies remains neutral. Today, Finland has established specific sector programs; however, the emergence and selection of these specific sector programs are driven by an ex-post recognition of clusters that have emerged in a neutral and competitive policy environment.

The evaluations should lead to concrete recommendations about which NSF and NIF programs need to be redesigned or eliminated, and which programs could be scaled up. At this point, it is not possible to pinpoint which programs have generated the best results. An independent evaluation should recommend which programs need to be re-designed or eliminated and which can be continued and scaled up. In the process, it would be important to identify opportunities to consolidate funding into larger pots as these are easier to administer and can have a more transformational impact. The Millennium Science Initiative, which funds large programmatic research projects and centers of excellence, could be a useful reference point for reforming the scientific research funding at the NSF (see Box 12). In the case of the NIF, in addition to grants to R&D projects it would be useful to foster the creation of dedicated, formal R&D units and laboratories in companies.

Box 12: Developing Centers of Excellence at the Millennium Science Initiative

The Millennium Science Initiative in Chile supports the creation and growth of centers of excellence. This is a Competitive Grant Program that launches regular calls for proposals to invite groups of researchers from universities and research institutes to work within Science "Institutes" and "Nuclei."

- Millennium Institutes comprise a Director, a Deputy Director, about 10 associated researchers plus senior and young researchers, graduate students, postdocs, and support staff (about 50 in total). The Institutes have an initial duration of five years, renewable for an additional five-year period, subject to the approval of periodic evaluations and to an exhaustive evaluation at the end of the fifth year. Annual funding is about $1.2 million.
- Nuclei are smaller and have a shorter duration. Each consists of a lead researcher, a deputy lead researcher, two or more associated researchers and a corresponding number of senior and young researchers, graduate and post-doctoral students, and support staff (about 25 in total). Nuclei last for three years, after which they can apply for a renewal for an additional three-year period. Annual funding averages $0.27 million.

The two-stage selection process for the centers that will receive funding relies on evaluations by committees formed of distinguished foreign scientists. This selection process has been accepted by the scientific research community as a fair, open, and merit-based system. The administration of the initiative is also recognized as being financially efficient (94 percent of the fund goes to Institutes and Nuclei and only 6 percent to management) and well administered (grants processing is faster than in other institutions).

Source: World Bank (2002).

Additionally, steps need to be taken to improve the capacity and operational performance of the entities responsible for the instruments. Interviews with experts administering the NSF and with beneficiaries suggest a need to increase transparency during evaluation and periodic and final reporting.[34] At the request of the NSF, the World Bank prepared a policy brief with recommendations to improve its competitive grant programs (Annex 4 provides a summary). Interviews with NIF experts and beneficiaries underline the importance of increasing the overall budget of the fund and the funding limits for projects to cover the increasing costs of innovation, increasing the administrative capacity of the agency administering the NIF so that it can meet the needs of the private sector.

An Innovation Law is being drafted by the MEET which would create a new Innovation Fund. In 2010, the MEET announced that the ministry is preparing a new Innovation Law to support the strategy by improving the institutional and policy framework for innovation. One of the proposals is to establish a new, more capable institution to take over the programs from the existing NIF. This new instrument would likely be in the form of an agency with a stronger legal basis that can also play a lead role in terms of the EU-funded programs supporting innovation.

Going forward, the Government could consider merging the NSF and NIF into one national agency to support research and innovation projects. Having a single entity ("one stop shop") would simplify the process for beneficiaries, who could be informed about the full range of financial instruments they can apply for, and would face uniform rules. It would also improve coordination and make it easier to build capacity in the public administration.

[34] Specifically, NSF beneficiaries highlight the following areas for improvement:
- Strict application of the NSF rules to avoid conflicts of interest arising from the participation of the same persons in the management of the fund and the evaluation of the project proposals and the research teams;
- Involvement of a larger pool of national experts in the evaluation of project proposals to exploit the existing capacity in research institutes and universities outside Sofia;
- Expanding the pool of international experts involved in the evaluation of project proposals;
- Development and adoption of mandatory criteria for evaluating proposals to ensure transparency;
- Keep the time-frame for evaluation of proposals as well as for reports as per the program of the Fund;
- Increase flexibility in projects budgets, as actual costs are calculated at the outset and changes in the cost of labor, materials and equipment can create significant difficulties for the performance of the projects.

Working closely with beneficiaries will be essential to sustain the quality of proposals if funding is scaled up. The track record to date underlines weaknesses in the capacity of beneficiaries, both in terms of the quality of the proposals—as reflected in the high percentage of rejected projects during the first phase of administrative eligibility—as well as in their ability to utilize the required funding.[35] Beneficiaries often overestimate their potential human resources, and in the case of private enterprises, their financial sustainability and ability to provide the necessary co-financing. Additionally, most SMEs do not have experience with innovation and do not have the capacity to develop successful partnerships with research institutions.

II. D. Increasing the effectiveness of EU funds targeting innovation

EU funding, primarily through OP Competiveness, is the main source of financing for innovation in Bulgaria, but absorption has been slow with only 36% of funds contracted.

Short-term actions:

- Improve administrative capacity and incentive structure for the calls for proposals in OP Competitiveness
- Develop IT systems and support tools for businesses to improve the quality of the project applications for competitive grants
- Develop a rating system for consultants that work with beneficiaries of OP Competitiveness to promote improvements in the quality of external support
- Channel some of the existing EU funds to larger-scale projects such as technology parks

Medium-term action:

- Improve the EU-funded instruments and schemes for the framework period 2014–2020, for example, by creating a dedicated OP for Research and Innovation

EU structural and cohesion funds are the main source of fresh public funds available for upgrading and modernizing Bulgaria's economy. With the onset of the global economic and financial crisis in Europe, the country has seen a sharp drop in FDI, halting the restructuring of its economy. Hopes for restoring growth and upgrading Bulgaria's economy have been pinned on absorbing EU funds. Bulgaria is entitled to some €8 billion of EU assistance for the period 2007–13 divided between 7 operational programs. Ensuring timely and well-targeted absorption of EU funds is critical for upgrading the country's economy and alleviating the negative impact of the global financial crisis.

The Operational Programme "Development of the competitiveness of the Bulgarian economy" (OP Competitiveness) is the main source of EU funds for research and innovation,[36] but

[35] In the NIF, approximately 9 percent of submitted applications were disqualified due to administrative non-eligibility and another 30 percent of submitted projects were evaluated as ineligible based on the capacity of the applicants and the eligibility of the project idea. The main reasons for rejection were that: beneficiaries did not possess the technical, organizational and financial resources in order to implement the project (considerable co-financing is necessary to implement the projects, and therefore the applicants need to show positive financial results for the previous financial years); projects were not innovative, and were seeking funds for investment; the description of aims, phases, activities and tasks of the project did not comply with the requirements of the application form.

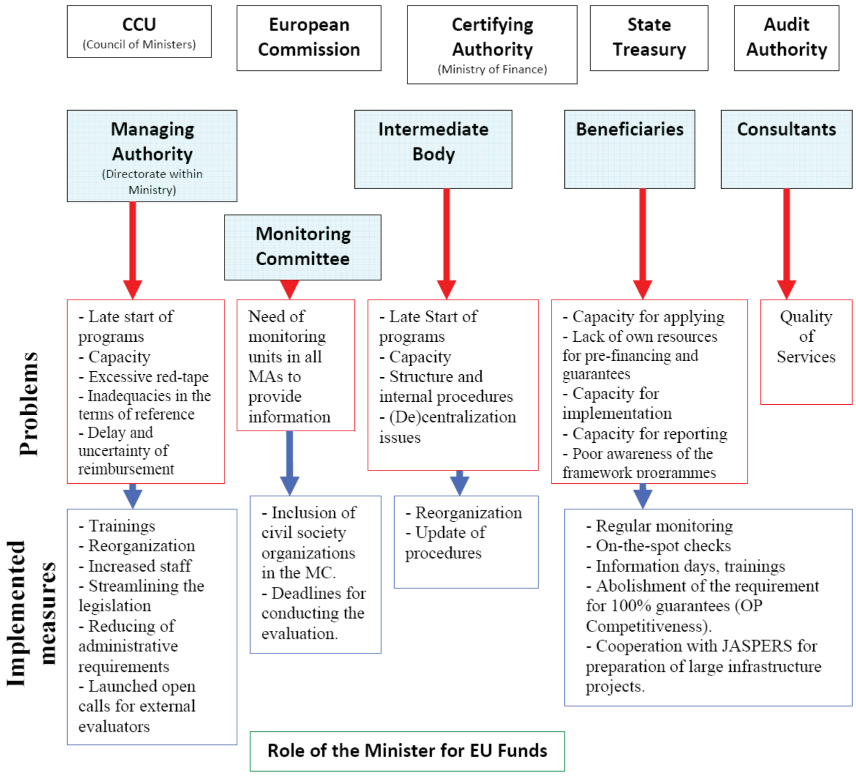
[36] Alongside earmarked OP resources, Bulgarian organizations can access EC Framework Programs, but because projects are allocated competitively at the EU level, they are much harder to access. According to the *Innovation Union Competitiveness report 2011*, as of March 2011, Bulgarian scientists participated in 337 projects awarded funding under the current Framework Programme for Research and Technological Development (FP7), which runs from 2007–13. The EC financial contribution for Bulgarian participants amounts to €54 million, a large share of which supports small research projects. Universities have the largest participation, followed by the Bulgarian Academy of Sciences, NGOs, and government agencies. SMEs have received funding for 131 projects with an EC contribution of €19 million. The increasing access to EU competitive resources is a positive development, but the success rates for scientific proposals (17 percent) and SMEs (14 percent) are still much lower that the EU average.

absorption has been slow. The total budget of OP Competitiveness for the period 2007–13 is €1.2 billion (of which 85 percent is from the European Regional Development Fund and 15 percent is in national co-financing). A total of 55.8 percent of the resources under OP Competitiveness are dedicated to upgrading by enterprises and innovation. As of May 2011, about 36 percent of the total budget funds have been contracted and 21 percent have been paid out. So far no assessment has been done on the impact of the program on beneficiaries and the wider economy due to relatively low disbursement levels.

Absorption of EU Funds for innovation has been delayed by several implementation problems. Initially, the low administrative capacity of the teams supervising the calls led to the late launch of the programs, faults in the terms of reference, delays in contracting, and delays and uncertainties in reimbursement procedures. Excessive red tape and restrictive eligibility criteria—in particular, the high co-financing and bank guarantee requirements for advance payments and cumbersome reimbursement procedures—have discouraged potential beneficiaries from applying. Another challenge has been the poor awareness of program requirements and weak capacity of beneficiaries to execute the project, especially because of the lack of resources to pre-finance project activities.

The government has put in place numerous measures to improve the implementation performance of EU-funded Operational Programmes (OPs). As shown in Figure 15, the government entities responsible for implementing the OPs, in coordination with the EC, have introduced measures to reinforce the capacity of the administration, particularly the intermediate body for OP Competitiveness, the Bulgarian Small and Medium Enterprises Promotion Agency (BSMEPA), which has experienced difficulties regarding administrative and organizational procedures. Additional measures include reorganizing and streamlining procedures, developing regular dissemination and monitoring for beneficiaries, and eliminating the financial guarantee requirements.[37]

Figure 15: Low Absorption of EU funds: Identified Problems and Implemented Measures



Source: ARC Fund 2010 Technical Note, commissioned by the World Bank.

[37] See the *Strategic Report of Republic of Bulgaria for 2009*, Annex 1 on Identified Difficulties in the implementation of the programs and the measured undertaken for overcoming them. Available at: http://ec.europa.eu/employment_social/esf/docs/strategic_report_bulgaria_2009_en.pdf.

At the ministerial level, the appointment of a Minister of EU Funds Management has strengthened the coordination of EU funds. The minister without portfolio is supported by four directorates at the Council of Ministers. The coordination role is both internal (the minister chairs the Council for Coordination of the Management of EU Funds, which gathers all ministers responsible for OPs), as well as external (the minister is the central representative of Bulgaria to the EC and other EU bodies for programming, management, and monitoring of EU funds.)

However, implementation capacity within the public administration remains uneven and would need to be reinforced by hiring experts with the right credentials. BSMEPA experts do not count with the right profile to design, run and evaluate innovation support programs. In part, this is because of personnel turnover, as new OP experts entering the Ministry and the Agency require training to cope with the workload. But it is also because the BSMEPA has not been able to attract personnel with sufficient technical and commercial experience. Based on the lessons from World Bank innovation projects with matching grant schemes supporting innovation, it would be useful to hire several experts with masters or doctoral-level degrees in fields relevant to the designated priority industries, and who have experience in technology commercialization, preferably obtained in private R&D laboratories or consulting.

By improving the effectiveness of the public administration, it will be easier to cope with the weak capacity and insufficient information among beneficiaries. First-time applicants to the EU-funded calls for proposals are typically not familiar with the procedures and selection criteria that will decide the success of their application. This is particularly true of the private sector, as researchers are increasingly competing for national and European resources through this type of mechanism. A streamlined process can encourage participation, but what is really needed is an excellent online system to submit the proposals and trained experts that can quickly respond to any questions. The goal should be that no beneficiary is left out purely for failing to fill-in the proposal forms as required, or failed to be reimbursed due to erroneous reporting. Because the project pipeline for these calls for proposals depends as much on word-of-mouth in the research and business community as it does on advertising in the newspapers, having a high satisfaction rate is a priority and could be measured through regular surveys.

Developing a rating system for consultants that work with beneficiaries would promote improvements in the quality of external support funded by OP Competitiveness. The consultancy market in Bulgaria has boomed in recent years, in particular in relation to EU accession, but the level and depth of expertise differ widely. Identifying and testing a reliable consultant is still quite a challenge for OP beneficiaries, and few provide quality complex services (e.g., elaboration of the cost-benefit analysis of projects) and possess deep knowledge of EU Funds rules as pertains to innovation projects. Outside major cities, beneficiaries often employ poorly prepared consultants. Developing an online rating system where beneficiaries can provide their feedback about the support they received would reduce the information asymmetry about consultants' quality.

The matching funds required by the EU-funded calls for proposals make it particularly critical for firms to be able to raise private funds. Inability to access external finance was one of the main reasons (the other being administrative reasons and bureaucracy) for enterprises failing to find co-financing to participate in the calls for grant funding, or for dropping-out after being selected.[38] This problem was also highlighted in the analysis of enterprise surveys in Part I. Because of the conservative banking environment and the lack of venture capital, firms have few private funding sources other than traditional collateral-backed bank loans. With few choices for funding, if a venture fails, enterprises face the dire consequences of losing their collateral and/or facing bankruptcy.

[38] This also affects the Bulgarian participation in the Competitiveness and Innovation Framework Program (CIP), which can support innovation activities (including eco-innovation) by SMEs. More involvement in this program would help Bulgarian companies to connect to EU level initiatives.

Bankruptcy itself carries a much larger stigma in most European countries than in the United States and can entail more long term consequences when financing is so strictly tied to the banking industry.

The Joint European Resources for Micro to Medium Enterprises (JEREMIE) initiative will directly support access to finance for SMEs and enlarge private risk financing. In 2010 the Bulgarian National Assembly ratified the agreement[39] between Bulgaria and the European Investment Fund (EIF) for the implementation of the JEREMIE Programme, which is funded by OP Competitiveness. The new partnership will provide substantial volumes of risk finance for businesses. Through this initiative, the financial institutions and fund managers will build their capacity to allocate funding to risky, innovative projects, which could help to mitigate the access to finance constraint. See Box 13 for details about expected implementation of this initiative.

Box 13: The JEREMIE Initiative

A holding fund with capital of €199 million is registered under the JEREMIE Initiative to manage funds on behalf of the Bulgarian government. The JEREMIE Holding Fund is foreseen to exist for 10 years, targeting SMEs that have their main economic activity in Bulgaria. Three funds for equity investments in the Bulgarian economy will be set up as part of the holding fund, namely for small start-up companies (venture capital), for small companies in the process of development (growth equity), and a mixed instrument between equity investments and loans (mezzanine).

It is envisaged that the Fund for small start-up companies will begin operations with a capital of €30 million. The JEREMIE Fund will contribute €21 million of this capital, and the remaining amount will come from external financing. The Fund for small start-up companies will invest up to a ceiling of €1.5 million annually in a business, while there is no such restriction for the other two funds. The growth equity and mezzanine funds will have a capital of €60 million, half provided by JEREMIE and half to be secured by their future managers. The ability to raise this additional financing will be one of the criteria for selecting the risk fund managers.

Reformulating the OP funding instruments based on the lessons to date and experiences of other countries will facilitate future absorption. As part of the mid-term review process, the MEET is considering moving funds away from smaller competitive grant programs–where the pipeline has proved an obstacle for disbursements—to infrastructure projects such as technology parks where large contracts can be executed by capable contractors. By using a more proactive approach that develops fruitful partnerships among a variety of businesses and government, the MEET could facilitate the implementation of large-scale projects. This could include a flagship project of world-class standards that integrates science and industry and would be designed to attract the international scientific community. It would be particularly advantageous to carry out such a project in the current programming period (i.e., by 2015) so it serves as a model for subsequent projects.

During the discussions for the 2014–2020 programming cycle, the government could consider creating a dedicated OP for Research and Innovation. The redesign would increase the synergies between OP Competitiveness and OP Human Resources Development. New EU regulations for the 2014–2020 cycle are expected to allow member states to build an Operational Programme which would be co-financed by both the European Regional Development Fund (ERDF, currently funding OPC) and the European Social Fund (ESF, currently funding OP HRD). Bulgaria should be able to take advantage of this new structure to further leverage EU funds. Lithuania recently redesigned its innovation programs to strengthen accountability, to create a more strategic and coherent results framework, and to ensure that instruments are tailored to the capacity on the ground (Box 14).

[39] The Memorandum of Understanding for the JEREMIE, JASPERS (Joint Assistance to Support Projects in European Regions) and JESSICA (Joint European Support for Sustainable Investment in City Areas) Programmes in Bulgaria was first signed in 2007.

Box 14: Lithuania's Experience in Re-designing European Programs for Innovation

Lithuania is an example of an ECA country that has recently redesigned its EU Structural Fund programs, shifting instruments from specific objectives to an umbrella which covers a wide range of activities in areas with perceived R&D potential. Its program focuses on the development of R&D infrastructure, human resources, and environment, structured through four components:

- R&D Programme for Cooperation between Public R&D and Business Sectors—Integrated Research, HE and Business Centers (Valleys) with a budget for 2007-2013 of €218.06 million.
- Common National Integrated Programme—12 national integrated programs in R&D-intensive economic sectors with a budget of €97.43 million.
- Researchers Career Programme— professional improvement of researchers at all stages of their career with a budget of €182.5 million.
- National Higher Education Programme—skills and competences of students and professors, investment in study infrastructure—with a budget of €221.28 million.

The R&D Programme for Cooperation Between Public R&D and Business Sectors is supporting the establishment of five science valleys—i.e., integrated science, study, and business centers—that are intended to boost collaboration between Lithuanian scientists and local and foreign companies.

The aim is to create a more modern R&D infrastructure, develop an internationally competitive research agenda, foster active science and business cooperation, and establish the conditions for commercialization of scientific results. The creation of valleys will be funded by EU structural funds, Lithuanian national funds, and private investments.

Each valley will develop specific scientific research trends including IT, financial, business and other consulting services, engineering technologies, chemistry and food industry, energy and electronics industries, biotechnologies, and medicine and pharmacy. The Ministry of Education and Science will allocate about €240 million. About 40 percent of the funds will be allocated to renovate infrastructure, and the rest to update scientific equipment. Another €152 million will be spent on scientific research and human development.

Source: Intelligentsia Consultants (2008), Putinaite (2010).

II. E. Developing targeted innovation policies and instruments for priority sectors: The cases of pharmaceuticals and the IT industry

Pharmaceuticals and IT are priority industries for Bulgaria because they are already large recipients of FDI and generate skilled jobs and exports; with appropriate support there is great potential to increase the R&D-intensity of these industries.

Short-term actions:

- Train more highly-qualified specialists through a close partnership with lead firms that offer training to higher education institutions and schools.
- Establish grants to retain young Bulgarian scientists and attract international experts in these priority industries.
- Support the development of R&D centers in partnership with international pharmaceutical and IT companies.

Medium-term action:

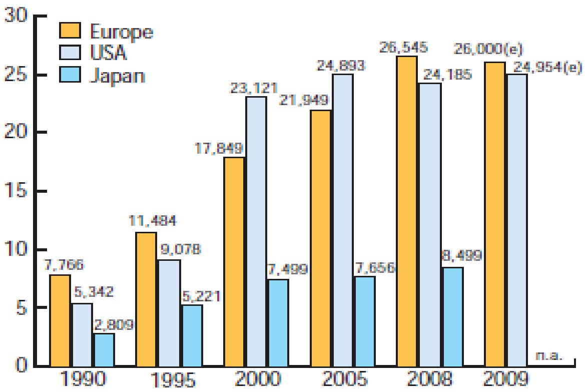
- Scale-up the NSF and NIF with new funding windows for priority sectors such as pharmaceuticals and IT.
- Improve the Business environment for the pharmaceuticals and IT industries.

This section provides an assessment of the innovative potential of two priority industries, pharmaceuticals and IT, and proposes policies to stimulate R&D in these industries. Pharmaceuticals and IT have been selected as priority industries in terms of attracting FDI and their potential to develop innovation based on Bulgaria's research specialization. The industries are among the seven priority sectors/clusters identified by the MEET for FDI attraction: IT and outsourcing, chemicals, electronics and electrical, transport equipment, machine building, agri-food, and healthcare. In parallel, the Scientific Research Strategy prepared by the MEYS also identifies these areas as part of the five research priorities to develop by 2020: (i) energy, energy efficiency, transport, green and eco technologies; (ii) biotechnologies and ecological food; (iii) new materials; (iv) cultural and historical heritage; (v) ICT.

Developing innovation policies and instruments for the Pharmaceutical industry

The Bulgarian pharmaceutical industry needs to be looked at through the prism of the European industry. In Europe, the research-based pharmaceutical industry is the leading high-technology industry, accounting for 16.5 percent of EU R&D investments and about 3.5 percent of EU manufacturing value added in 2008.[40]. In spite of the impact of the global financial crisis, the R&D activities of the European pharmaceutical industry increased by 5.3 percent.[41] According to 2009 estimates of the European Federation of Pharmaceutical Industries and Associations (EFPIA), the industry generates 630,000 jobs, including 113,400 in R&D facilities, which generate €26 billion in R&D investment (see Figure 16). It is a source of Europe's export competitiveness, with a trade surplus of €55 billion in 2009 compared to €7.1 billion in 1990.

Figure 16: Pharmaceutical R&D in Europe is larger in the United States and Japan (in €million)



Source: EFPIA member associations, PhRMA, JPMA.

Note: e= estimate, current exchange rate.

Bulgaria's pharmaceutical sector generates many skilled jobs, including a growing number in clinical trials. The Bulgarian pharmaceutical industry generates about 20-25,000 jobs,[42] including about 3,000 in R&D. These researchers work in private labs and are involved in clinical trials, which have increased as leading MNEs outsource trials to Bulgaria due to lower costs. Interviews with company managers indicate there are about 140 clinical trials per year, each costing €50,000, for a total annual expenditure of about €7 million. About ten companies engage local researchers to conduct clinical trials in Bulgaria, although the research results are not necessarily employed by local R&D labs. These companies tend to have limited staff and are primarily engaged in administering clinical trials.

At the same time, large pharmaceutical producers spend a small fraction of their annual turnover on R&D. The foreign-owned Actavis and the domestically-owned Sopharma deploy a small fraction of their annual turnover (about 5 percent) in R&D. A budget of €1–2 million per year for development activities is the standard for large Bulgarian generics producers, as opposed to the multibillion budgets of leading MNEs in the pharmaceutical industry. Bulgarian companies primarily

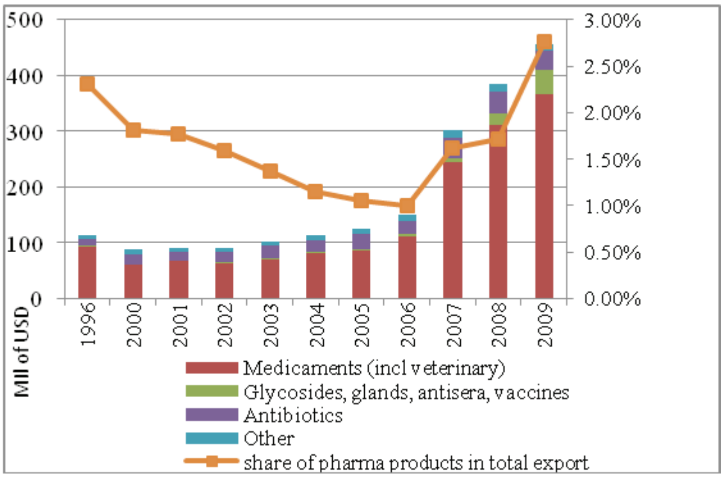
[40] The software and computer services industry in Bulgaria takes a second position with 9.6 percent of EU R&D investments, as per 2009 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG Research.

[41] Key figures from the 2010 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG Research.

[42] Data provided here is an approximation based on interviews carried out with the industry.

produce generic drugs, and their studies remain focused on proving bioequivalence between generic and patented drugs.[43]

Figure 17: Export of Bulgarian pharmaceutical products tripled in the last three years



Source: UN Comtrade.

Pharmaceutical exports increased sharply in the last five years, which could signal a turning point in terms of the industry's regional competitiveness (Figure 17). While the total European pharmaceutical market stands at €147 billion (at ex-factory prices) in 2008, the Bulgarian market is one of the smallest at only €617 million, although the retail market in Bulgaria is growing at a fast pace.[44] The industry's growth has outpaced domestic sales, and Bulgaria is now an export hub for the two leading companies, Actavis and Sopharma, both of which have substantial exports in generic drugs to Russia and CIS countries. The major importers of Bulgarian drugs are Russia (27 percent of total exports), Romania (11 percent), Croatia (8 percent), Ukraine (7 percent), and Germany (6 percent).

Specific hurdles to the development of the pharmaceutical industry include:

- **Administrative hurdles after patents expire delay manufacturing of new generics:** There are substantial delays for manufacture of new generic drugs after patent expiry caused by regulations in Bulgaria. The capacity of the relevant regulatory bodies, such as the Bulgarian Drug Agency, would need to be improved to ensure compliance with EU legislation relating to marketing authorization, maximum time-limits for pricing, and reimbursement decisions.

- **Distribution of imported medical products of doubtful quality forces local producers to compete on price:** The majority of SME producers of generic medicine in Bulgaria purchase medical dossiers from companies in other countries such as China, India, and Turkey. Interviews with Bulgarian pharmaceutical producers raise questions about the quality of the registration process and therefore the ultimate quality of the drugs being imported, and the manufacturers are concerned that these undermine their competitiveness.

- **The lack of homegrown innovation endangers long-term competitiveness.** R&D in this field used to be carried out in state-owned enterprises and at the Bulgarian Academy of Science (BAS). Former RDIs such as the Chemical Pharmaceutical Research Institute (now part of Sopharma) and BAS institutes continue to be active in R&D[45], and medical universities are playing an increasing

[43] There are substantial forms of innovation in the generic products sector, but research activities to develop innovative molecules have never been a priority in Bulgaria due to the high costs (€1 billion on average per molecule) and long timeframes which can run to 10 years of R&D.

[44] The retail market climbed from €350 million in 2002 to €878 million in 2009 and a forecasted €948 million in 2010.

[45] The ESF/ALLEA independent assessment of BAS notes that one third of the BAS life-sciences institutes have scientists producing internationally competitive research, but the publication record and impact are still weak compared to top EU institutions.

role. The biggest problem is that the R&D results are not turning into patents, and they are not being commercialized. Collaboration with R&D-intensive international drug companies also remains extremely limited.

- **Demand for public support instruments is weak.** Few Bulgarian pharmaceutical companies or public research organizations participate in national (NSF, NIF) or EU support instruments (schemes under OP Competitiveness and FP7 R&D program in life sciences and the new Innovative Medicines Initiatives). According to our interviews with the pharmaceutical industry and researchers, deficient program implementation, specifically at the stages of selection and reimbursement, are key issues.

Developing innovation policies and instruments for the IT industry

Bulgaria's computer industry was sizeable prior to 1990. The country was the leading producer and supplier of personal computers to socialist countries. The situation changed with Bulgaria's transition to the market economy: liberalization in Bulgaria and in countries that used to buy the IZOT mainframes and Pravetz personal computers (Figure 18), privatization, the lack of an IT strategy, and inadequate financing led to the dismantling of the computer industry. Exports of computer hardware all but disappeared.

Figure 18: The Pravetz 8C personal computer

Two decades later, the IT industry is growing again and it has become a priority sector for the Bulgarian government. The Bulgarian Association of Software Companies (BASSCOM) estimates there are about 700 companies in the software industry. The software companies generate around 2 percent of GDP, employing 15,000 IT specialists, who earn 4–5 times the average salary in other sectors. The Bulgarian IT industry is recognized on the global market for offering quality. Top IT specialists who left the country 10–15 years ago, followed the wave of development of the IT industry in Bulgaria and started to come back, taking senior positions in foreign and domestic IT companies.

FDI in the IT industry gained pace in the early 2000s. The Bulgarian IT industry became an outsourcing partner for foreign companies, who took advantage of the cost effectiveness it could provide. But in the past 3–4 years the industry has been gradually moving toward its own product development, thus retaining more value added for the local economy. Leading global companies (e.g., IBM, Microsoft, CSC, SAP AG, HP, VMware) have entered the Bulgarian market, investing millions of dollars and generating thousands of jobs.

Foreign investments include R&D-intensive facilities that have greatly boosted Bulgaria's patenting track record. R&D-intensive investments include a Technology Support Center in Sofia established by HP, which created 3,000 new jobs, and SAP Labs Bulgaria and SAP Research Group, which were established in 2000 and 2010 respectively. As mentioned in Part I, this entry into the industry has been critical in proving that Bulgaria's research potential in the IT sector can be developed in a short period of time—for example, Bulgarian developers working as part of multi-national teams in SAP have already been granted 91 patents in the USPTO since 2007 (out of 116 total patents awarded to Bulgarians in this period).

Domestic IT companies are mainly small but flexible. Large domestically-owned IT companies (e.g., Sirma Group, Information Service JSC) are among the key players on the Bulgarian market, but most of the local companies are small and flexible, offering a variety of products including accessories and consumables, audio- and video-conferencing systems, PCs, servers and mini-machines, control and measurement systems, network components, multimedia systems, IS re-engineering, IT consulting, and complex B2B solutions.

The IT industry has developed training programs that could enlarge Bulgaria's potential to become a regional hub of excellence. The European Software Institute Center Bulgaria[46], a center of excellence which opened in 2003 with multi-million dollar seed funding from USAID and UNDP is today a successful business venture, operating in 10 countries in South East Europe and the Caucuses. Over 1,000 professors and students have been trained through IT courses, voluntarily provided by experts of the center. The center offers Capability Maturity Model Integration (CMMI) business practice, making Bulgaria the only South East Europe country on the CMMI map. Global companies are also providing training in order to build a solid corps of Bulgarian IT engineers in the future.[47]

There are several key challenges to the continued growth of the IT sector in Bulgaria:

- **There is a shortage of skilled specialists that can work in the IT sector.** The availability of skilled and relatively inexpensive human capital played a critical role in attracting global companies to Bulgaria in the past decade. However, our interviews with companies in the IT sector suggest that skills shortages have been an issue for the past 3–4 years. Currently, 6,000 new IT specialists are graduating each year in Bulgaria from about 30 universities, and there are about 9,000 IT-certified professionals on the market, but IT sector requires specialists who are better trained and qualified.

- **The regulatory burden is high for firms in the IT industry**. Although the overall burden that regulation imposes on managers in Bulgaria has fallen in recent years, a significant concern is the predictability of how regulations are enforced and interpreted (World Bank 2010). The average senior manager of a manufacturing firm reported spending only about 5 percent of his/her time dealing with regulation, compared to 11 percent for managers of IT firms.

- **The overall IT infrastructure has improved, but there are still some weaknesses with regards to internet penetration.** According to *Europe's Digital Competitiveness Report 2010*, Bulgaria is one of the European leaders in broadband speed and e-Business applied to HR services. Yet, Bulgaria ranks very poorly in the EU for internet penetration in residential and enterprise sectors, e-Government, and e-Commerce. Making IT more readily available to the larger population will help build the industry and promote knowledge development.

- **National instruments proved useful for the IT industry, but so far there has been weak demand for EU-funded instruments.** A significant proportion of the competitive grants under the NSF and the NIF were won by IT companies between 2005 and 2008. Bulgaria's IT sector has also benefitted from EU Framework Programme (FP) grants. This is because IT companies tend to be more entrepreneurial and the development projects tend to be well suited in terms of size and scope to benefit from this type of grant. But few Bulgarian IT companies have participated in OP Competitiveness calls for proposals.

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[46] The European Software Institute is based in Bilbao (Spain) and is a partner of the Software Engineering Institute, Carnegie Mellon University.

[47] For example, VMware Bulgaria, a subsidiary of the Silicon Valley firm specialized in cloud infrastructure solutions, offers a free VMware Certified Professionals (VCP) course through their IT Academy. Over 1,200 schools and 8,000 students are using the eLearning part of the VMware IT Academy, while over 200 schools are participating in the Instructor-Led part of the IT Academy program and over 3,000 students have been trained and are candidates to become a VCP.

Policy recommendations for the Pharmaceutical and ICT industries:

- **Maintain a strong position for Bulgaria's pharmaceutical and ICT industries by training more highly-qualified specialists.** The training programs currently offered by firms or associations like BASSCOM, in partnership with leading universities in Bulgaria, are a positive step forward. However, more support could be given to these efforts by offering financial support to universities for training faculty and students, and encouraging upgrading of the scientific education programs at high schools and universities.

- **Strengthen the scientific capacity of research organizations.** Capacity to cooperate with the private sector could be developed by recruiting and retaining young Bulgarian scientists and attracting internationally-recognized experts who can redirect the research agenda into more competitive areas. International recruitment would accelerate the integration of the Bulgarian research and innovation system into the European Research Area and increase the success rate of Bulgarian researchers in all parts of the Framework Programme 7. These international researchers would not only train highly skilled Bulgarian students in science and technology—and thereby increase the talent pool required for attracting private R&D investments—but would also directly connect Bulgaria with private R&D investors from abroad.

- **Scale-up the NSF and NIF to better target priority sectors such as pharmaceuticals and IT, and create a better platform for using instruments from European initiatives.**
    - Increase funding under the National Innovation Fund and the National Science Fund that could be allocated in targeted windows for IT and pharmaceuticals.
    - Improve OP Competitiveness' guidelines and conditions for programs that fund SMEs, by allowing clusters that are currently not eligible for funding under OP Competitiveness to apply for funding in the "Support for the development of clusters in Bulgaria" program.
    - Companies in the Bulgarian IT industry can benefit from participation in European initiatives, like the Future and Emerging Technologies (FET) Flagship Initiatives, programs that fund innovation by IT companies in the framework of the Danube Region Strategy and the "Digital agenda" initiative.

- **Improve the business environment for the pharmaceuticals and IT industries**. The administrative capacity and expertise of the Bulgarian Drug Agency can be improved through partnerships with best performers in Europe like the Denmark Drug Agency and the German Drug Agency. It would be valuable if the recently adopted E-Government Strategy and the discussions of the National ICT Strategy dealt with the issue of frequently changing legislation regarding the ICT industry, and the interaction between business and regulators.

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ANNEX 1
Measuring Competitiveness: Insights from the Economic Literature

Despite its apparent simplicity and special appeal to policy makers, competitiveness remains a concept that is often misunderstood and difficult to quantify. Competitive advantage has been consecrated as a way to improve the performance of firms, sectors and economies as a whole (Porter, 1990) and various competitiveness indexes have become extremely popular in policy and media circles (Thomson, 2004). Most definitions present competitiveness in a multidimensional manner, as the success of an entity (a firm, sector, country, or group of countries) in competing with its peers. However, this multi-level approach induces problems in identifying what exactly one means by competitiveness and the level at which this should be measured.

A better understanding of the microeconomic underpinnings of competitiveness and the role of its components is crucial for national economic policy and growth perspectives. While competitiveness is the result of superior productivity, it is also rooted in a country's microeconomic successes (sophistication and individual strategies of national firms), national system of innovation (R&D investments, product quality and innovation, human capital), and its institutions (policies, regulations, culture). Secondly, there is a strong two-way link between competitiveness (or productivity) and trade: high productivity improves the terms of trade, while export performance is an important engine for growth, value added and productivity.

Given its widely acknowledged importance, many academic studies have proposed a series of measures to capture competitiveness. These metrics encompass a large variety of aspects such as economic factors (e.g. the ability to attract investment, employment rate, cost of living), business factors (management efficiency, corporate governance, finance), infrastructure (basic infrastructure, scientific and technological one, education, research and development), as well as governmental efficiency (fiscal policy, institutional quality, public spending, business environment), all of which shape a country's ability to compete internationally (IMD, 2010; Competitiveness Report, WEF).

Box A. 1: Measuring the competitiveness of exports

Following Hausmann et al. (2007), the unit value distance (UVD) for a country is computed as follows :

$$UVD_{c,t} = \sum_{i} \log\left(Pmax_{i,t} - P_{i,t}\right)\frac{xval_{i,c,t}}{X_{c,t}}$$

where *c* refers to the country, *t* is the time period, P_i is the price of product *i*, $Pmax_{i,t}$ i s the highest priced export for good *i* worldwide, *xval* are the exports of good *i* and *X* are the total exports of country *c.** This provides a measure of the room for improvement in quality based on the relative price that a country's exports command in the global marketplace.

A measure of export sophistication at the individual product level (PRODY) equals the weighted average of the per capita income of exporting countries:

$$PRODY_{i,t} = \sum_{c} \frac{(xval_{i,c,t}/X_{c,t})}{\sum_j (xval_{i,c,t}/X_{c,t})} * Y_{c,t}$$

where $Y_{c,t}$ is the GDP per capita, $xval_{i,c,t}\,/\,X_{c,t}$ is the value-added share of the commodity in the overall export basket of a country *c*. The weights are the revealed comparative advantage (RCA) of each country in each commodity, normalized to one. The sectors (or products) are subsequently ranked based on their 'income content'.

* *The main weakness of these measures lies in the quality, availability, and harmonization of the data across countries and time.*

continue on next page >>

Taking the individual product measure of sophistication (PRODY), we can construct a sophistication measure for the whole export basket of a country (EXPY), which is equal to the weighted average of the sophistication of each of its exports:

$$EXPY_{c,t} = \sum_{i} \left(\frac{xval_{i,c,t}}{X_{c,t}} \right) PRODY_{i,t}$$

Innovation, exports and competitiveness: an intricate relationship

Since the 1980s the research on economic growth has shifted from analysing price- and cost-related factors to explore the role of technology and innovation[48]. The new research corresponds to a long-term Schumpeterian view of the crucial role that innovation plays in the international success of firms, sectors or countries. The new growth theory suggest there are increasing returns and positive spillovers from R&D efforts at multiple levels (firm, industry or country) –e.g. (Paul Romer 1991), (Grossman and Helpman 1991)(Aghion and Howitt 1992)— and that a country's network of trade and investment partners impacts their productivity (Coe and Helpman 1995)(Wolfgang Keller 2004). In parallel, evolutionary economics focuses on the sector-specific nature of innovation, and its impact on competitiveness (Nelson and Winter 1977) (Dosi 1988).

East Asia's growth experience suggests that, before harnessing the power of innovation, export-led industrialization has been instrumental in achieving economic development. Globalization has amplified growth opportunities many times over by removing prior restrictions such as the size and dynamics of home markets, export barriers or geographic distances. Many examples from the booming Chinese economy show dramatic transformations: rural villages 20 years ago that now are world-wide leaders in the production of a specialized good, taking full advantage of global economies of scale. As lower-income countries leapfrog on their development path, and price competition intensifies, the competitiveness of middle-income countries has come under threat.

Exports are a critical ingredient in generating higher value added and GDP growth. The recent literature on industrial organization, exports and growth presents two stylized facts: first, there is a U-shaped relationship between export specialization and income per capita, and secondly, developing countries that produce "sophisticated" goods tend to grow faster ((Robert C. Feenstra and Andrew K. Rose 1997), (Jean Imbs and Romain Wacziarg 2003) (Klinger and Lederman 2004). The reason is that underdeveloped and developing economies tend to specialize in narrow niches for both production and exports, usually in low-tech industries. As income rises, countries tend to diversify and introduce new and more sophisticated products. Finally, at high levels of income, some export lines close down and there is again an overall tendency of concentration, especially towards the upper value added echelons of products.

Diversification of production can help countries to achieve growth and overcome export instability or negative impacts of terms of trade in primary products. Cadot, Carrere, and Strauss-Kahn 2007 find that industrial diversification precedes export diversification: while the turning point for the former is around US$ 16,500 (PPP), export diversification remains positive until levels of US$ 22,500 (PPP)[49]. What this implies is that in order to be competitive internationally, one must first develop core production capabilities. Diversified economies are better equipped to take advantage of the export opportunities in the global market and harness them to accelerate growth.

[48] International cross-country studies show that almost 60 percent of the variation in income per capita originates in productivity differences driven by technological innovation.

[49] For example, Bulgaria's GDP per capita in PPP terms is still below this point, averaging around US$ 13,000 in 2009.

Both trade and growth theories predict a robust two-way relationship between exports and innovation. For example, recent models that endogenize innovation decisions by firms predict that only the most successful firms in a market make the leap into exporting and investing abroad, taking advantage of their superior technology and know-how; see (Marc J. Melitz 2003) (Marc J. Melitz and Gianmarco I.P. Ottaviano 2005). Often, empirical studies find exporting success to be associated with higher propensity to innovate (Cassiman and Golovko 2007) (Lachenmaier and Wößmann 2006) and learning-by-exporting effects (Clerides, Lach, and Tybout 1998).

There is mounting evidence that innovation, exports and measures of competitiveness (at the firm-, sector- and country-level) are closely linked. The causality appears to run both ways, as firms that are more productive and innovative go abroad with their products, while there are feedback effects that translate through learning by exporting (Bernard and Bradford Jensen 1999). In the case of Bulgaria's export and innovative performance, adopting a "smart specialization" agenda is an appealing growth strategy, but this has to take into account the surrounding externalities from EU and be broad-based, as investing in high-tech niches will not improve the average productivity in the manufacturing sector.

ANNEX 2
Econometrics Analysis of the Decision to Innovate

The econometrics analysis makes a regression of various indicators of innovation and technology upgrading on firm-specific characteristics as well as industry and location dummies:

$$\textit{Probability to upgrade} = \beta_0 + \beta_1 \textit{Export} + \beta_2 \textit{ Human Capital} + \beta_3 \textit{ Access to Finance} + \beta_4 \textit{ Firm specific characteristics} + \varepsilon$$

The full list of variables used in econometrics analysis is presented in Table A.1.

Table A.1: Variables Used in the Regression[50]

Variable	Description
New Product/ Service	Dummy variable equal to 1 if the firm introduced new products or developed new services in the past three years
Product/ Service upgrade	Dummy variable equal to 1 if the firm upgraded an existing product line or service in the past three years
Positive R&D	Dummy variable equal to 1 if the firm spent on R&D activities, either in-house or contracted with other companies (outsourced), in the past three years
Technology Upgrade	A dummy variable equal to 1 if the firm did any type of upgrading, either new product/ service, or positive R&D
Export	Dummy variable equal to 1 if the firm exports its production directly or indirectly
Age	Number of years since the firm began operations
Size*	Based on the number of employees: size = 0 if 0<employees<5, size = 1 if 5=<employees<20, size = 2 if 20=<employees<100, size = 3 if employees>=100
Education	Percentage of the firm's labor force employed at the end of fiscal year 2007 which had a university degree
Use of a loan	Dummy variable equal to 1 if the firm has a line of credit or a loan from a financial institution
Certification	Dummy variable equal to 1 if the firm has an internationally-recognized quality certification
Foreign Ownership	Dummy variable equal to 1 if the enterprise is owned by private foreign individuals, companies or organizations
Capital	Dummy variable equal to 1 if the firm is located in Sofia
Manufacturing	Dummy variable equal to 1 if the firm is in the manufacturing sector
Services	Dummy variable equal to 1 if the firm is a service provider

** We use the classification of firm size in the WB Enterprise surveys. In the EU, the distribution is: micro (0-9), small (10-49), medium (50-249), large (250 +).*

[50] Variables indicating the percent of the firm which is owned by the Government/State and whether the firm is a joint venture were omitted due to few observations.

Table A.2: Determinants of Innovation based on Firm-Level Surveys

	WB Enterprise Survey 2009			
	New Product/ Service	Product/ Service Upgrade	Positive R&D	Technology Upgrade
Export	0.964052	1.132702	0.6054211	0.6991257
	(-0.08)	(0.28)	(-1.16)	(-1.09)
Age	0.9739049	0.9581287	1.02096	0.9935665
	(-1.52)	(-2.57)***	(1.31)	(-0.51)
Size	1.56569	1.416518	2.068571	2.030768
	(2.05)**	(1.72)*	(3.37)***	(4.35)***
R&D spending	15.95038	7.308163		
	(6.34)***	(4.43)***		
Certification	1.685036	1.872391	1.414112	1.650684
	(1.33)	(1.66)*	(0.92)	(1.75)*
Foreign	1.171779	0.4513225	0.3643282	0.4638749
	(0.28)	(-1.42)	(-1.76)*	(-1.78)*
Use of loan	0.9044065	1.550062	0.8845888	1.048988
	(-0.3)	(1.41)	(-0.36)	(0.48)
Capital	3.23382	2.985201	10.54046	1.805982
	(2.75)***	(2.46)**	(6.32)***	(1.63)
Manufacturing	1.088174	1.169843	0.5195967	0.4268048
	(0.2)	(0.41)	(-1.61)	(-2.66)***
Services	1.537435	0.5700452	0.7190346	
	(1.01)	(-1.47)	(-0.8)	
Observations	261	261	261	266
Pseudo R^2	0.3248	0.2312	0.2299	0.1358

Odds ratios are presented; *** - significant at 1% level, ** - significant at 5% level, *- significant at 10% level
Source: Authors' calculations.

The key regression results are that:

- A firm's propensity to innovate is positively and significantly correlated with R&D spending once controlling for all other factors. Such a strong connection is expected since R&D is an essential input for innovation.
- Innovative companies are more likely to be located in Sofia.
- Bigger companies are more likely to introduce innovative activities.
- The probability of product or process upgrade is higher if the company obtained international certification.
- The export dummy is not significant for the majority of regressions. One of the possible explanations for this relationship is that many Bulgarian export companies operate in traditional sectors with limited room for innovation.
- Bulgarian companies operating in manufacturing sectors are less innovative. The results suggest that companies operating in services sectors are more innovative.

ANNEX 3
Benchmarking Bulgaria's Technological and Scientific Performance

Table A.3: Post-2000, Most Patented Inventions are Connected to IT

Patenting Class	1963-2000
Metal Founding	18
Organic Compounds	15
Electrolysis: Processes, Compositions etc	14
Electric Heating	14
Drug, Bio-Affecting and Body Treating	13
Patenting Class	**2001-2010**
Data Processing: Database and File Management	26
Multicomputer Data Transferring	22
Interprogram Communication or Interprocess Communication	11
Data Processing: Software Development, Installation, and Management	11
Memory (Computers and Digital Processing Systems)	9
Data Processing: Document, Operator Interface, and Screen Saver	9

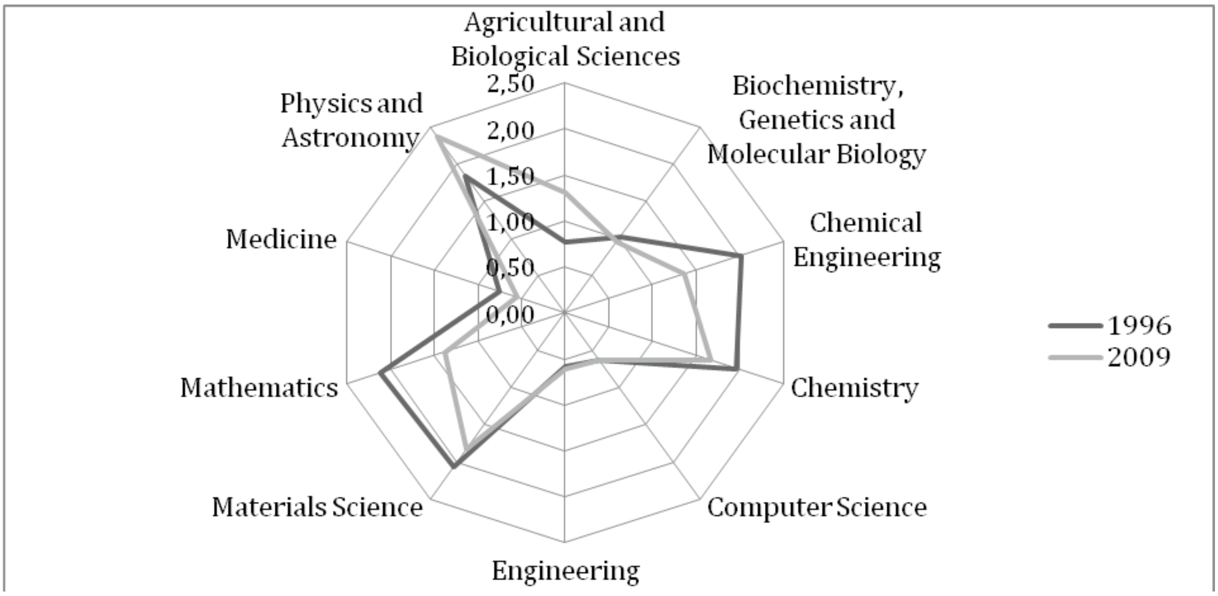
Source: USPTO. Note: these numbers refer exclusively to the inventions with a Bulgarian first-inventor.

Table A.4: Scientific Publications and Citation Totals (1996-2008)

Country	Citable documents	Citations	Citations per Document	Scientific impact (H index)
Italy	581,455	6,809,577	12.29	432
Finland	121,358	1,714,200	15.10	273
Hungary	70,330	633,534	9.37	183
Turkey	162,296	821,820	6.03	139
Bulgaria	29,342	165,992	5.92	97
Romania	41,408	175,079	5.00	96
Croatia	30,886	136,669	4.90	92

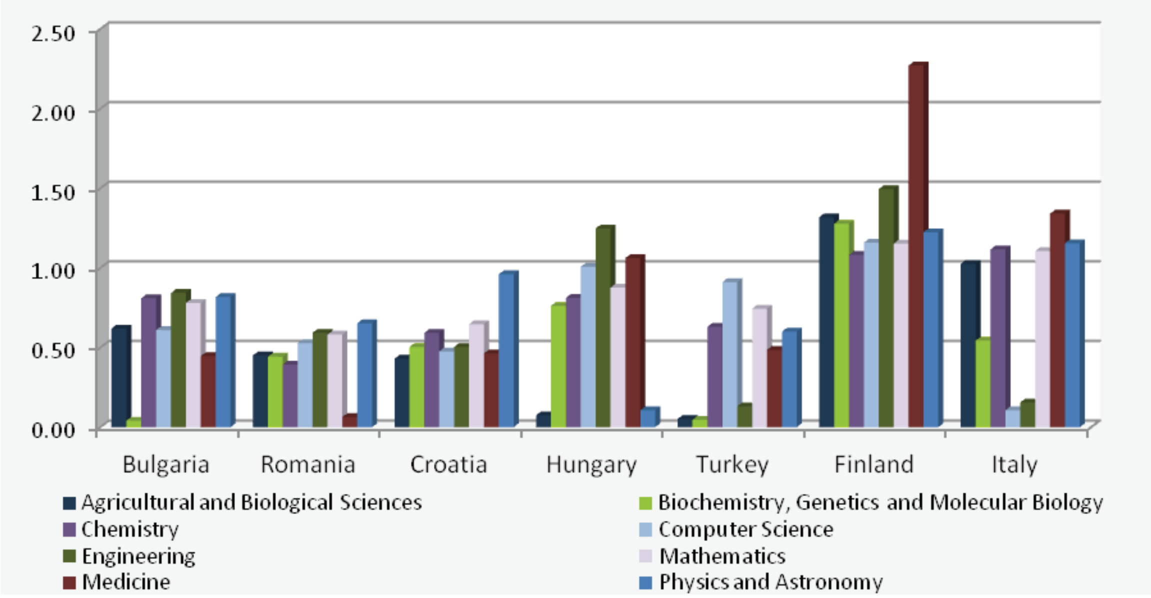
Source: SCImago based on SCOPUS data (accessed March, 2010).

Figure A.1: Specialization Index for Bulgaria: 2009 vs. 1996



Source: Authors' calculations based on SCOPUS data (2010).

Figure A.2: Relative impact index in selected disciplines for Bulgaria and comparators: 1996-2009



Source: Authors' calculations based on SCOPUS database (accessed March, 2010).

Table A.5: World Share of Publications for Bulgaria and Comparator Countries: 1996-2009

	World share of publication (%) - average between 1996 and 2009						
	Bulgaria	**Romania**	**Croatia**	**Hungary**	**Turkey**	**Finland**	**Italy**
All disciplines	***0.16***	***0.25***	***0.17***	***0.38***	***0.95***	***0.66***	***3.26***
Agricultural and Biological Sciences	0.01	0.01	0.02	0.04	0.08	0.07	0.22
Biochemistry, Genetics and Molecular Biology	0.02	0.01	0.01	0.06	0.09	0.09	0.22
Chemistry	0.01	0.04	0.02	0.05	0.06	0.04	0.25
Computer Science	0.01	0.01	0.00	0.02	0.03	0.04	0.16
Engineering	0.01	0.04	0.01	0.02	0.08	0.06	0.03
Mathematics	0.01	0.03	0.01	0.03	0.04	0.03	0.19
Medicine	0.03	0.02	0.05	0.07	0.39	0.17	1.00
Physics and Astronomy	0.03	0.05	0.01	0.05	0.05	0.06	0.36

Source: Authors' calculations based on SCOPUS database (accessed March, 2011).

Table A.6: Top Scientific Partners for Bulgarian Publications (1981-2009)

International collaborations	1981-1990			1991-2000			2001-2009		
	Rank	**Total**	**%**	**Rank**	**Total**	**%**	**Rank**	**Total**	**%**
GERMANY	2	590	3.97	1	1694	9.07	1	2,845	13.33
USA	3	225	1.52	2	1061	5.68	2	1,759	8.24
FRANCE	5	201	1.35	3	896	4.80	3	1,452	6.80
ITALY	8	120	0.81	4	715	3.83	4	1,320	6.19
UK	7	120	0.81	7	392	2.10	5	964	4.52
SPAIN	27	15	0.10	6	486	2.60	6	866	4.06
RUSSIAN FEDERATION	1	874	5.89	5	622	3.33	7	836	3.92
BELGIUM	22	25	0.17	13	240	1.28	8	800	3.75
POLAND	6	146	0.98	13	240	1.28	9	767	3.59
SWITZERLAND	18	37	0.25	10	293	1.57	10	608	2.85
Total (all countries)	14,839			18,685			21,340		

Source: Authors' calculations, Web of Science (accessed March, 2010).

ANNEX 4
Eliciting High-Quality Scientific Research through Competitive Grants

As countries of all income levels step up their efforts to transform into "knowledge economies," increasing amounts of public funds are being directed to nurture scientific capabilities and promote scientific excellence. Competitive grant programs (CGPs)[51] are one of the favored instruments to allocate additional resources because these programs have been used with great success in the US and other OECD countries. But CGPs in emerging countries usually face problems that hinder their ability to elicit high quality research. These problems are related to the relatively small size of the research community, the lack of a competitive funding culture within the national innovation system and weak capacity in the implementing agency. By looking at evaluations of CGPs in both developed and developing countries we draw lessons that can be used to improve the performance of CGPs

Policy challenge #1: Setting goals for a CGP in a small economy with a STI system that is behind the global frontier

Large economies with developed STI systems generally provide more fertile ground for CGPs as there is abundant capacity to be mobilized both in the private sector and in public research organizations. But countries with small and emerging STI systems can successfully implement CGPs designed to: (i) mobilize research in areas where there is already significant capacity; (ii) leverage capacity from international partners to increase the quality standards of national research by including top scientists in the evaluation process; (iii) enhance the administrative capacity to administer the CGP.

CGP's cannot act as the main driver of capacity-building in areas with no critical mass of researchers, but by encouraging inter-disciplinary and/or interregional research, they can be used to promote the rise of new research areas and the inclusion of new agents into the STI system.

When allocating resources to projects, CGP's need to strike a balance between (a) building nuclei of scientific capacity that support the sustainable progress of research; and (b) encouraging new ideas and areas to flourish. One approach to achieve this balance is to establish several funding windows corresponding to different thematic/sectoral objectives or specific national priorities, while keeping one window open for proposals that do not comply with the eligibility criteria in these specific calls. For example, in addition to research programs structured around high-priority themes, the National Environment Research Council in the UK (NERC) has a special window of grant funding for unsolicited applications.

Policy challenge #2: Connecting outputs and outcomes to the selection mechanism

To ensure an alignment between funding and goals, the objectives of the program must be mapped into the selection process for research projects. Typically, this is done by developing a rating system that is used to compare proposals against each other and to the minimum standards required by the program. A rating system must be fair and consistent, and it must provide peer reviewers with the tools to compare highly heterogeneous research proposals:

- As scientific excellence is generally the first-order objective of CGPs, it should enter the rating system as one of the key criteria.

[51] Competitive grant programs share the following characteristics:
- *The grants are used to finance and manage standalone and programmatic scientific research projects by individuals, groups and consortia;*
- *Project proposals are submitted as a response to open and public calls for proposals;*
- *Funding for projects is allocated through peer review by experts; and*
- *Grants are given for a limited time, that can vary between one to five years and as a result tend to cover salaries for temporary research staff, operational expenses, short-term training needs, research supplies and critical laboratory equipment.*

- All evaluation criteria and weights should be made explicit in the call for proposals and the application structure must match the rating system.
- Reviewers should be asked to issue an evaluation in line with rating criteria.

Policy challenge #3: Making the overall selection process and external peer-review more efficient and transparent

Policymakers and the implementing agency running the CGP face the challenge of maximizing the fairness, transparency and efficiency of the selection process while minimizing the associated administrative burden, cost and time. This review proposes the following recommendations:[52]

The call for proposals

- To succeed in soliciting a large number of proposals, it is important that the call for proposals is advertised widely enough to the appropriate audiences and that the goals of the program and its rating criteria are clearly communicated.
- In the event that several financing windows exist, it is highly desirable that potential candidates have access to a calendar of call for proposals, deadlines, technical information and available resources for all windows before the beginning of the year.
- When implementing a CGP in a scientific community that is not accustomed to this kind of process, communication tools such as workshops, a web portal, and/or a helpline can help to elicit more and better proposals.

The review process and the reviewers

- The review process should aim to reduce the screening time for proposals and achieve an adequate allocation of proposals to reviewers.[53]
- Agencies implementing CGPs in countries with small research systems face the challenge of finding enough highly-qualified reviewers. Potential solutions include requiring applicants to provide a list of potential reviewers (with strict conflict of interest guidelines) and to seek alliances to share the pool of reviewers with neighboring countries.
- The quality of the reviews can be addressed by: limiting proposal length, ensuring that each proposal is organized according to the rating criteria and providing clear guidance to reviewers on how proposals should be rated. This can decrease the amount of time spent on each review and increase the quality of the review.
- Experience in different countries has shown that it is easier to meet the program goals if members of the review and oversight bodies are selected according to clear rules and represent key stakeholders.

Policy challenge #4: Amplifying the impact of a CGP on scientific excellence and societal spillovers

A successfully run CGP reaches beyond the individual projects and has a catalytic effect on improving the performance of a large part of the research community. The following recommendations have been drawn from the experience of CGPs that have successfully secured growing public funding through the years:

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[52] The recommendations are focused on elements of the selection process that have been identified by agencies such as the NIH, NSF and the UK research councils.

[53] Investing in a reliable IT system that that does not accept incomplete proposals or allows for factual corrections to occur before proposals are sent to peer-reviewers can be extremely helpful in speeding up the process.

- *Track the results of research projects that are getting funds.* One tool to mitigate unsatisfactory performance is to introduce a clear monitoring and evaluation (M&E) framework that will follow the projects throughout their implementation. This framework should include financial and procurement monitoring of projects as well as technical issues related to the program goals. While it is not cost-effective to conduct technical reviews of all projects, it is useful if some reviews are built into the general financial management and procurement audit process for randomly selected projects.

- *Continue to monitor the results even after financing ends.* Many research outputs and outcomes materialize only in the long term, so following project beneficiaries beyond the duration of financing is the only way to determine whether the types of projects financed are having the desired societal impacts. Obtaining this information can provide valuable feedback to program design, including the selection process and the terms and conditions of grants. Post-financing M&E can help to identify the main obstacles faced by beneficiaries in continuing and extending the projects once CGP financing expires.

- *Showcase successful projects.* By compiling a portfolio of successful projects, the implementing agency can establish the credibility of the program and disseminate the results to a wider audience. Showcasing can be a good tool to build social and political legitimacy for the program, especially when projects have substantial societal impact beyond the direct beneficiaries. It can also lead to a positive "brand" associated with CGP-sponsored projects, which helps beneficiaries to secure future funding, and gives potential future applicants a clear picture of the type of projects that are preferred.

- *Periodically carry out an external evaluation of the CGP.* Monitoring and evaluation of the overall performance of the program is necessary to ensure it is meeting its intended objectives.[54] This process will be facilitated if there is consistent monitoring of variables such as demand for grants, time taken for the review, beneficiary satisfaction as well as tangible outcomes tracked by the M&E framework for individual projects. When an evaluation by an independent panel of experts exposes design and implementation failures, it is important to follow through with corrective actions.

- *Take steps to ensure that research outputs are communicated to potential private sector partners to accelerate commercialization.* To ensure knowledge absorption, innovation, and productivity growth, research outputs from CGPs must be connected to industry and the economy. Clear rules that facilitate and encourage quick dissemination of the outputs and follow-on R&D activities should be established about any IPR derived through projects funded by the program. If the CGP seeks to finance projects with high commercialization potential, this should be clearly stated in the goals and reflected in the rating system, the application process, and the choice of peer reviewers. A combination of post-financing M&E of projects and explicit bridges and alliances with other financing institutions (e.g., IPR offices) can increase the likelihood that a project continues on the path to commercialization.

- *Establish partnerships to offer post-CGP financing and services.* The implementing agency has a very intimate viewpoint from which to assess the needs of researchers and research teams and how outputs that have been produced could be further developed. From this position, it can effectively create partnerships with other agencies so that there are explicit links between the available pools of public funds for science and innovation. In the European context, national instruments also should also consider how existing beneficiaries can tap into EC funding opportunities. Partnerships with technology transfer offices and firms with significant R&D capacity can help to achieve a more efficient sequencing between scientific-oriented research and follow-on technological R&D.

[54] To achieve maximum legitimacy and transparency of monitoring, organizations such as the NIH and the NSF "outsource" periodic reviews by external and independent expert panels, to which program information is fully disclosed. These panels carry out a critical analysis of this information and conduct extensive consultations of key stakeholders, producing detailed reports that describe the main challenges to meeting program goals and provide specific recommendations. Making the recommendations resulting from the expert-panel review binding will ensure its continuous improvement and protect itself from falling hostage to special interests.

ANNEX 5
Improving the Instruments to Support Business Innovation under OP Competitiveness

"*Support for the Introduction of Innovative Products and Processes and Delivery of Innovative Services"* is one of the granting schemes under OP Competitiveness. The Call aims to support innovative enterprises that consider commercialization of innovative products, processes and services but lack resources to finance this activity. The Call was initially launched in 2008, however only a few companies applied for the grant. In 2010 the government announced another tender for the Call with the total budget of €25 million. To address the problems of weak application pipeline the Ministry of Economy, Energy and Tourism requested the World Bank to review the parameters and eligibility criteria of the Call. The review focused on whether changing the eligibility criteria could increase the number and quality of the applications. In addition, the results highlight implementation issues. The results of the review are summarized in Table A.7 and Table A.8.

Table A.7: Issues and Recommendations to Improve the Design of the Call for Proposals

Issue	Recommendation
Short duration of individual projects (up to 24 months)	Consider extending the duration to 3 years for larger proposals, while including annual milestones to monitor progress: • Similar programs find it useful to provide extensions beyond 2 years– for example, 10% of biomedical R&D funded by SBIR grants receive a third year of support
Applicants should possess or be in the process of acquiring IPR for the product or process to be commercialized	Eliminate this eligibility criterion, but (i) include *ex ante* possession of IPR as a criterion for ranking applications and (ii) encourage companies to obtain IPR as a result of the projects: • In Bulgaria patent holders are mostly individuals, not firms • Few patents are filed by Bulgaria in USPTO or EPO, and those that are have a low "impact", which means that the actual value of patents is limited • Including this criterion may trigger "perverse incentives" to apply for patents at BPO just to fulfill this criteria, regardless of the value of this IPR • Specifically, IPR is not very useful as a protection device for IT or for innovative services
IT companies need to prove that new software will be innovative by going to a government commission	Develop a focused ranking for selecting the best IT projects and involve industry experts in the review process: • Government officials are unlikely to have the technical or market know-how to assess the potential of new software products/ services • Although the IT industry is growing in Bulgaria, few software-related applications were received (or funded) in past Calls

Issue	Recommendation
In-house R&D personnel costs are not an eligible cost	Permit R&D personnel costs to be included as eligible expenses, possibly counting them as part of the matching contribution by the firm: • This creates a bias towards outsourcing R&D to service providers. This may enhance project results, but at the cost of reducing sustainability of innovative capacity within firms • There is a risk that R&D providers will actively push projects, undermining the objective of the Call to promote market-oriented projects
Cumbersome application and selection process	Provide guidelines that explain how applications will be reviewed: • Applicants are more likely to prepare an application if they understand what type of projects will be selected and have examples to guide them • The ranking criteria should be spelled out; for example, technical indicators (innovativeness & soundness of the proposed approach, qualifications of the implementing team) and financial indicators (expected revenue and profits)
Companies have inadequate capacity to prepare project application	Create a separate facility that supports the preparation of project applications: • The US SBIR has separate windows (Phase I & II) awarding competitive grants to assist with the costs of feasibility studies and marketing plans • Such a window existed in the National Innovation Fund and it would be useful to reopen it, linking it to the EC calls
Broad coverage of the projects	Prioritize 4-5 thematic areas in each Call: • If each Call prioritizes specific technological areas (e.g., clean tech, health, ICT) it will incite companies in these industries to apply, and make it easier for the implementing agency to communicate with relevant industry associations
Limited knowledge among potential beneficiaries about the Call	• Consider sending repeated announcements to industry associations, companies with R&D labs, companies in targeted industries • Create outreach programs – mailing list, conferences, forums, seminars, press releases, information pamphlets.

Table A.8: Recommendations to Improve the Implementation Phase of the Call

Issue	Recommendation
Cumbersome review process	Consider separating the review process into two stages: • Currently a comprehensive application is needed from the start, making this an onerous burden. • In other EU calls for proposals, applicants send a short project outline in the first stage, and only those with more promising projects are asked to submit a full application Assemble a pool of reviewers that include experts with experience in key industries and technologies: • To ensure reviewer independence and foster focused and productive panel discussions, reviewers need to have sufficient know-how and commitment.
Excessive red tape	Decrease the screening time to review applications, especially in the administrative review stage: • Long screening time discourages applications and can also reduce the interest of companies in launching the projects • Encourage electronic submission of the necessary documents • Limit the number of projects evaluated by each reviewer • Speed up payments/ reimbursements if project implementation is appropriate: • Currently, firms have delivered reports that are satisfactory, but receipt of the grants can be delayed.
Insufficient monitoring and evaluation of the results	Develop a system to evaluate the program results: • Establish a M&E system to follow projects and/or beneficiaries that have been awarded grants • Consult reviewers to determine corrective actions or even discontinue funding if projects under implementation show unsatisfactory performance • Create a database that includes information about the participants in the call and project outputs, focusing on commercialization metrics • Employ an independent reviewer to assess the program on a regular basis.