The bottleneck caused by little domestic demand for R&D and a weak private sector in all but Slovenia is likely to remain a major structural weakness for Southeast European R&D systems for years to come.

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9 · Southeast Europe

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INTRODUCTION

Southeast Europe encompasses the relatively developed science systems of Greece and Slovenia, the 'semi-developed' systems of Bulgaria, Croatia, Romania and Serbia, along with science systems in real need of development – those of Albania, Bosnia and Herzegovina, Kosovo, Montenegro and the Former Yugoslav Republic of Macedonia. The Republic of Moldova shares many features with this last group of countries, although it follows a specific post-Soviet system.

Contemporary Southeast Europe is the most diverse region in Europe in terms of socio-economic development, institutional frameworks and the level of science and technology (S&T) capacity.

There is a ten-fold difference in per-capita income between the richest (Greece and Slovenia) and poorest (Moldova) countries in this region (Table 1). This is both a historical legacy and the result of the civil wars that accompanied the gradual break-up of Yugoslavia in the early 1990s. In fact, the disintegration of Yugoslavia was only complete in 2008, after popular referenda in Montenegro (May 2006) and Kosovo (February 2008) opted for independence from Serbia.

Four countries from Southeast Europe have so far acceded to the European Union (EU): Greece in 1981, Slovenia in 2004 and Bulgaria and Romania in 2007. These countries are covered in the present chapter but also appear in that on the EU (*see page* 147). The remainder either have candidate status for the EU (Croatia, Former Yugoslav Republic of Macedonia and Turkey) or uncertain prospects regarding membership (Albania, Bosnia and Herzegovina, Kosovo, Moldova, Montenegro and Serbia).

For those countries still on the outside looking in, European integration represents the only viable project for ensuring social and political coherence. For those countries that are already EU members, prosperous neighbours are the best guarantee of political stability and economic growth.

In the 1990s, all but Greece grappled with the challenges of an economic transition to post-socialism following the disintegration of Yugoslavia. This led to a deterioration of their science systems, which in some cases has been extremely severe, as described in the *UNESCO Science Report 2005*.

At the end of the first decade of the 21st century, Albania, Bulgaria, Croatia Romania and Slovenia have all fully recovered from the crisis of transition from the Soviet system to a market economy. In the remaining countries, however, income levels still compare unfavourably with income per capita during the socialist period. Nonetheless, since 2000, the economies of all of the Southeast European countries have been growing at average rates of around 3% or higher. With the onset of the global recession in 2008, growth rates in the region are likely to slow down considerably.

The key challenge for the majority of these countries is to ensure further sustainable economic growth. These are open economies; however, the majority of them are still burdened with high unemployment, weakness in the rule of law and an undeveloped financial system.

CONDITIONS FOR R&D

Disparities in the pace of restructuring

The socio-economic features of Southeast European economies strongly influence the role of science in the region and prospects for national economic growth based on domestic knowledge. Their research and development (R&D) systems face acute challenges, in particular regarding science-oriented innovation.

The pace of restructuring varies enormously. Albania, Bosnia and Herzogovina – and the Former Yugoslav Republic of Macedonia to some extent – are the most disadvantaged. They are still striving to establish functioning R&D systems and are thus primarily addressing science policy issues. At the other end of the scale, Bulgaria, Croatia and Romania are implementing very much EU-driven and EU-inspired changes. Together with Turkey, these three countries are making a visible attempt to shift the focus from conventional science policy towards innovation policy. Individual national plans, such as the 2005 Turkish *National Science and Technology Strategy*, have created new momentum which, if it continues, could provide examples of good practice for other countries in the region (*see page* 202).

In Southeast Europe, external conditions for innovation, such as institutions, market efficiency and business sophistication, have shown improvement since the early 1990s, as a result of institutional changes in these transitional economies. However, these changes have not necessarily been accompanied by a greater capability

The Rio-Antirrio, a cable-stayed bridge in Greece

Photo: Parisvas/ iStockphoto

Table 1: Key socio-economic indicators for Southeast European economies, 2008

	Annual average growth rate, 2002–2008 (%)	GDP per capita, (current international) $PPP 2008	Unemployed (% of labour force) 2008	Employment in industry (% of total employment) 2008	Gross fixed capital formation (% of GDP) 2008	Trade (% of GDP) 2008	Exports of goods and services (% of GDP) 2008	Domestic credit to private sector (% of GDP) 2008	Rule of law*, 2006	FDI net inflows (% of GDP) 2008
Albania	5.7	7 293	22.7^{-7}	13.5^{-2}	32.4	90.5	31.2	36.0	-0.70	7.6
Bosnia and Herzegovina	5.6	8 095	29.0^{-1}	–	24.4	73.6	36.8	57.8	-0.52	5.7
Croatia	4.3	17 663	8.4	30.6^{-1}	27.6	92.2	41.9	64.9	0.03	6.9
Rep. of Moldova	6.1	2 979	4.0	18.7^{-1}	34.1	132.3	40.7	36.5	-0.66	11.7
Serbia	5.2 10	544	13.6	26.2	20.4	82.1	29.7	38.4	-0.57	6.0
Montenegro	6.4	13 385	30.3^{-3}	19.2^{-3}	27.7	115.0	40.3	80.4	–	19.2
Romania	6.8	13 449	5.8	31.4	31.1	70.3	29.9	38.5	-0.17	6.9
Slovenia	4.6	27 866	4.4	34.2^{-1}	27.5^{-1}	141.6	70.2^{-1}	85.6	0.84	3.5
Bulgaria	6.1	11 792	5.7	35.5^{-1}	33.4	143.7	60.5	74.5	-0.14	18.4
Greece	4.1	29 356	7.7	16.4	19.3	55.0	23.1	93.5	0.65	1.5
FYR Macedonia	4.3	9 337	33.8	31.3^{-1}	23.9	131.1	52.6	43.8	-0.47	6.3

n = data refer to *n* years before reference year

*Rule of law measures the extent to which a population has confidence in, and abides by the rules of, society. It includes the incidence of violent and non-violent crime, the effectiveness and predictability of the judiciary and the enforceability of contracts.

Source: World Bank, Knowledge for Development, KAM database, July 2010

among firms to absorb new technology and innovate (Radosevic, 2007). Both the new EU member states and the ex-socialist countries have come to realize that policies have not succeeded so far in promoting growth in the absence of strategies that directly address S&T and training, although there are of course also major intra-regional differences in terms of technological readiness.

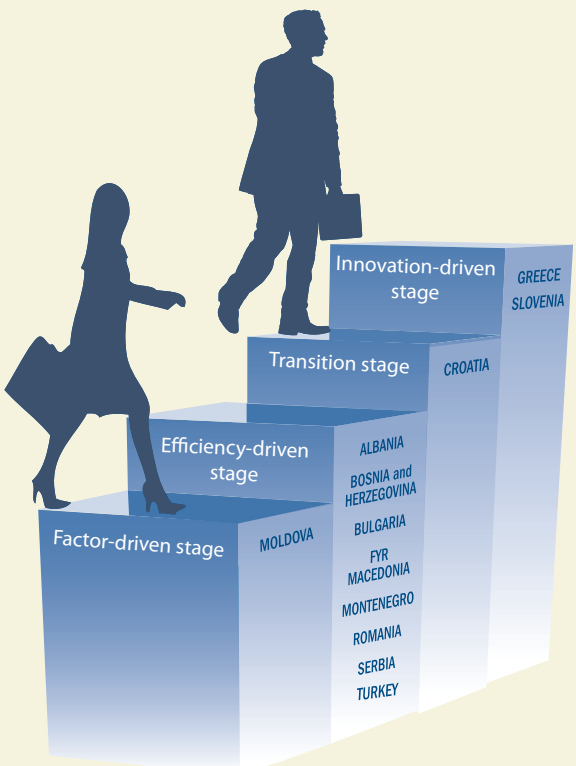
Science, technology and innovation (STI) play very different roles in economic growth in the sub-region. The *Global Competitiveness Report* (WEF, 2010) categorizes countries according to their stage of transition towards a globally competitive economy, taking into account drivers of growth that range from the availability of labour or raw materials to measures of efficiency and innovation (Figure 1). The report considers eight of the Southeast European countries to be at the 'efficiency-driven' stage and Slovenia and Greece to be at the 'innovation-driven' stage. Nestled in-between is Croatia, in transition from efficiency- to innovation-driven. Albania and Bosnia and Herzegovina were upgraded to efficiency-driven economies in 2008, whereas Moldova has remained at the factor-driven stage.

Weak demand for R&D

The R&D systems of countries in Southeast Europe cover a wide spectrum in terms of their relative size, performance and role in society and the economy. However, all but Slovenia share a common feature: domestic demand for R&D and for skilled employees is relatively weak, especially compared to the supply of R&D (Radosevic, 2007). There are several reasons for this. One is no doubt the structure of industry, which is dominated by small firms working in traditional industries that do not exploit new technologies. Lack of capacity is another factor. Serbia easily has the biggest demand–supply gap, both because of unsophisticated industries and the inability of local demand to make up for limited international co-operation. Poor demand for R&D is also the greatest weakness of the new EU Member States.

Throughout the region, R&D systems have stabilized in recent years and are gradually recovering from the recession caused by the transition to a market economy. In the new EU member states, the pace of change is much faster, as these countries are enjoying significant increases in funding of their R&D through EU structural funds (*see page* 173).

Figure 1: Drivers of growth: ranking of Southeast European economies, 2010



Note: The Global Competitiveness Index ranks countries according to three types of attribute. 'Basic requirements' encompass institutions, infrastructure, macro-economic stability, health and primary education. 'Efficiency enhancers' include higher education and training, labour efficiency, financial market sophistication, market size and technological readiness. 'Innovation and sophistication' factors include business sophistication and innovation.

Source: WEF (2010) *Global Competitiveness Report 2010/2011:* www.gcr.weforum.org

R&D INPUT

R&D expenditure

Throughout the region, the decline or, at best, stabilization of employment in R&D has been accompanied by either stagnation or a drop in the share of GDP invested in R&D. Only Slovenia and Romania have managed to inverse the trend. Serbia, meanwhile, is trying to make up lost ground (Figure 2).

Differences in gross domestic expenditure on R&D (GERD) are much greater when population size is taken into account (Figure 3). For example, Slovenian investment per capita in R&D is 2.5 times that of Greece and 21 times that of the Former Yugoslav Republic of Macedonia.

Sectoral structures of R&D funding and performance differ significantly from employment structures, largely due to the lower capital intensity of R&D in higher education when compared to the business sector (Figures 4 and 5). This explains the relatively higher share of GERD spent in the business enterprise sector, the much lower share of the higher education sector and the relatively similar position of the government sector.

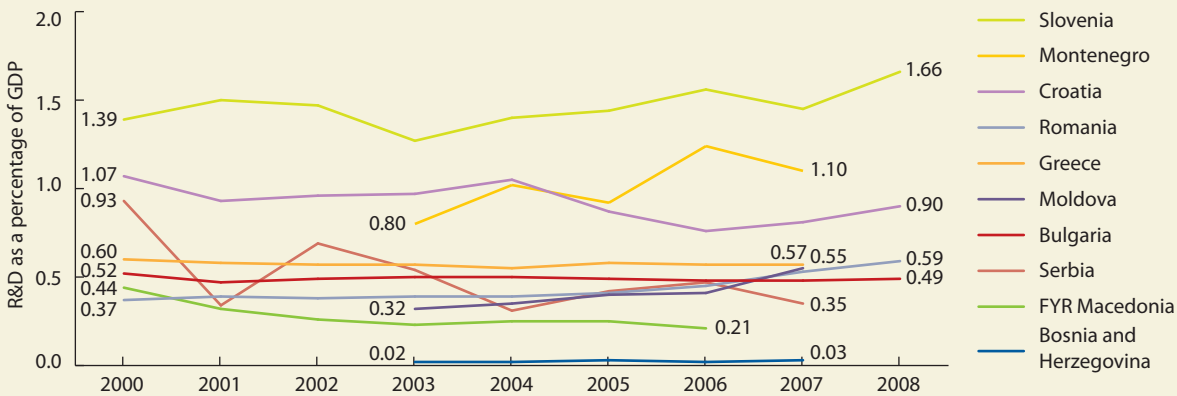
The main source of R&D funding in the sub-region is the government (Bulgaria, Croatia, Romania and Serbia) or a combination of government and foreign sources (Greece). Only in Slovenia is the business enterprise sector the dominant funder and performer of R&D, which is to be expected, given the relatively strong role of innovation and knowledge in Slovene growth. On the whole, the business sector enjoys limited support from government in most countries, as evidenced by the relative similarity of its shares in R&D funding and in performance. Only in Romania is the business sector heavily financed by government, where business accounts for 48.5% of R&D performed but only 30.4% of R&D funding. The higher education sectors in all Southeast European countries are also largely government-funded. With EU accession, the shares of foreign funding (primarily from the EU) are likely to increase in both Romania and Bulgaria.

The above structural features indicate a relatively slow transformation of R&D towards enterprise-based R&D systems. Yet, during the transition period and until recently, the trend was towards a stronger higher education sector. With continuing recovery and economic growth, we can expect the business enterprise sector to take on added importance.

Severe brain drain

As a consequence of poor demand for R&D, Albania, Bosnia and Herzegovina, Bulgaria, Moldova, Montenegro, Romania, Serbia and the Former Yugoslav Republic of Macedonia all suffer from severe brain drain. An assessment of the severity of this affliction ranks these countries at between 109th and 121st out of the 125 countries studied (WEF, 2007).

Figure 2: GERD/GDP ratio in Southeast Europe, 2000–2008 (%)

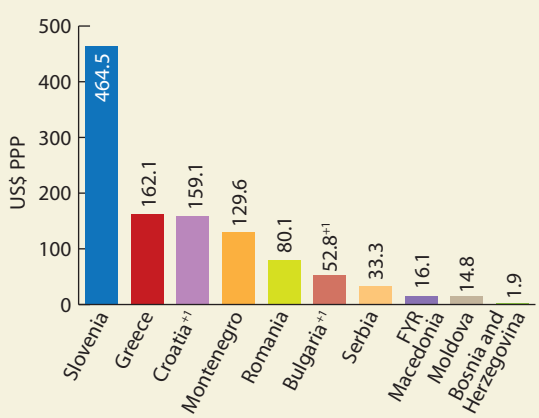


Source: UNESCO Institute for Statistics database, August 2010

Growing demand for education

In parallel, there is a growing demand for education, which is perceived as being the best way to avoid unemployment or increase one's chances of emigrating. Strong economic growth since 2000 has created more employment opportunities for the highly skilled. This has swollen the number of tertiary graduates at bachelor level in all but Bulgaria. One of the positive legacies of socialism is the high quality of mathematics and science teaching in schools, as evidenced by assessments in Croatia, Romania, Serbia and Montenegro (WEF, 2008).

Figure 3: GERD per capita in Southeast Europe, 2007



+n = data refer to *n* years after reference year

Source: UNESCO Institute for Statistics database, August 2010

In Romania, Serbia and the Former Yugoslav Republic of Macedonia, there has been a huge expansion in the number of undergraduates. Their number increased by between 95% and 287% over 2002–2008. There has also been a stark increase in the number of master's degrees and PhDs awarded in the region (Figure 6).

Declining or stagnant numbers of researchers in Croatia, Moldova, Romania and the Former Yugoslav Republic of Macedonia suggest a shrinking demand for R&D. Despite economic growth, the R&D systems of these countries have actually downsized, while others have remained stable or progressed (Figure 7).

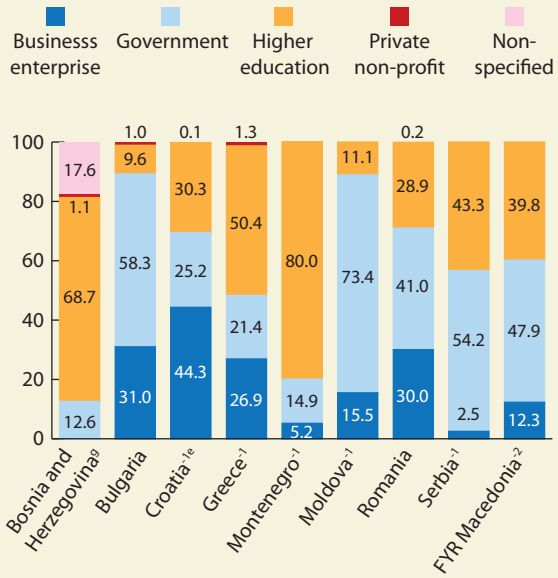
Systemic change in R&D

A decreasing demand for R&D accompanied by a growing number of tertiary graduates suggests that Southeast European economies are facing significant structural changes in terms of the demand for knowledge. Once very focused on R&D, demand for knowledge is becoming non-R&D-based.

In addition, formerly extramural-based R&D systems are experiencing difficulties in adjusting to an enterprise-based R&D system. As in other countries at a similar level of development, R&D systems in the sub-region are either dominated by the government sector or by the higher education sector (Figure 8).

Slovenia is the only country where private industry is the biggest employer. In Slovenia, this reflects the country's

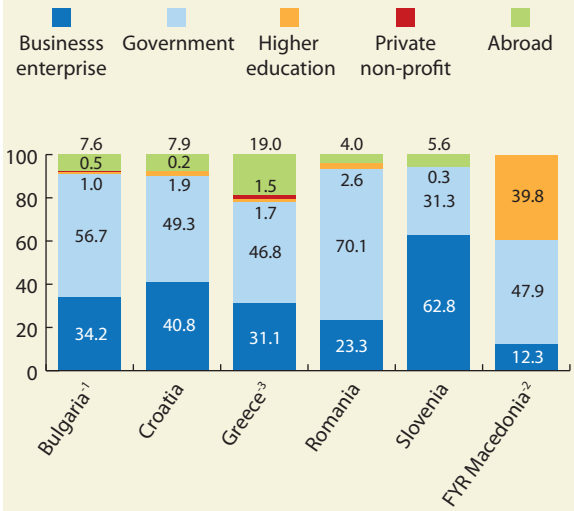
Figure 4: GERD in Southeast Europe by perfoming sector, 2008 (%)



-n = data refer to *n* years before reference year
g = underestimated or partial data e = estimation

Source: UNESCO Institute for Statistics database, August 2010

Figure 5: GERD in Southeast Europe by source of funds, 2008 (%)
Selected countries



-n = data refer to *n* years before reference year

Source: UNESCO Institute for Statistics database, August 2010

high level of development and the increasing role of knowledge in ensuring the competitiveness of industry. It is alos the case in Romania but this was much more a reflection of the unrestructured network of former industrial institutes that still operate under state ownership to the detriment of the development of in-house R&D.

Countries in Southeast Europe do, however, have some trends in common. Between 2001 and 2006, there was a relative rise in employment in the higher education sector in all but Slovenia and a drop in employment in the government sector in all but Romania.

The shift towards higher education is symptomatic both of the neglect of university R&D in the past and of better financial opportunities for universities, enabling them to combine R&D and teaching.

Growth in employment in the private sector has been observed in all but Croatia, Serbia and Romania but remains modest in all but Greece and Slovenia.

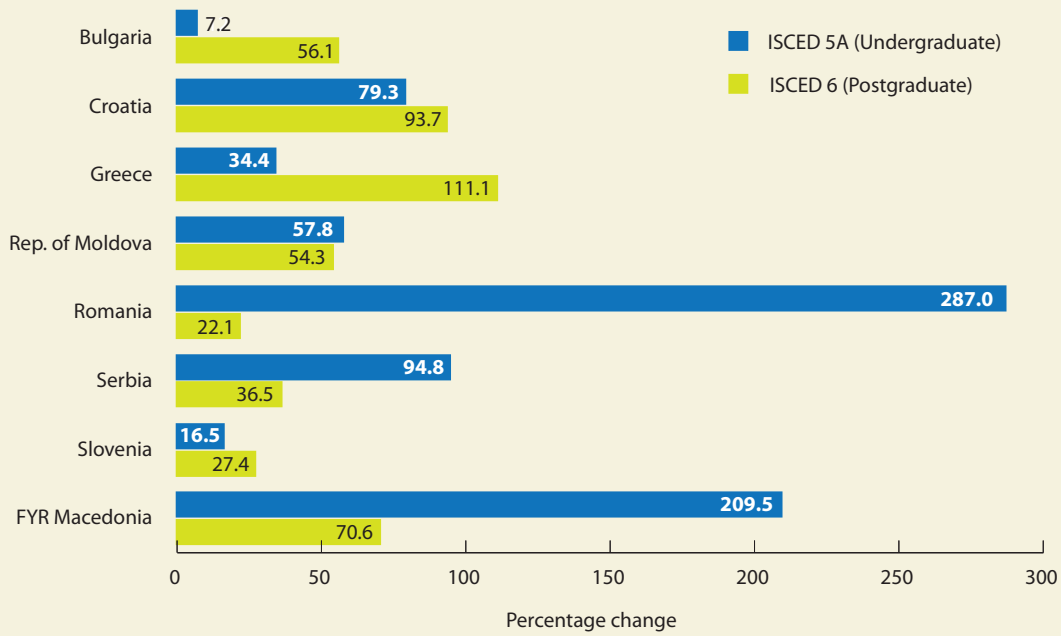
R&D OUTPUT

Publications and patents

The current performance of R&D in Southeast Europe is strongly linked to investment per capita and to the overall level of development. Trade in licenses is a useful indicator for measuring performance, in that it not only shows the degree to which countries are involved in exchanging knowledge but also relates to both the size of R&D systems and to the technological level of industry.

Slovenia, Croatia and Greece are far more involved in this type of exchange than their neighbours (Table 2). These three countries are also the biggest contributors in the region to world S&T in terms of three important indicators: the number of papers published per capita, the number of US patents obtained per capita and the amount received per capita in royalty payments and receipts. In this context, university–industry linkages are the most developed in Slovenia and Croatia. That this is not the case in Greece is largely due to the low technological level of Greece's industry.

Figure 6: Growth in numbers of tertiary graduates in Southeast Europe, 2002–2008 (%)



Note: For Greece, the period covered for undergraduates is 2002–2007, for Romania, it is 2004–2008 for graduates.

Source: UNESCO Institute for Statistics database, August 2010

Published scientific papers are not only a key output of a country's science system; they also indicate the degree to which the country is integrated in the international scientific community. In this respect, Greece stands out in the region in terms of the overall number of published scientific articles, with three to four times as many as any other country in the sub-region (Table 3). That said, the most developed science system in the sub-region is that of Slovenia, as evidenced by the number of scientific papers published per capita (Figure 9). Bulgaria, Croatia, Romania and Serbia are all intermediate countries. As for Albania, Moldova, Montenegro and the Former Yugoslav Republic of Macedonia, they all have relatively undeveloped science systems.

Science in Southeast Europe is dominated by four broad disciplines: physics, engineering/technology, chemistry and clinical medicine (Figure 10). In all but Albania, these four areas account for from 56% (Croatia) to 89% (Moldova) of all scientific publications. There was no significant evolution in the relative specialization of published scientific texts between 2002 and 2008, according to Science Citation Index data.

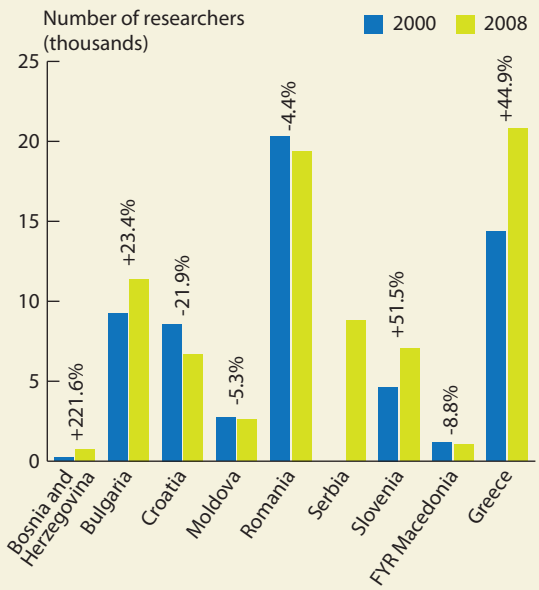
COUNTRY PROFILES

As we have seen above, the combination of weak demand for local R&D and innovation, on the one hand, and poor support systems for science and innovation, on the other, are the biggest bottlenecks to more effectively harnessing S&T to socio-economic growth in Southeast Europe.

Constraints on the demand side are further reinforced by constraints on supply, embodied by persistently strong external and internal brain drain coupled with an ageing pool of researchers. This portrait applies mainly to those countries in the Western Balkans[1] and to Moldova – the very same countries that are yet to become EU members and which face uncertain prospects for future EU membership.

Whereas the EU members from Southeast Europe share their neighbours' weakness on the demand side, they are generally in a much better position when it comes to their support systems for science and innovation (Slovenia and Greece) and the opportunities at their door for greater R&D funding and better S&T governance (Romania and Bulgaria).

Figure 7: Growth in researchers (FTE) in Southeast Europe, 2002 and 2008 (%)



Note: For Bosnia and Herzegovina and Romania, the period covered is 2003–2007, for FYR Macedonia 2002–2006 and for Greece 2001–2007.

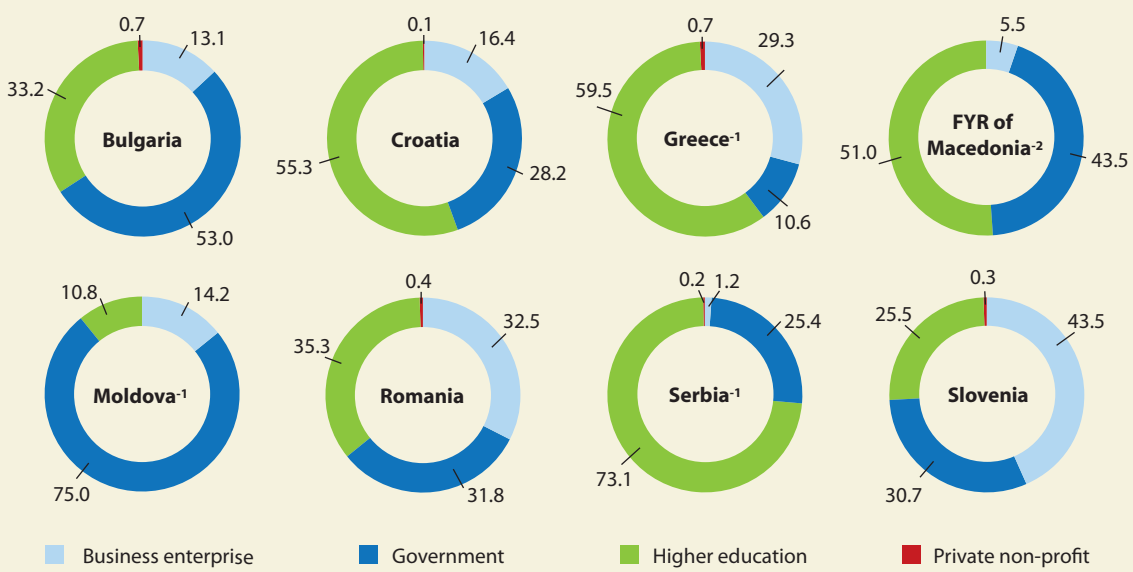
Source: UNESCO Institute for Statistics database, August 2010

A review of changes in individual countries reveals yawning differences in the degree of development and pace of restructuring of R&D systems, not to mention S&T governance (Nechifor and Radosevic, 2007). The R&D systems of Albania, Montenegro and Bosnia and Herzegovina – and to some extent the Former Yugoslav Republic of Macedonia – are the most disadvantaged. These countries are still striving to establish functioning R&D systems and are primarily addressing issues of science policy. Moldova is a specific case of a post-Soviet R&D system that has not reformed substantially. Bulgaria, Croatia and Romania have R&D systems at similar levels of development. In these three countries, there is a visible attempt to shift the focus from a narrow science policy to an innovation policy, or to integrate science into innovation policy.

As new EU members, Romania and Bulgaria have begun instigating vigorous changes that include introducing new sources of funding and internationalizing R&D. This should result in a substantial reform of their R&D systems in the medium term.

1. The Western Balkans encompass Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, Montenegro and Serbia.

Figure 8: Researchers (FTE) in Southeast Europe by sector of employment, 2008 (%)



-n = data refer to *n* years before reference year

Source: UNESCO Institute for Statistics database, August 2010

Table 2: R&D output in Southeast Europe, 2006
In terms of patents, publications and royalty payments

	Total royalty payments and receipts (US$ per capita) 2006	University–company research collaboration (scale of 1–7) 2007	Patents granted by USPTO (per million population) annual average 2002–2006
Albania	2.39	1.7	0
Bulgaria	10.38	2.7	0.74
Bosnia and Herzegovina	–	2.4	0.10
Croatia	50.02	3.6	2.45
Greece 42.53		2.9	1.87
FYR Macedonia	6.64	2.9	0.10
Moldova	1.48	2.3	0.33
Romania	10.22	2.7	0.34
Serbia	–	3.1	–
Slovenia	85.62	3.8	9.40

Source: World Bank, Knowledge for Development, KAM database, http://go.worldbank.org/JGAO5XE940, March 2009

In view of its R&D capacities, Serbia should also be in this group. However, owing to its international isolation in the 1990s, accompanied by a dire economic situation, Serbia is trailing behind in terms of change, especially when it comes to gearing its science system towards innovation.

Although the structure of industry differs greatly in Slovenia and Greece, both of these countries have well-established frameworks for science and innovation governance. We shall begin with them in the following country analyses before moving on to the two other EU member states then the countries of the former Yugoslavia, before concluding with Albania and Moldova.

Slovenia

The Slovenian R&D system managed to elude a post-socialist crisis in the 1990s. Since joining the EU, Slovenia's research system has been developing well. Business sector investment in R&D is growing, even as public expenditure remains stable as a percentage of GDP. In terms of scientific output, indicators such as publishing and citation rates for scientific articles and the impact factor all show a strong progression, while the overall system continues to internationalize. In parallel, the inclusion of various measures supporting R&D and innovation in the EU's structural assistance programmes within the EU's Seventh Framework Programme for Research and Technological Development (FP7, 2007–2013) is providing the necessary stability for public investment in R&D (*see page* 172).

The government has used EU funds to implement two operational programmes. The first is Slovenia's Operational Programme for Strengthening Regional Development Potential. This focuses on improving the competitiveness of the country's enterprises and its research excellence, and promoting entrepreneurship and infrastructure for economic development, with a total investment of €558.71 million. The second is the Operational Programme for the Development of Human Resources. This programme benefits from a fund of €39.54 million to foster entrepreneurship among experts and researchers and to promote their adaptability to the world of corporate competitiveness. These two operational programmes complement the Programme of Measures and provide the basis for effective implementation of a national policy to encourage entrepreneurship and competitiveness, as well as the efficient use of resources from structural funds.

Although business R&D is developing relatively well, linkages with the public sector remain weak. In 2006, for example, only 10.1% of public R&D funds went to the business sector, a decline of approximately 20% since the turn of the century. This trend suggests that demand for business knowledge is best met by the business sector's own R&D capacities and that public research should keep to its own areas of interest (ERAWATCH, 2008).

Measures designed to stimulate private investment in R&D include a corporate income tax subsidy, various means of co-financing R&D projects, subsidized loans for R&D investment, co-financing of the services that technology parks offer the business sector, development of business incubators and mobility schemes, and support for technology centres and platforms. One policy measure to improve the quality of research is the establishment of centres of excellence. The government has supported the establishment of 10 such centres, providing a new form of co-operation between business and public research.

Greece

The Greek science system operates in an economic environment with limited demand for R&D, due to an industrial structure dominated by traditional business

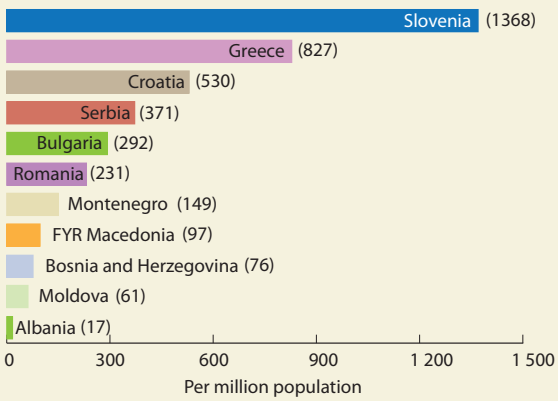
Table 3: Scientific publications in Southeast Europe, 2002 and 2008

	2002	2008	change (%)
Albania	35	52	48.6
Bosnia and Herzegovina	35	287	720.0
Bulgaria	1 528	2 227	45.7
Croatia	1 254	2 348	87.2
Greece	5 588	9 296	66.4
FYR Macedonia	104	197	89.4
Moldova	160	223	39.4
Montenegro	–	93	–
Romania	2 127	4 975	133.9
Serbia*	1 003	2 729	172.1
Slovenia	1 609	2 766	71.9

* Serbia includes Montenegro for 2002.

Source: Thomson Reuters (Scientific) Inc. Web of Science, (Science Citation Index Expanded), compiled for UNESCO by the Canadian Observatoire des sciences et des technologies

Figure 9: Scientific papers per million population in Southeast Europe, 2008



Source: Thomson Reuters (Scientific) Inc. Web of Science. (Science Citation Index Expanded), compiled for UNESCO by the Canadian Observatoire des sciences et des technologies. Population data from Eurostat and World Bank, March 2009

activities and small and medium-sized enterprises. Even though Greece has developed an R&D-oriented innovation policy, the non-R&D-intensive structure of its industry is limiting the policy's impact on the economy and employment (PRO-Inno Trendchart, 2007).

Business R&D is not only stagnant but also negligible, despite persistent efforts to reorient firms towards R&D and other knowledge-intensive activities. Most of these efforts have been undertaken within the EU's structural assistance programme for competitiveness and entrepreneurship, and the five regional programmes covering the 13 regions of Greece. Thematic priorities include information and communication technologies (ICTs), agriculture, fisheries, food science and biotechnology.

Greece has set itself a target of devoting 1.5% of GDP to GERD by 2015. This is ambitious, given that Greece's GERD/GDP ratio has been a steady 0.6% since the turn of the century. The EU contribution to this effort amounts to €1 291 million. Nearly half of these EU funds (46.5%) are channelled into areas related to innovation: innovative investments; R&D activities and infrastructure; the provision of advanced services to firms and entrepreneurship; and strengthening linkages between R&D units and small and medium-sized enterprises. However, faced with limited local demand, R&D-intensive firms have reoriented themselves towards EU funding or foreign markets.

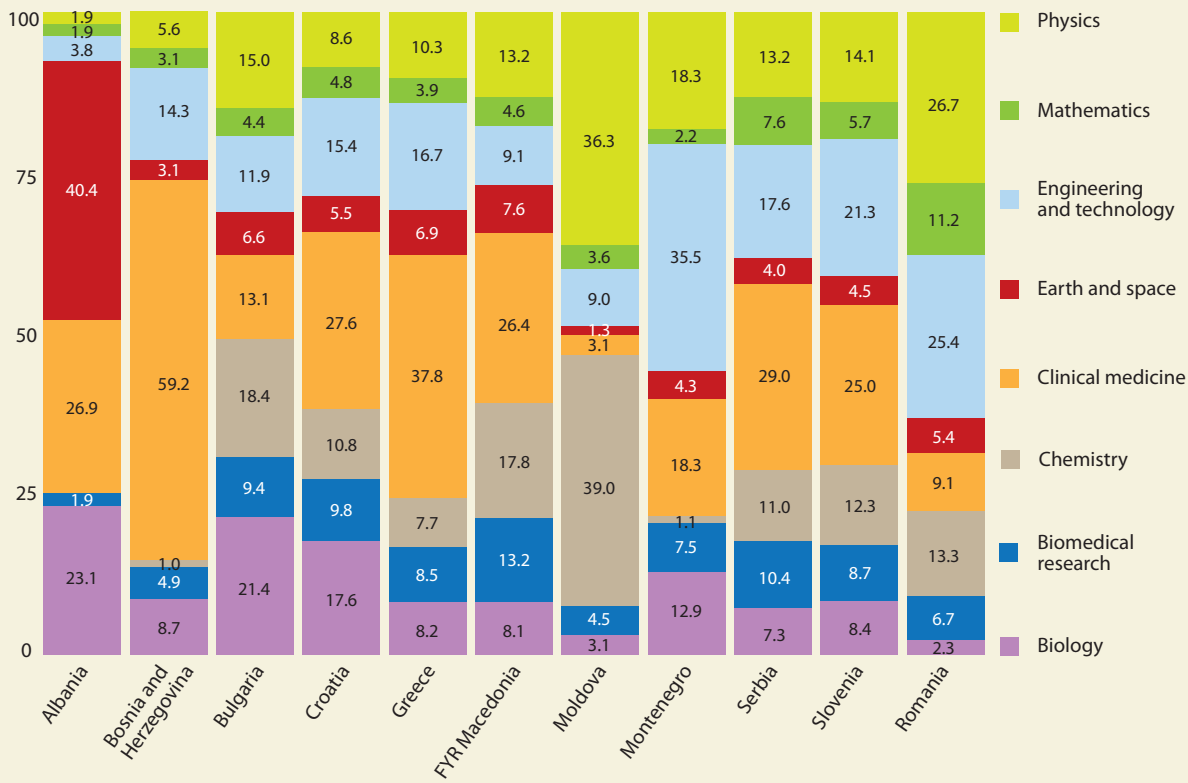
In parallel, the education system in Greece remains unreformed and slow to meet new demands, despite having expanded considerably. This is because any form of evaluation of the education system or accountability was rejected for many years. Without feedback from the labour market, teaching methods and curricula have remained based on centrally selected manuals. There is an ongoing debate about possible reforms, mainly in universities. A reform law re-regulating administrative issues has begun a very slow and controversial process of implementation.

Romania

The Romanian R&D system has emerged from its own 'transition crisis' and is now recovering, especially since Romania gained EU membership in 2007 (*see page* 172). There has been some growth in public R&D expenditure, up from 0.37% in 2000 to 0.46% in 2006, as part of the government's commitment to meeting the 3% target of the Lisbon Strategy (Box 1).

The need to converge towards EU norms and practices has strongly influenced science and innovation policy in Romania. The decision-making system has been

Figure 10: Publications in Southeast Europe by major field of science, 2008 (%)



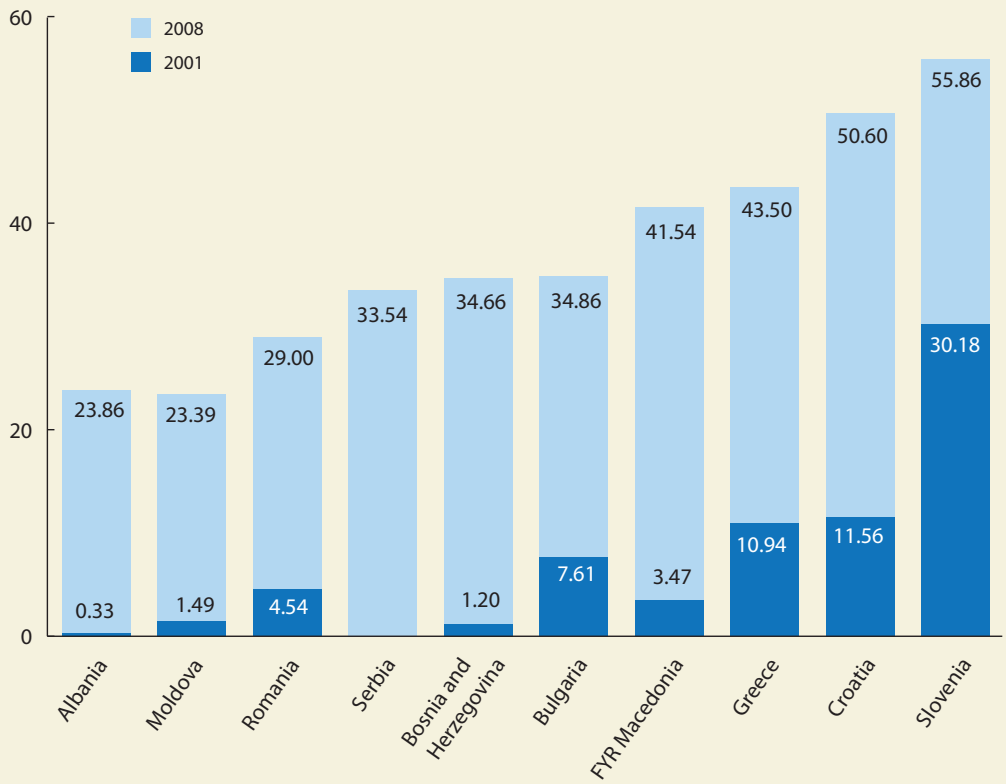
Source: Thomson Reuters (Scientific) Inc. Web of Science, (Science Citation Index Expanded), compiled for UNESCO by the Canadian Observatoire des sciences et des technologies

decentralized, funding systems have diversified and become more flexible, there has been a gradual increase in domestic competition-based funding, and the country's first *National R&D and Innovation Plan* has rewarded and assisted outstanding R&D groups.

Romania's second *National R&D and Innovation Plan* (2007–2013) contains strong provisions for investment in research, highly consistent with the priorities of the EU Seventh Framework Programme. The priorities of the *Plan* reflect the results of the first Romanian foresight exercise in S&T. As part of this exercise, a broad Delphi survey was employed in which over 3500 experts identified in the first phase of the project were consulted in two rounds. As a result of the survey, nine priority domains were identified as having substantial potential for socio-economic progress and the second plan was built around them. These nine priority domains are: ICTs, energy, environment, agriculture, food safety and security, biotechnologies, innovative materials, processes and products, space and security, and socio-economic and humanistic systems. Each of the nine domains comprises several priority themes.

Within the framework of the second plan, competitive bidding for five of the six programmes was organized in 2007 and 2008. A better utilization of resources is expected in the years to come, through support for research programmes directed more towards satisfying demand from the public and private sectors. Stricter norms have

Figure 11: Internet users per 100 population in Southeast Europe, 2001 and 2008



Source: United Nations Statistical Division, Milliennium Development Goals Indicators

also been introduced in the second plan for evaluation and quality control during a project's life-cycle.

On the downside, international co-operation in R&D remains very weak in Romania, a situation exacerbated by the paltry demand for R&D from the business sector. Infrastructure for science-oriented innovation also remains underdeveloped but it is expected that, through EU-support programmes, this situation will turn around. The benefit of improvements to the public R&D system may be limited unless business R&D expands and takes on new orientations. Accession to the EU has certainly had a positive impact on the mobility of students. In the long term, this should provide Romania with more highly skilled employees and improve the absorptive capacity of firms.

Bulgaria

The Bulgarian research system bears similarities to that of Romania. For one thing, it is emerging from a prolonged period of downsizing, restructuring and meagre investment in R&D. The country's EU accession has promoted a large spectrum of institutional changes in the governance of science and innovation.

The National Innovation Fund within the Ministry of Economy and Energy has become the primary public financial instrument for implementation of Bulgaria's National Innovation Strategy. The Ministry has also approved the creation of several Centres of Entrepreneurship within Bulgarian Technical Universities. An important step towards developing innovation in

Box 1: The Lisbon Strategy's elusive 3% target

When the European Council met in Lisbon in March 2000, the Heads of State and Government assigned to the EU the objective of becoming, by 2010, 'the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion' (Lisbon European Council, 2000). Two years later in Barcelona, they fixed a target for each country of devoting 3% of GDP to R&D by 2010. It was proposed that two-thirds of this share (2% of GDP) come from the private sector. Non-EU members are not bound by these ambitious goals.

Of the four EU members from Southeast Europe, only Slovenia stands a chance of achieving the Lisbon goals, particularly that for private-sector investment in R&D.

However, many 'older' EU members are also struggling to attain the elusive Eldorado. In 2008, just two European countries exceeded the 3% target – Sweden and Finland – and the average for the 27-member European Union was 1.8%.

Source: author

For details of the situation in the EU, see page 166.

Bulgaria is the implementation of the European PHARE project focusing on the cluster approach and establishing the cluster model.

Each individual ministry has a plan to shape and implement sectoral research policies but there is no national co-ordination body. As a result, synchronizing sectoral policies and achieving synergy is proving problematic. Another weakness of the innovation system is the lack of well-developed public–private partnerships.

The government has recently introduced incentives for private financing of R&D through the establishment of the National Innovation Fund (NIF) and National Science Fund (NSF). These funds introduce competitive bidding for up to 50% of R&D project funding.

In parallel, the state has committed to increasing public spending on research and innovation: the annual NSF budget for 2008 nearly quadrupled to roughly €32 million over the previous year. Although the share of the competitive funding provided by the NSF and NIF remains low, it still allows funds to be allocated to the best proposals. Other strong points are that the NSF projects are evaluated by international experts and that, since 2007, 30% of grants can be used for additional remuneration of any young researchers who have participated in the preparation of a project proposal.

It should be noted, however, that these two funds would need to be substantially bigger to have an impact on R&D and innovation. The government would be wise to reallocate part of the current institutional funding to these competitive funds.

Long-term research funding is highly dependent on European funding, notably via the EU structural funds (*see page* 173). EU membership is also providing Romanian researchers with greater access to knowledge. However, links are still missing between innovative Romanian enterprises and the bulk of the R&D system (Ruslanov, 2007). The country's support system for science-oriented innovation remains undeveloped.

Croatia

The Croatian R&D system is strongly oriented towards research in the public sector. This helped to preserve and maintain the national science base during the 1990s but also led to neglect of the private sector. As a result, the private sector's technological capacities are weak, generating a limited demand for local R&D. Support for science-oriented innovation is currently being developed through five technology centres and the Croatian Institute of Technology (Svarc and Becic, 2007). This dynamic will most likely be pursued, with expected accession to the EU in the next few years.

However, the scope of innovation policy is confined to infrastructural support for the commercialization of private R&D results. There is a need to broaden this framework and to foster co-operation between public science and private industry.

Serbia

Serbia made only cosmetic changes to its R&D system during the 1990s. The country's R&D system has transformed itself gradually by diversifying sources of income and activities, by closing R&D institutions and by

reducing reliance on domestic R&D activities. This 'silent transition' (Kutlaca, 2007) has been accompanied by brain drain and an absence of middle-aged researchers.

Since 2003, Serbia has begun establishing a support system for science-oriented innovation through technology incubators, innovation centres and science and technology parks. The downsized business sector remains in crisis, however, pending changes in ownership and larger inflows of foreign direct investment. The opportunity for Serbia to participate in EU Framework Programmes for R&D will most likely prove beneficial for the country's R&D system.

Former Yugoslav Republic of Macedonia

The Former Yugoslav Republic of Macedonia has begun modernizing its science system and is in the process of preparing a national science policy. In 2005, it initiated this reform by introducing a new system of project evaluation. A year later, the government approved the national Programme for the Development of Scientific Research Activities for the period 2006–2010, the first official programme adopted by the government relating to developing the country's R&D capacities.

Bosnia and Herzegovina

More than a decade after the inter-ethnic war following the break-up of Yugoslavia, Bosnia and Herzegovina has not yet established its own R&D system. Current investment in R&D is estimated to be between 0.05% and 0.15% of GDP (Matic, 2007; Papon and Pejovnik, 2007). The division of political and administrative responsibilities among the three levels of government[2] makes it very difficult to define and implement country-level science policy.

For many years, the country remained isolated in terms of access to EU R&D funding and other co-operation agreements. This was partly due to its inability to operate as a single entity in international relations. This changed on 1 January 2009 when Bosnia and Herzegovina became an 'associated country' with respect to the EU Seventh Framework Programe. This new status will, at last, enable the country to access the international R&D community; it is also an important incentive to overcome internal fragmentation.

2. Inherited from the General Framework Agreement for Peace in Bosnia and Herzegovina, signed in 1995

Montenegro

Four years after gaining independence from Serbia in May 2006, Montenegro is in the process of establishing its own science system and science policy. The country's S&T system consists of the Montenegrin Academy of Sciences and Arts (founded in 1973) and the University of Montenegro (founded in 1974). The university comprises 14 faculties and one college, with 1 000 students, and incoroprates four scientific research institutes.

Albania

Public investment in R&D is less than 0.18% of GDP in Albania and there is little business R&D to speak of (Sulstarova, 2007). Brain drain strongly undermines the rejuvenation of the country's R&D system.

Albania initiated a reform in 2005 by creating a single system of scientific research, concentrated in universities. In 2007, 14 of the institutes attached to the Academy of Sciences were subsumed into universities.

Since 2008, the Albanian government has initiated a range of policy measures. In June 2009, it published a *Cross-cutting Strategy for Science, Technology and Innovation in Albania*. This identifies five 'strategic goals' for the country to 2015:

- to triple public spending on research to 0.6% of GDP;
- to increase the share of GERD from foreign sources to 40% of the total, including via the EU's Framework Programmes for Research and Technological Development;
- to create four or five Albanian centres of excellence in science;
- to double the number of researchers through 'brain gain' incentives like a Young and Returning Researchers grant scheme and the training of new researchers, including 500 PhDs: three new doctoral programmes are to be established in Albanian universities;
- to increase innovation in 100 companies through investment in local R&D, or via consortia with either academic research institutes or foreign partners.

The *Cross-cutting Strategy* is to be implemented in synergy with the *National Strategy for Development and Integration* (2007–2013) and other sectoral strategies, including Albania's *Higher Education Strategy* (2008).

Box 2: The Venice Process

Since 2001, the Venice Process has been rebuilding scientific co-operation among Southeast European countries. The goal is to encourage countries to share limited resources and to heal the scars of a decade of political and socio-economic turmoil. In parallel, the process sets out to build scientific co-operation between the sub-region and the rest of Europe, in order to prepare countries for integration into the European Research Area.

The process was officially launched at the Venice Conference of Experts on Rebuilding Scientific Co-operation in Southeastern Europe, on 24–27 March 2001. Seven months later, the recommendations adopted by the conference met with the unanimous approval of the ministers responsible for science and technology from the countries concerned, at a roundtable organized during UNESCO's General Conference. Also attending the roundtable were numerous countries from the EU and several non-governmental organizations.

The Venice Process is named after the host city of UNESCO's Regional Bureau for Science and Culture in Europe (BRESCE). Since 2002, UNESCO's Venice office has provided science policy advice and expertise to Southeast European countries, in order to raise awareness of the importance of investing in S&T for national and regional development. In addition to gathering ministers and other high-level decision-makers together on issues related to STI governance, BRESCE has contributed to the elaboration of national STI strategies in Bosnia and Herzegovina and in Albania.

Moreover, the Venice office has provided financial support and organized programmes to encourage regional networking in life sciences, environmental sciences and astronomy as a means of tackling brain drain, supporting communication services and strengthening scientific co-operation as a tool for reconciliation and dialogue.

Four new Southeast European networks

In 2003, Prof. Alexander Boksenberg of Cambridge University (UK) undertook an expert mission to the main centres of astronomy in the region on behalf of UNESCO. This resulted in a programme entitled Enhancing Astronomical Research and Observation in Southeast Europe and Ukraine, with financial support from the Italian government. Within this programme, the most important telescope in Southeast Europe was upgraded with financial support from BRESCE. Today, the Astronomical Observatory of Rozhen in Bulgaria which hosts the telescope has become a major research facility shared by researchers throughout the sub-region.

A Southeast European Astronomical Research Network has also been created with statutes drafted by its members. The network has since established a co-ordination mechanism for astronomical research, the Sub-regional European Astronomical Committee, which has a rotating presidency and secretariat. A large number of astronomical events in the region have been organized within this framework, some of which have benefited from financial support from UNESCO's Venice office.

Galvanized by this success story, the Venice office has gone on to support the creation of a Human Genetics and Biotechnology Network, which met for the first time in March 2006 at the Research Centre for Genetic Engineering and Biotechnology in Skopje (Bulgaria).

The Venice office also spear-headed the establishment, in 2007, of a sub-regional network for Risk Assessment and Mitigation, co-ordinated by the Institute of Geodynamics in Athens and a sub-regional Mathematical and Theoretical Physics Network, hosted by the Faculty of Science and Mathematics at the University of Niš in Serbia.

The GRID computing project

UNESCO's GRID project is sponsored by the Hewlett Packard company. Since 2004, it has helped to combat brain drain and facilitate networking by donating GRID computing technology to seven universities in Southeast Europe. This has enabled students to collaborate on research projects with their peers worldwide without having to leave their home institution. Seed money provided by the project has also given students the opportunity to participate in short exchanges with universities abroad.

Source: UNESCO

Also in 2009, Albania launched its first survey of R&D statistics, including business R&D and innovation, with the support of UNESCO.

Moldova

Moldova is the only post-Soviet country in Southeast Europe. Its R&D system continues to be organized around the Academy of Sciences. Investment in R&D has continued its downward spiral, dropping to 0.4% in 2004 from 0.6% in 2000. Between 2000 and 2004, employment of research scientists and engineers declined by 5%. Mass emigration accompanied by brain drain is hindering domestic innovation and entrepreneurship.

INTERNATIONAL CO-OPERATION

The violent break-up of Yugoslavia in the 1990s threw most of the Western Balkan countries into isolation for the greater part of the decade, including in terms of international scientific co-operation. The first decade of the 21st century marks a new era, one in which science systems of Western Balkan countries are being rebuilt and reconnecting to the R&D networks of the EU. The process is still painfully slow. It is being hindered not only by external factors like EU policies but, to an even greater extent, by the lack of a national consensus on the need to base economic growth on science-oriented innovation.

Since 2000, UNESCO has been leading initiatives to improve co-operation in the region, within what has come to be known as the Venice Process (Box 2). This process has since been followed by various EU initiatives such as the Southeast European ERA-NET, a horizontal network that aims to structure and expand the European Research Area to the Western Balkan countries. Strengthening the relationship between the EU and the Western Balkan countries, including Moldova, is the most effective way to overcome their isolation and give them greater access to international R&D networks.

In addition, international co-operation may further improve with the integration since 2007 of the Western Balkan countries into the EU Seventh Framework Programme for Research and Technological Development (FP7). The FP7 is now the single biggest source of foreign R&D funding for Western Balkan countries and represents a major opportunity for them to introduce the notion of excellence into evaluation criteria.

Beyond Europe, the major partner for individual countries in Southeast Europe is the USA, through bilateral co-operation. There is of course also considerable scope for intra-regional bilateral co-operation, one of the goals of the Venice Process. This bilateral co-operation within Southeast Europe should include not only bilateral projects but also fellowships, information services and joint refereeing systems.

Box 3: Measuring implementation of the *Science Agenda*

Where does Southeast Europe stand in relation to the *Science Agenda*, the document adopted by governments on 1 July 1999 at the World Conference on Science organized by UNESCO and the International Council for Science?

One of the *Science Agenda's* 90 recommendations was for countries to devote a greater share of GDP to R&D. In most of Southeast Europe, there is the political will to do just this. In the four EU member states from the region, a range of measures have been taken which point in the right direction. Among the three most recent EU members – Bulgaria, Romania and Slovenia – there is also a trend towards a diversification of funding sources for R&D.

Most countries from the region are increasing support for university–industry partnerships as a way of enhancing science-oriented innovation, another recommendation of the *Science Agenda*. However, the experiences of those countries that are ahead in this area, including Greece, indicate that this is a slow process hampered by a lack of domestic demand.

Another recommendation advocates a greater mobility of professionals between universities and industry, and between countries, as well as through research networks and inter-firm partnerships. In Southeast Europe, the level of support for professional mobility varies widely.

The biggest weakness in the region remains an insufficient focus on institutions of higher learning in the fields of engineering, technological and vocational education, not to mention lifelong learning.

Source: author

For details of the *Science Agenda*: UNESCO (1999)

CONCLUSION

The diversity of Southeast Europe is both a massive obstacle (such as in terms of competitiveness) and an asset for intra-regional integration and integration with the EU.

Countries also have points in common. Demand for R&D tends to be weaker than supply, with the notable exception of Slovenia. Even supply is hampered by continuing severe external brain drain.

In those countries with functioning R&D systems, namely Bulgaria, Croatia, Romania and Serbia, there is a need to broaden the focus of science and innovation policy and to link public R&D to the countries' industrial, agricultural and health care sectors. These countries also need to make better use of international assistance to integrate R&D into the European Research Area and to facilitate linkages between the EU and domestic systems of innovation.

There has been some limited progress in integrating the Western Balkan countries into the European Research Area. International stakeholders are aware of the need to support S&T to facilitate this integration and ensure long-term growth. However, this will necessitate huge improvements in infrastructure and a restructuring of the countries' S&T systems.

The Western Balkan countries in particular cannot afford *not* to increase investment in R&D funding, even though the benefits are sometimes only seen in the long term. The alternative would be for them to fall farther behind the rest of Europe in terms of economic development. However, this increase should be accompanied by a strong focus on funding both excellence and locally relevant research. This will require fair competition, priority-setting, transparency and international criteria of excellence.

The 'Europeanization' of the region's R&D systems via EU research networks will serve to connect the research endeavours of countries in Southeast Europe with the best the EU can offer in terms of R&D teams. We can expect a better balance between incentives (selection through project funding) and stability (the share of institutional funding). However, the bottleneck caused by little domestic demand for R&D and a weak private sector in all but Slovenia is likely to remain a major structural weakness in Southeast European R&D systems for years to come.

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