Greece in crisis

Costas M. Soukoulis

In spite of substantial progress over the past 35 years, underfunding and lack of evaluation are preventing Greek research and technology from reaching its true potential. A coordinated effort between government, academia and industry could lead to viable solutions to the current crisis.

Higher-education research and technology in Greece weren't always in dire need of reforms and economic stimulus. Optimism flourished in the late 1970s and early 1980s when an intensive effort was made to increase the number and radically modernize the structure of national research centres. Milestones in this effort were the establishment of a new Ministry of Research and Technology responsible for the regulation of research activities, and the creation of new research centres operationally associated with selected universities. Further cause for optimism came from the fact that, in 1981, Greece became the tenth member of the European Union (EU), a development of decisive importance because it opened up the possibility for Greek researchers to compete for funding within the European Framework Programmes. During the 1980s and early 1990s, graduate studies within Greek universities leading to PhD degrees were gradually modernized, while studies leading to Master's degrees were established for the first time. New research areas, such as computer science, molecular biology, lasers, microelectronics, materials, and photonics were initiated and subsequently strengthened, while the corresponding old curricula were revised and expanded. At the same time, Greece became a member of several international scientific organizations, including the European Center for Nuclear Research (CERN), the European Molecular Biology Laboratory and the European Space Agency.

Perhaps not totally prepared for these new research structures and pace of educational progress, the modernization effort also led to an overgrowth in the number of universities and technological educational institutions that were created. At present, in a country of just over 11 million people, there are 26 universities and 14 technological educational institutions distributed over 63 cities. The creation of so many institutions and the practice of spreading similar and unnecessary departments throughout the country — the outcome of national politicians succumbing to pressures from local officials looking to stimulate the economic activity in their cities — has proven not only detrimental to a better education experience for the students, but has also led to an unorganized expansion that nowadays hinders the introduction of new research structures.

Assessing Greek research

Compared with fellow European countries, there is no doubt that over the past 35 years research and development in Greece has improved significantly. There are now research groups that can successfully compete on the international stage. Indeed, in 2011, Greece was among the top 15% of the 27 European countries in terms of funding per researcher awarded from several European Framework Programmes[1,2] by the European Commission (Fig. 1). And Greek researchers in the 1990s succeeded in receiving funding that was three times higher than the European average. Vibrant, research-intensive organizations[2] include the Foundation for Research and Technology Hellas (FORTH), the Center for Research and Technology Hellas (CERTH), the National Technical University of Athens (NTUA), the National Center for Scientific Research 'Demokritos',

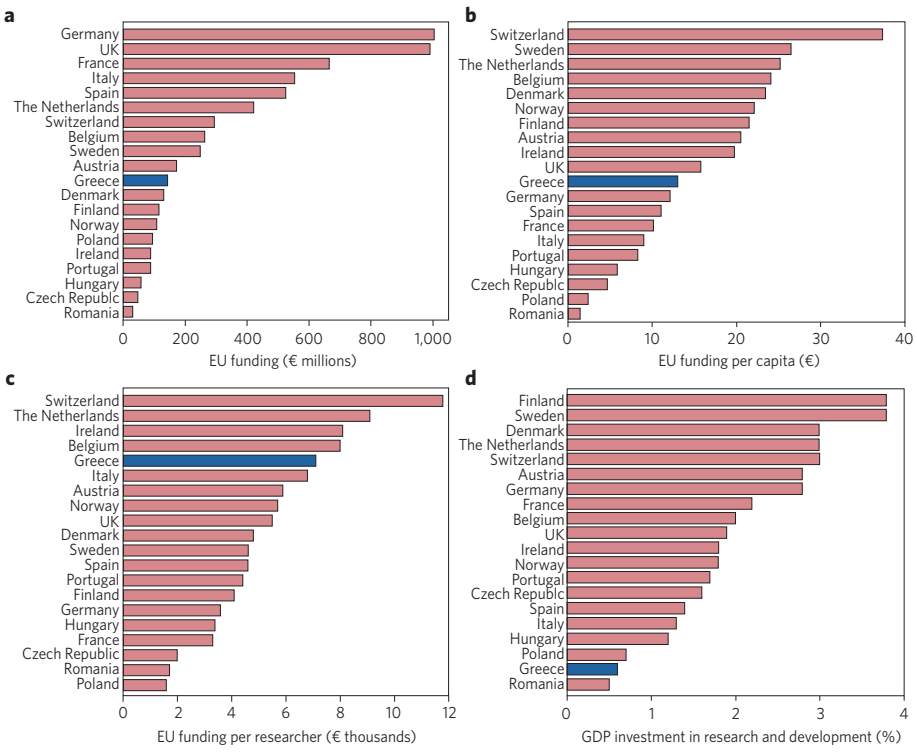

Figure 1 | European science funding for 2011. **a**, The amount of funding that the EU provided to each country. **b**, The amount of EU funding divided by the population of each country. **c**, The amount of EU funding per researcher. **d**, The percentage of GDP invested in research and development in each country. The data are obtained from ref. 1.

and the Institute of Communications and Computer Systems (ICCS).

It is also interesting to note that among the top 1% of the most cited papers in the world, 1.13% are from Greece, a number[3] comparable to countries such as the USA (1.19%), Canada (1.09%) and Italy (1.10%), but less than the top European country, Switzerland (1.91%). As a result of the positive steps taken in the 1980s and 1990s, Greek universities nowadays offer their students high-quality courses in both science and engineering with up-to-date content. Finally, mainly because Greek families traditionally consider a university education as an effective means of upward social mobility, a substantial percentage of Greek students are highly motivated and have a strong scientific background.

Having addressed these positive indicators, Greek research is still well below its true capabilities. Several factors have prevented the realization of its full potential.

Inadequate funding. The funding of research in Greece from all sources amounted in 2010 to only about 0.57% of the gross domestic product (GDP) or €1.3 billion, the lowest among the 15 countries of the EU (ref. 4; before its recent expansion to 27 countries). This also includes a very substantial contribution, 0.15% of the GDP, coming mainly from the EU through the so-called structural funds and through the competitive grants of the Framework Programmes for Research. Other countries, by contrast — Finland and Sweden (3.8%), Japan (3.4%), Denmark and The Netherlands (3.0%), Austria, Germany and USA (2.8%), France (2.2%), UK and Canada (1.9%), Ireland and Norway (1.8%), Portugal (1.7%) and Italy (1.3%) — show a much higher percentage[4] of GDP investment in research and development. Greek domestic funds mainly cover salaries of tenured and tenure-track employees, and other inelastic running expenses. Competitive project-based grants for individuals or research teams financed exclusively by Greek sources are currently not available. Scientists have to apply for such grants through the EU Framework Programmes. Furthermore, some intermittent national competitive grants, partly supported by the EU structural and cohesion funds, have become available during the past decade. The sporadic character of the availability of national competitive research grants, in combination with the overall inadequate funding, constitutes a serious obstacle for the development of Greek research.

> The Greek state does not evaluate the research and teaching performance of its universities.

The financial meltdown of the past three years has made the situation even worse[5]. Regular budgets have been slashed by 35%; matching funds have disappeared; salaries have diminished by about 50%. As an example, the regular yearly net income for a full professor with more than 25 years of service is just over €20,000. Severe restrictions were also put in place for tenure-track hiring. These dramatic measures, being enforced across the board without considerations of the quality of performance, severely damage science and research. Under such conditions, recruitment has become next to impossible and the brain drain has increased noticeably.

Lack of evaluation. The second important factor impeding Greek research is the lack of evaluation. The Greek state does not evaluate the research and teaching performance of its universities. Any attempt is met with fierce resistance by well-organized and politicized groups — whose members are both faculty and students. Only recently have some departments undergone official evaluation, but they have not been compared with other departments in the same discipline within the country or internationally. It should be emphasized here that there are several pockets of excellence within the Greek universities and research centres. However, without adequate funding and proper evaluation we risk losing some of these groups of excellence, whose formation took so much effort, expense and time.

The research centres, on the other hand, have a balanced administrative system and are allowed to collaborate with universities. A rather limited use of this opportunity has been made mostly by the University of Crete and FORTH. Furthermore, the institutes of these research centres have undergone three comparative evaluations over the past 20 years by senior external experts through site visits. Unfortunately, the results of these evaluations were ignored by the state, as far as the regular budgets were concerned, and have had a minor effect on infrastructural funding. Meanwhile, Greek research was performing rather well in international rankings (Table 1).

Table 1 | Ranking of different research areas.

Research area*	Citations per paper†	Rank in World (Europe)‡
Physics and astronomy	13.20	26 (17)
Chemistry	14.99	24 (16)
Materials	10.92	20 (13)
Chemical engineering	13.09	11 (9)
Engineering	8.16	20 (13)
Mathematics	7.64	29 (16)
Computer science	8.39	26 (15)
Biochemistry, genetics and molecular biology	17.54	28 (17)
Medicine	12.36	25 (15)

*The research areas were taken from ref. 9. †The data in column 2 is for the period 1996–2011 and shows the number of citations per paper for different research areas in Greece. ‡Where Greece is ranked in the world and western Europe. The criterion used is the average number of citations per paper published during 1996–2007.

Empty 'mergers'. Restructuring of universities and research centres has been attempted in the past two years mainly through mergers. It was argued that these mergers would bring substantial savings, promote excellence and increase the efficiency of the system. Unfortunately, in most cases, the savings have been negligible. The performance of researchers and professors hasn't been improved, no one has been dismissed as a result of the mergers, and no improved utilization of lab or office space has been achieved. Indeed, as far as promoting excellence, experience has shown that forcing together two groups of different levels of quality, results in a period of upheaval, followed by an equilibrium state that is closer to the quality of the lower-level partner. Increased efficiency could thus be achieved only if serious and comparative evaluations precede the merger.

Can Greek research survive?

There are some recent signs that permit a small degree of optimism: first, as mentioned previously, the Greek research and development system is still successful in securing competitive EU funding despite

the economic downturn. Second, recent legislative action concerning the system by which universities are administrated is moving in the right direction. This could help bring new blood and possibly fresh ideas to the top administrative level as well as reduce the detrimental role of the overly politicized student organizations. Further, matching funds have started reappearing and structural funds are once again being used for financing national research grants.

However, significant action is necessary before competitive research in Greece can overcome decades-long burdens and difficulties that are holding it back from achieving its true potential.

First, bureaucracy and unnecessary restrictions imposed on the Greek research system by new laws that have swiftly been passed over the past two years under the pressure of the 'troika' (representing the creditors) should be removed. For instance, the restrictions on hiring, salaries and other expenses should only be applied to the funds that come from the Greek government. These restrictions should not apply when the funds come from international grants or the private sector. This would allow research institutions to offer competitive salaries and fellowships to post-docs and graduate students to attract highly qualified, young researchers. If not, Greece could lose its best, young researchers.

Second, the research performance of university departments and research institutes should be systematically evaluated by bibliometric data[6,7], which should be collected by the Ministry of Education as well as by international committees-of-experts by discipline. This would allow similar research units to be ranked so that they can be compared, and thus permit a more effective way of distributing the limited funds available. And despite these challenging times the state has both the knowledge and funds from the EU to directly finance centres of excellence to keep worthy Greek scientists at home.

Third, important lessons should be learned from other European higher-education and research policies. In Greece, the large number of universities is a central issue. To put things into context, Austria, Switzerland and Denmark have, respectively, a population of 8, 7 and 6 million people operating in 14, 12 and 5 universities, respectively. In 2007, Denmark managed to merge the excessive number of its universities into just five. Such restructuring after a careful evaluation of performance, albeit painful, can be a way of correcting excesses of the past and to develop a functional university system.

The state has both the knowledge and funds from the EU to directly finance centres of excellence to keep worthy Greek scientists at home.

Other lessons could be learned from Turkey (for example, Bilkent University, a private institution), The Netherlands as well as other European and international universities, which teach their courses in English. The purpose is twofold: first, to attract scientists from every corner of the world, because almost all high-profile academics know and use English, and second, to prepare future generations for an international competitive labour market. Many of the students in these universities come from around the world and pay tuition fees. In Greece too, the International Hellenic University (IHU) in Thessaloniki is providing programmes in English, attracting about one-fifth of its students from abroad. Excellent Greek students do not pay tuition fees to IHU and will not do so in private Greek universities in the future. Perhaps now, in this difficult period, it is the appropriate time to consider reforming Greek higher-education institutions so that they can provide undergraduate and postgraduate courses in foreign languages, as well as charge tuition fees to create a source of income for the financially drowned Greek universities.

Finally, a current concern is that Greece produces an extremely small number of start-up and spin-off companies (for example, FORTHnet in 1995, FORTH Photonics in 2002, Pharmathen in 1993). Again, one of the greatest problems that start-up companies face is bureaucracy. Obtaining funding is also one of the hardest tasks an entrepreneur can face in Greece, and this situation must change as a matter of priority. Moreover, the patenting activity in Greece, albeit improving, is still low. Indeed, according to Eurostat[8], in 2007, Greece only filed 109 patents and had the second lowest number of high-technology patents among EU countries at the European Patent Office.

Greek science and technology has enormous potential, as the significant progress of past decades has shown, but the country faces important challenges for restructuring and reforming its higher-education system, as well as linking it with industry and the real economy. Awareness of the decades-long problems and deficiencies as well as of the possible routes to solve them, some of which have been outlined here, may help shape a national strategy that will be of benefit in the long term to the students, academics and inhabitants of the country, forming the basis for a knowledge-based economy and a prosperous economic future. ❐

Costas M. Soukoulis is a Distinguished Professor at the Physics Department at Iowa State University and a Senior Scientist in the Ames Laboratory, Ames, Iowa 50011, USA. He has been an associated member of IESL-FORTH at Heraklion, Crete since 1983, and was a Professor (part time) at the Department of Materials Science and Engineering, University of Crete (2001–2011).
e-mail: soukouli@iastate.edu

References

1. European Research Ranking; http://www.researchranking.org
2. European Commission *Innovation Union Competitiveness Report 2011 Country Profile — Greece*; available via http://go.nature.com/q78j54
3. Van Noorden, R. *Nature* **492,** 324–327 (2012).
4. http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
5. Feder, T. *Phys. Today* 24–27 (April, 2012).
6. Altanopoulou, P. *et al. Quality in Higher Education* **18,** 111–137 (2012).
7. Lazaridis, T. *Scientometrics* **82,** 211–216 (2010).
8. European Commission *Science and Technology Statistics at Regional Level*; available via http://go.nature.com/zACzbe
9. http://www.scimagojr.com