Our future
As a knowledge society?

José Mariano Gago

ROARS

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INSTITUTO SUPERIOR TÉCNICO
UNIVERSITY OF LISBON
gago@lip.pt
LIP and Instituto de Prospectiva
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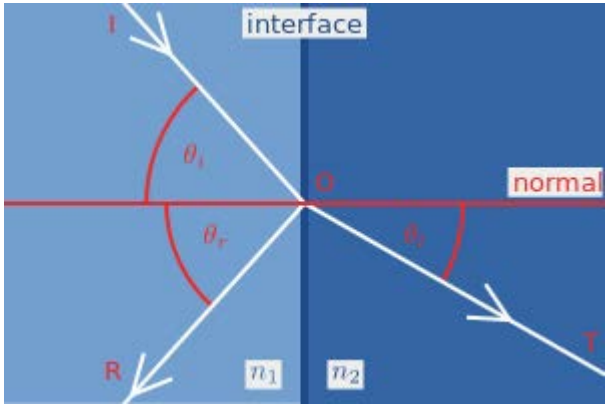


I used to start introducing students to the text on Mechanics of Landau and Lifshitz, and the use of the principle of least action, by recalling how it is related to the trajectory of light and by encouraging them to reading about the history of ideas on this subject. But first I would tell them about the progrom against jews in Lisbon, in April1506, and as it all started with the reflection of light.

$$\delta \int_{t_1}^{t_2} L(\mathbf{q}, \dot{\mathbf{q}}, t) dt = 0$$

Hero of Alexandria (Heron) (c. 60) described a principle of reflection, which stated that a ray of light that goes from point A to point B, suffering any number of reflections on flat mirrors, in the same medium, has a smaller path length than any nearby path.

Ibn al-Haytham (Alhacen), in his Book of Optics (1021), expanded the principle to both reflection and refraction, and expressed an early version of the principle of least time. His experiments were based on earlier works on refraction carried out by the Greek scientist Ptolemy.

Pierre de Fermat
The generalized principle of least time in its modern form was stated by Fermat in a letter dated January 1, 1662, to Cureau de la Chambre. It was met with objections made in May 1662 by Claude Clerselier, an expert in optics and leading spokesman for the Cartesians at that time. Amongst his objections, Clerselier states:
... Fermat's principle can not be the cause, for otherwise we would be attributing knowledge to nature: and here, by nature, we understand only that order and lawfulness in the world, such as it is, which acts without foreknowledge, without choice, but by a necessary determination.

The original French, from Mahoney, is as follows:
Le principe que vous prenez pour fondement de votre démonstration, à savoir que la nature agit toujours par les voies les plus courtes et les plus simples, n'est qu'un principe moral et non point physique, qui n'est point et qui ne peut être la cause d'aucun effet de la nature.

Historically, Fermat's principle has served as a guiding principle in the formulation of physical laws with the use of variational calculus (Principle of least action). (public source:wikipedia)

Igreja de são domingos, lisboa

1506

- A historiografia situa o início da matança no Convento de São Domingos de Lisboa, no dia 19 de abril de 1506, um domingo, quando os fiéis rezavam pelo fim da seca e da peste que tomavam Portugal, e alguém jurou ter visto no altar o rosto de Cristo iluminado — fenómeno que, para os católicos presentes, só poderia ser interpretado como uma mensagem de misericórdia do Messias - um milagre. Um cristão-novo que também participava da missa tentou explicar que esse milagre era apenas o reflexo de uma luz, mas foi calado pela multidão, que o espancou até a morte.

Uma das duas únicas gravuras sobreviventes ao Terramoto de Lisboa 1755 e ao incêndio da Torre do Tombo: "Von dem Christeliche – Streyt, kürtzlich geschehe – jm. M.CCCCC.vj Jar zu Lissbona – ein haubt stat in Portigal zwischen en christen und newen chri – sten oder juden, von wegen des gecreutzigisten [sic] got." (Da Contenda Cristã, que recentemente teve lugar em Lisboa, capital de Portugal, entre cristãos e cristãos-novos ou judeus, por causa do Deus Cruxificado

The world of knowledge is changing rapidly (1)

a larger fraction of humanity aspires to education and
higher education is increasingly perceived as tomorrow's general education

in 2010: 177 M (+77% since 2000)

students enrolled outside their country of origin: 0.8M in 1975, 2.1M (2.1%) in 2000, 4.1M in 2010 (2.3%)

Higher Education has become an aspiration for all, and not exclusively for the social elites, and is increasingly perceived as a social, economic and political driving force for progress in developing countries – providing a renewed constituency for scientific development, political democracy and justice, and for the quality of general education

higher education is becoming a major political actor in part of the developing world

source:UNESCO

The world of knowledge is changing rapidly (2)

science is increasingly global and increasingly perceived as linked to human, social and economic progress

2002 > 2007
5.7 > 7.1 M researchers (+25%)
780 > 1150 b US$ (+45%)
1.1 > 1.6 M publications (international cooperation: 8% in 1987, 20% in 2007)

Source: UNESCO

Mass higher education
(drives new social constituencies for science and education …)

1. Became an irrepressible and inevitable social response to globalization
2. Shapes political evolution (and revolution) in the developing world
3. Crystalizes aspirations to social mobility and promises of social progress – that will remain largely unfulfilled
4. Opens up new opportunities for socioeconomic and education policies: HE institutions as economic enablers, diversifying and interconnecting education pathways, linking education and work, fostering community action
5. Helps women in approaching gender equality
6. Is a curse and a challenge, both for government and for HE staff and management
7. Will become a universal battleground for religious and ideological fanaticism
8. Will trigger migration fluxes of qualified human resources against closed borders
9. Will allow for a new political role of interconnected researchers and academics at world level and for renewed North-South HE partnerships
10. Brings about the conditions for unprecedented science development

11. May change the world of knowledge and the world at large (might it bring Peace!)

…steering new directions for science agenda setting at world level…

Public risks (prevention, mitigation, response) emerge as new factors shaping science and technology policies: natural disasters, ageing and chronic diseases, as well as new pandemics; industrial and environmental risks, water and food, energy. *But opacity remains the rule in the relations between S&T research and security and war.*

Data Intensive Science is no longer restricted to particle physics, astronomy or meteorology but tend to become pervasive, namely in the biological sciences. ICT and all sciences tend to become closed interlinked. *However, connectivity and networking are not synonyms to equality! And increased conflicts are to be expected concerning infrastructures, resources, information and IPR.*

The Arts are investing not only scientific tools but scientific knowledge production itself and are generating new innovator agents. In parallel, research and science education are exploring new citizen science interventions.

New social actors emerge as part of the setting up of new scientific agendas, as well as new producers of scientific knowledge: patients, amateurs, users and S&T professionals.

Academic and Scientific Networks are becoming key at a global scale. New models for the sharing of resources and capacity building are adding new dimensions to international fluxes of students and scientists.

Renewed competition by national policies for qualified human resources, capital investment, market share and information are shaping collaborative and competitive S&T agenda setting.

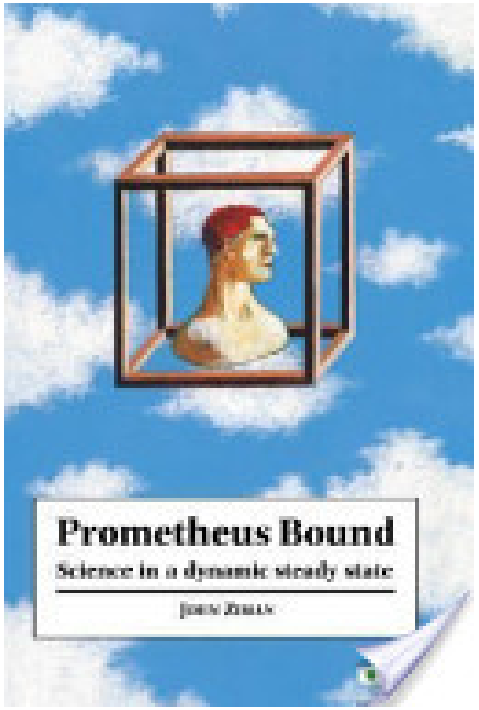
John ZIMAN (1925-2005)

Prometheus Bound, Science in a dynamic steady state

Cambridge University Press, 1994

After expanding for centuries, science is reaching its limits to growth. We can no longer afford the ever-increasing cost of exploring ever-wider research opportunities. In the competition for resources, science is becoming much more tightly organized. A radical, pervasive and permanent structural change is taking place. This already affects the whole research system, from everyday laboratory life to the national budget. The scientific enterprise cannot avoid fundamental change, but excessive managerial insistence on accountability, evaluation, 'priority setting', etc. can be very inhospitable to expertise, innovation, criticism and creativity. Can the research system be reshaped without losing many features that have made science so productive?

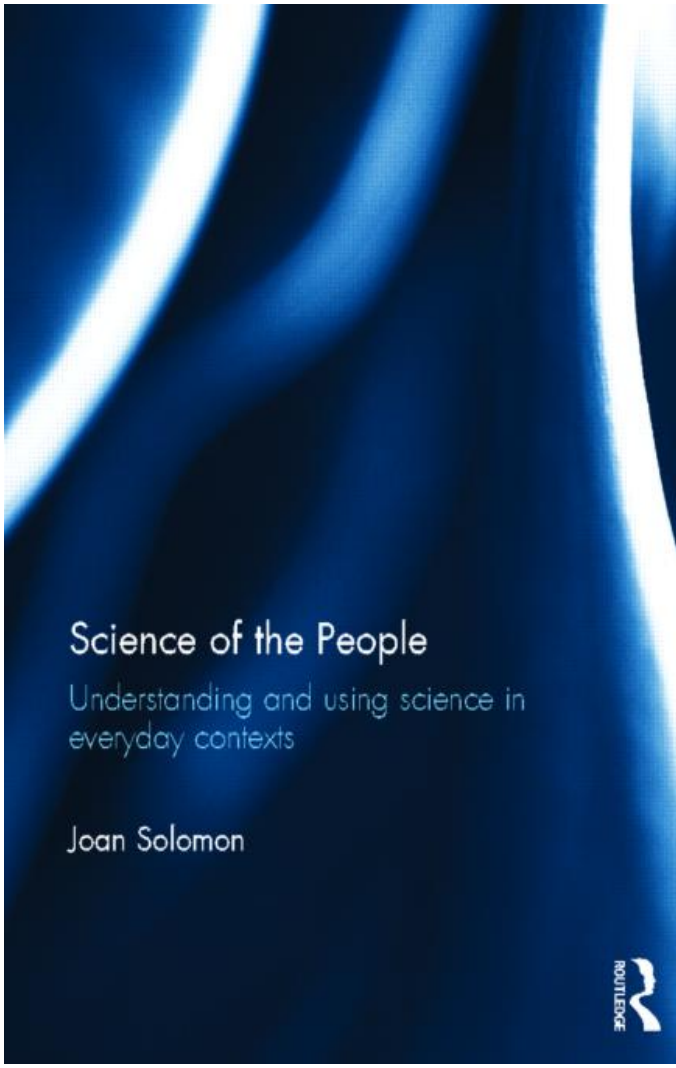
Revisiting John Ziman and Joan Solomon, very dear old friends I still mourn, is more than ever necessary for our action: opposing the bureaucratic diseases of science policy JZ had somehow anticipated. (from the paranoia of cabalistic "evaluations", to the temptation of micro-governance as required by strict "accountability") and reflecting with JS upon common people's relations with science , as a way to building up a renewed social constituency for science.



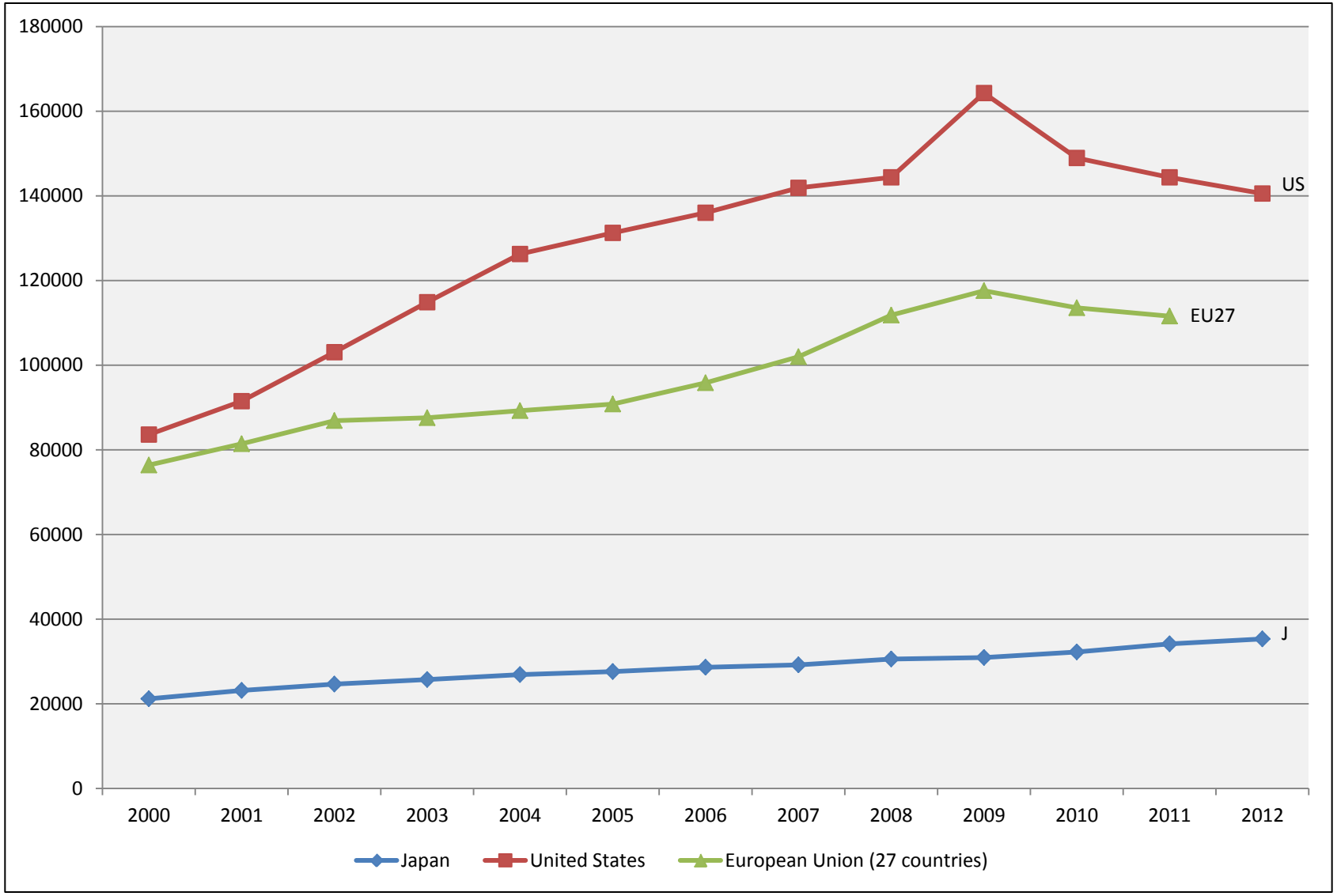
Joan Solomon (-2009)
Science of the People: Understanding and using science in everyday contexts (Routledge, 2013)

"Until her daughter, Bess, found the manuscript of this book, no one knew it existed. It has now posthumously been published. It is a great book - and a major contribution to the field of science education. How do people understand science? How do they feel about science, how do they relate to it, what do they hope from it and what do they fear about it?

Science of the People: Understanding and using science in everyday contexts helps answer these questions as the result of painstaking interviewing by Professor Joan Solomon of all and sundry in a fairly typical small town in England. The result is a unique overview of how a very wide range of adults, united only by local geography, relate to science. Many of the findings run contrary to what is widely believed about how science is learnt and about how people view it." *(review by Michael Reiss)*



Government budget appropriations or outlays for RD: GBAORD (million current PPP $)



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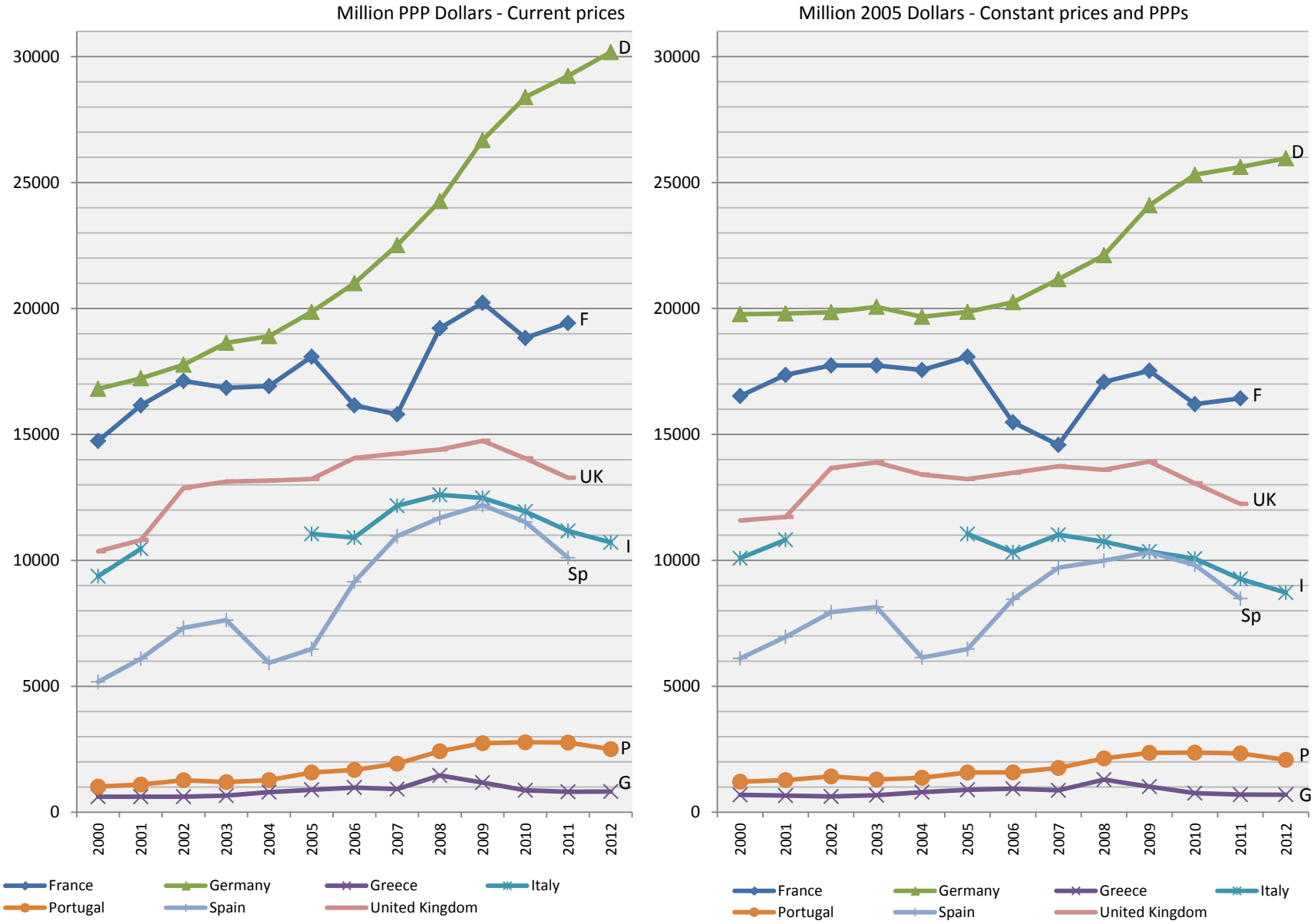
Government budget appropriations or outlays for RD:



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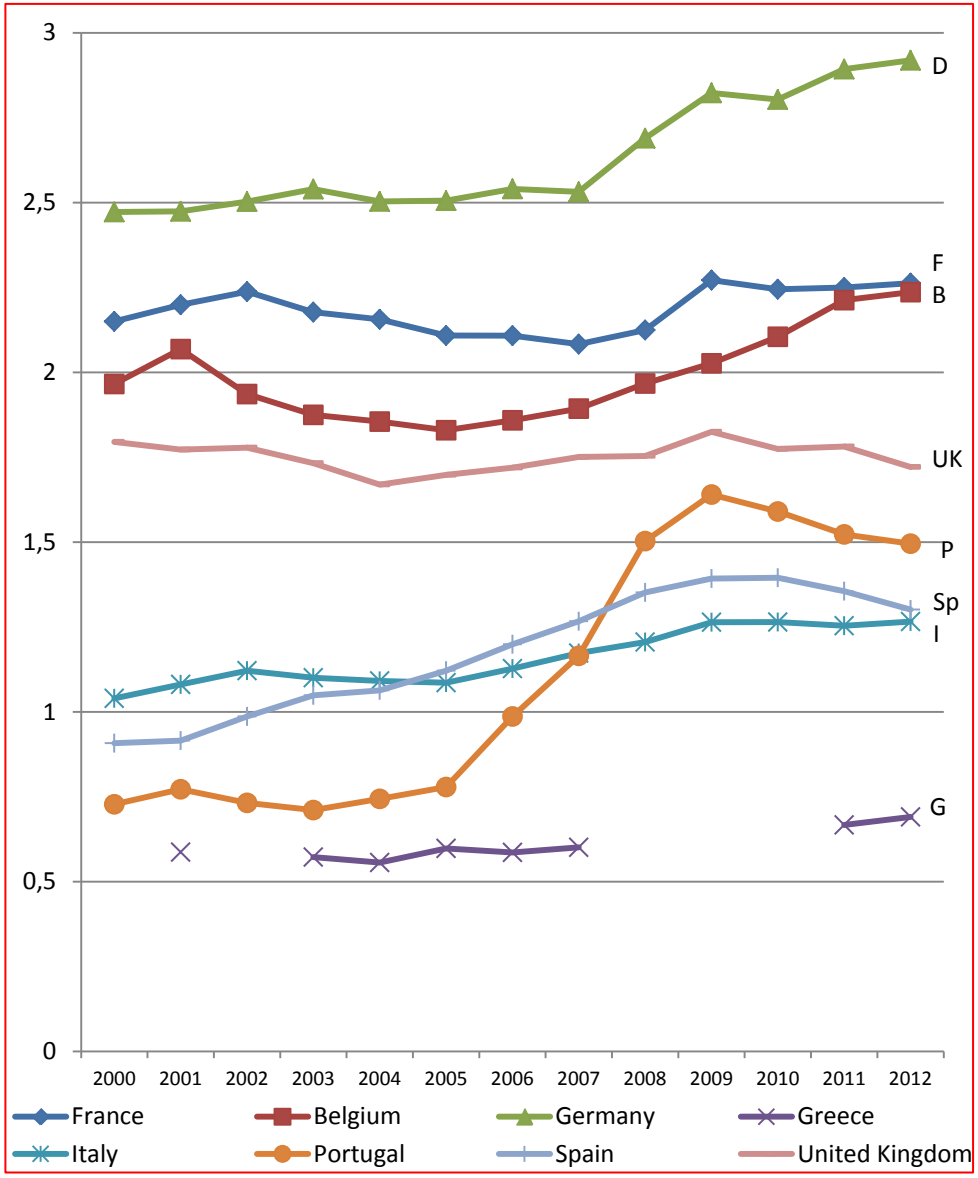
Main Science and Technology Indicators: GERD as a percentage of GDP



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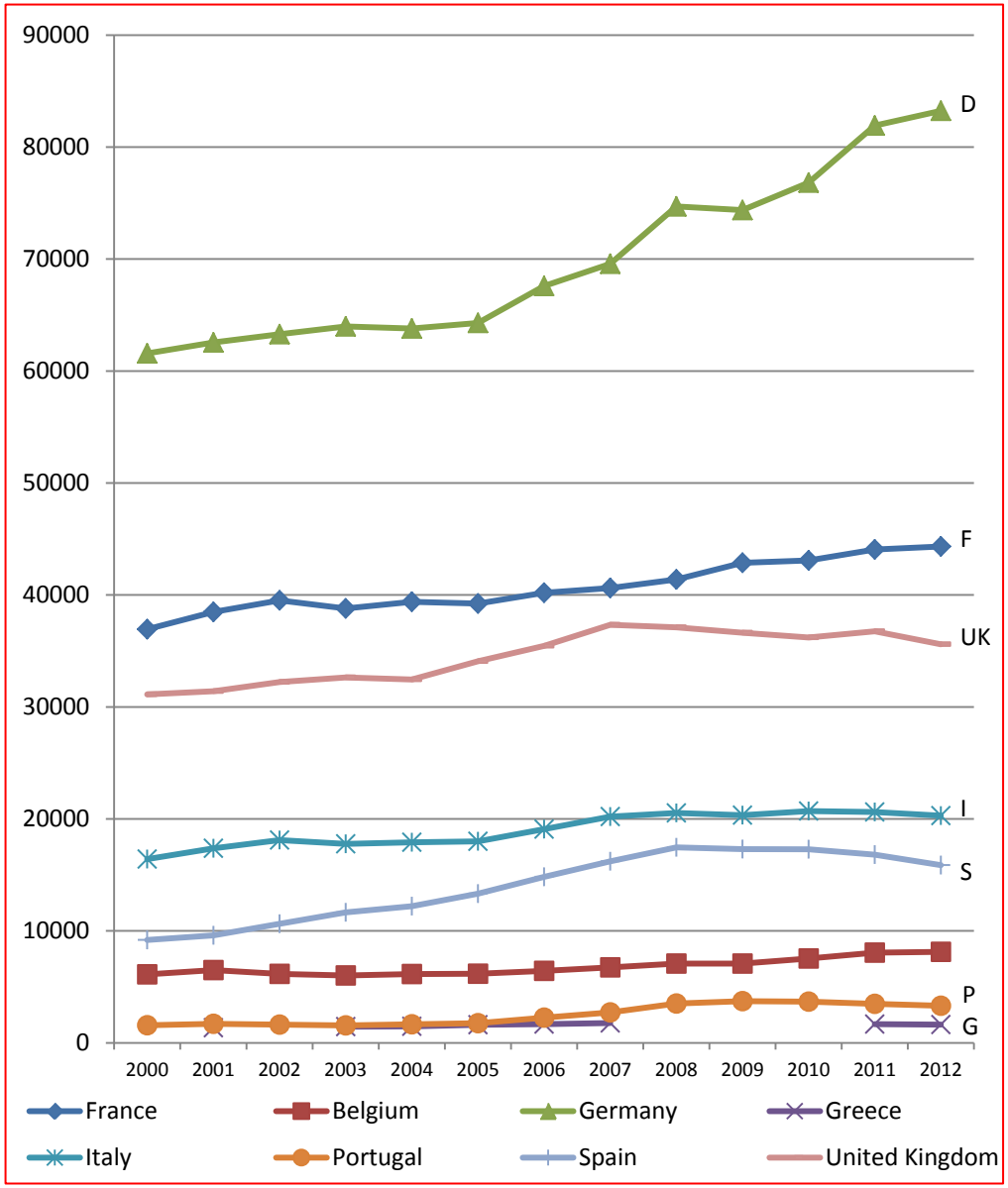
Main Science and Technology Indicators: GERD -- (million 2005 dollars -- constant prices and PPP)



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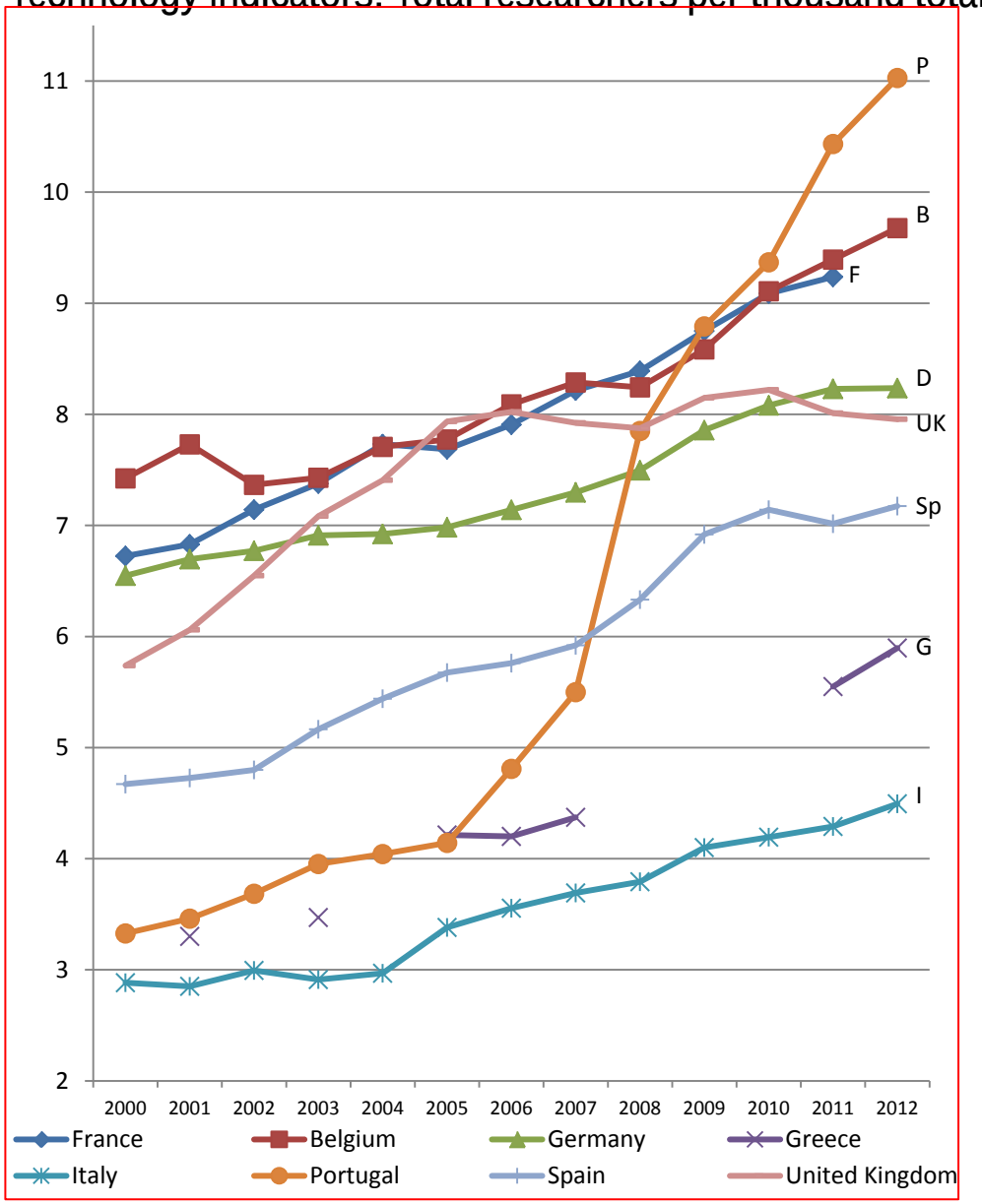
Main Science and Technology Indicators: Total researchers per thousand total employment



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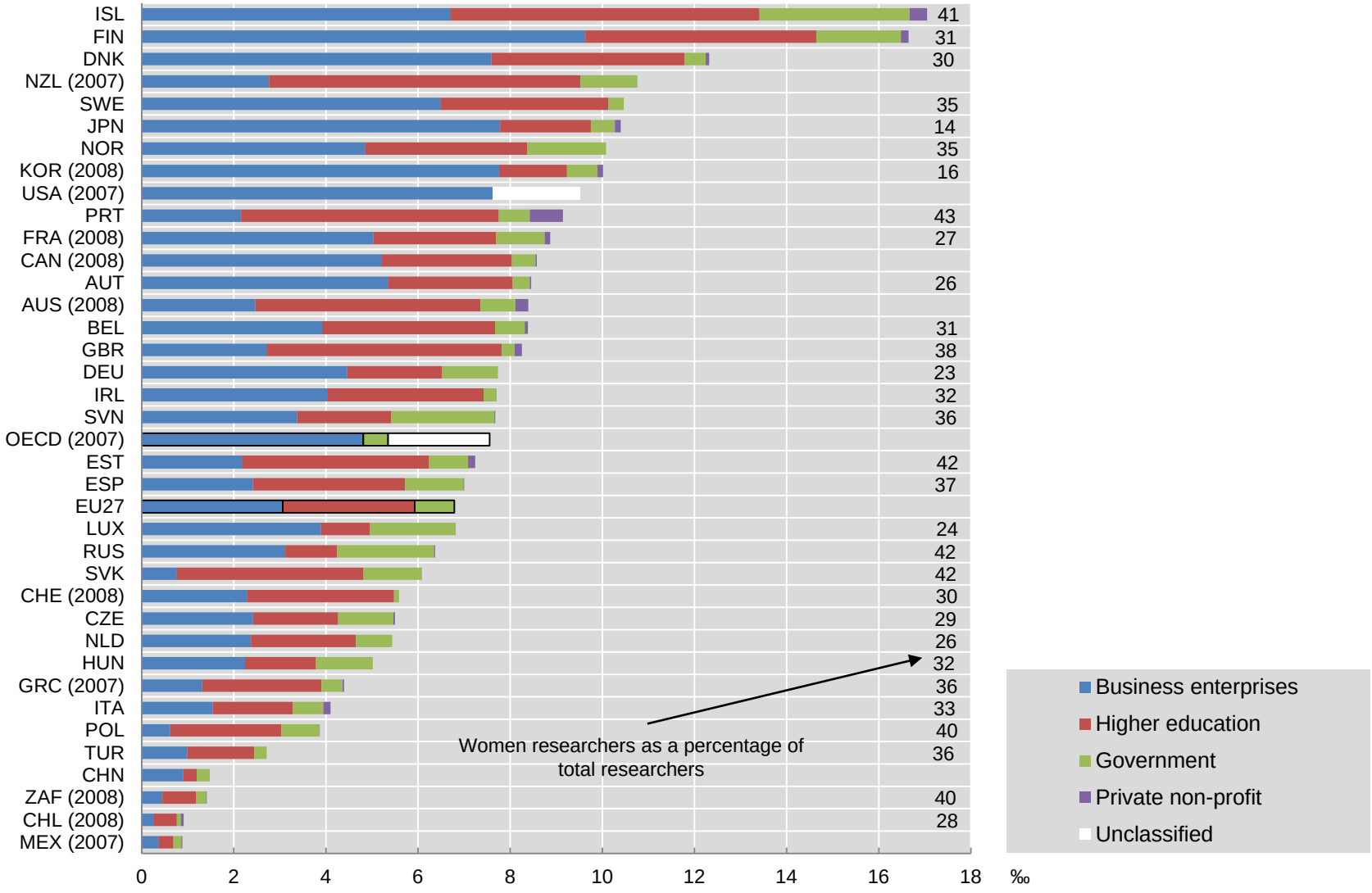
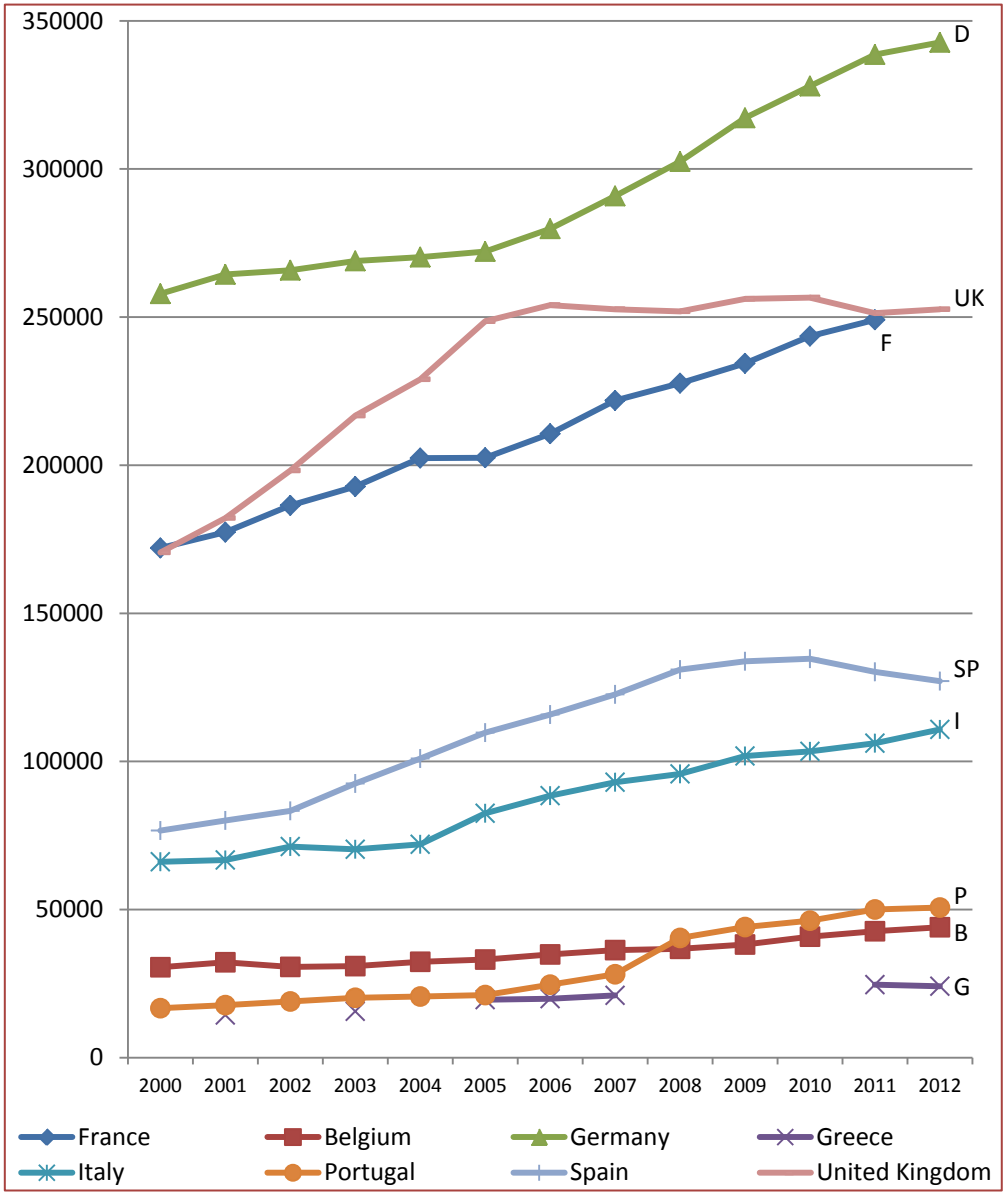
Researchers by R&D performing sector, 2009

Per thousand employment



OECD, Main Science and Technology Indicators Database, June 2011.

Main Science and Technology Indicators: Total researchers (FTE)



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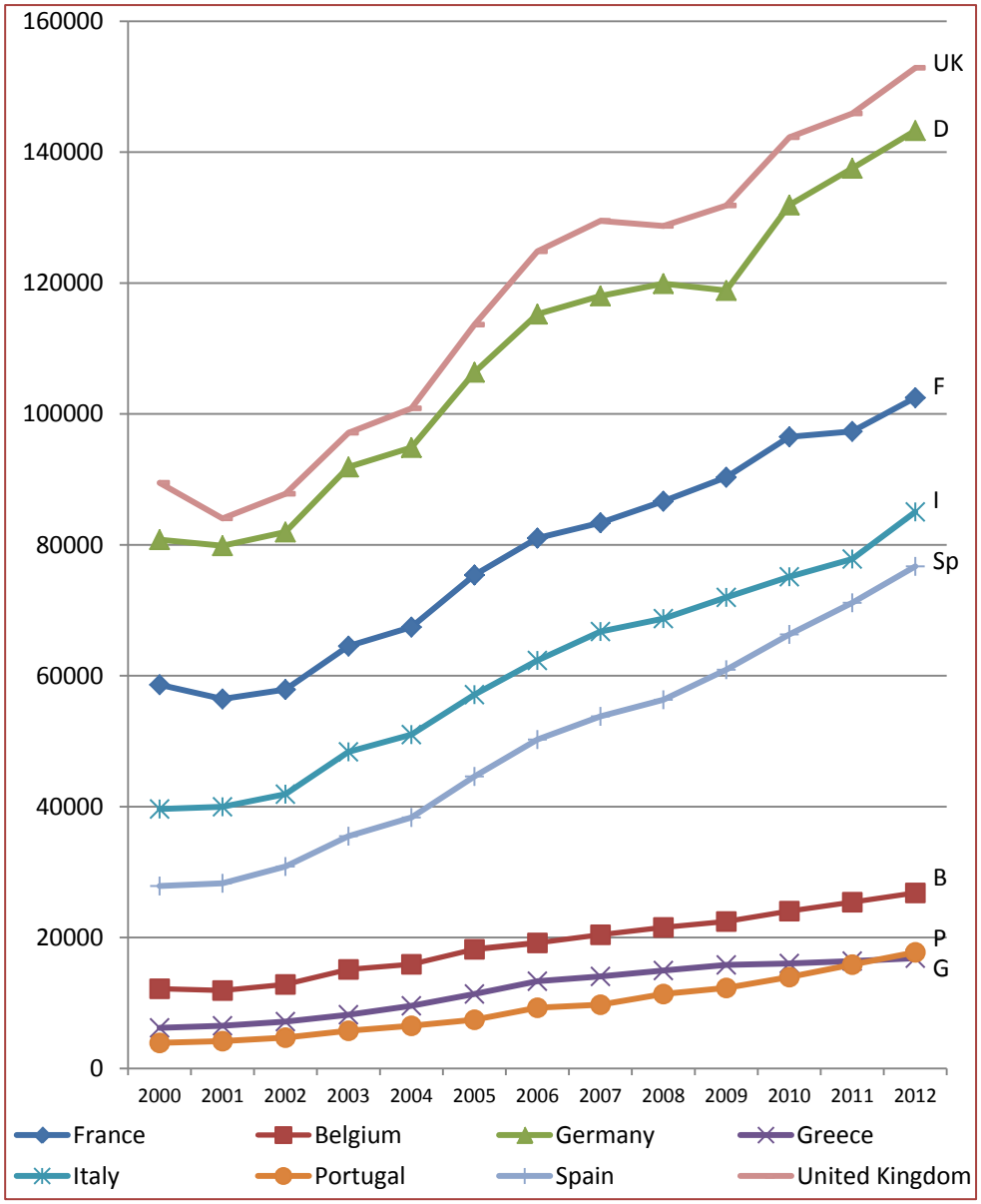
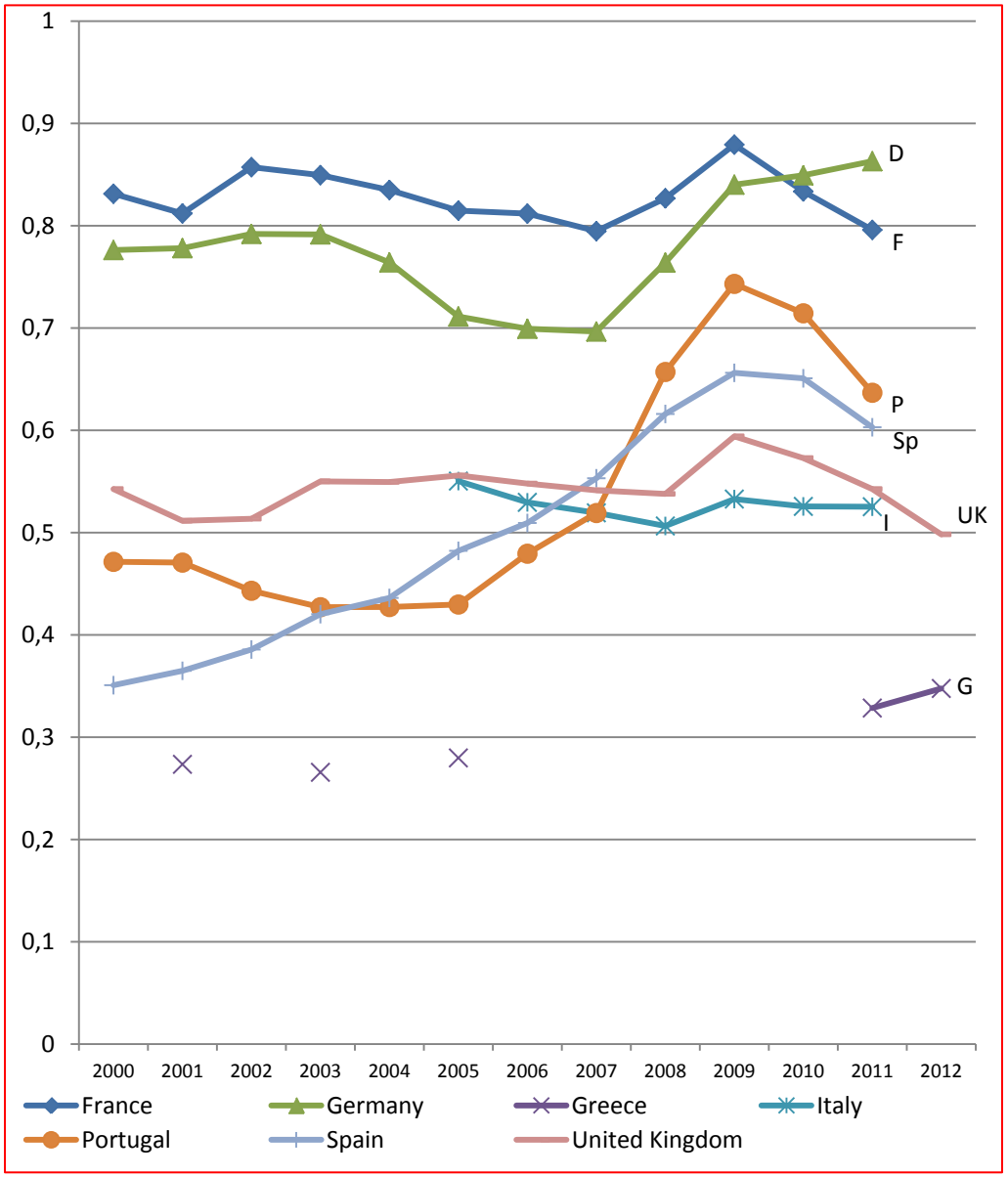
Science and Technology Indicators: Scientific publications, number



IPP.Stat - Data extracted on 10 Feb 2014 11:27 UTC (GMT) from OECD.Stat

Science and Technology Indicators: Government-financed GERD as a percentage of GDP



Data extracted on 10 Feb 2014 15:27 UTC (GMT) from OECD.Stat

Table 5
China in the world economy, 1300–2030 AD

	China	Japan	India	Western Europe	USA	World	China/World
Year			Population (million)				Ratio
1300	100.0	10.5	88.0	58.4	1.7	360.0	0.28
1500	103.0	15.4	110.0	57.3	2.0	438.4	0.23
1820	381.0	31.0	209.0	133.0	10.0	1,041.8	0.37
1913	437.1	51.7	303.7	261.0	97.6	1,791.1	0.24
1950	546.8	83.8	359.0	304.9	152.3	2,524.3	0.22
1973	881.9	108.7	580.0	358.8	211.9	3,916.5	0.23
2003	1,288.4	127.2	1,049.7	394.6	290.3	6,278.6	0.21
2030	1,458.0	121.0	1,421.0	400.0	364.0	8,175.0	0.18
			Per Capita GDP (1990 international $)				
1300	600	475	500	593	400	530	1.13
1500	600	500	550	771	400	566	1.06
1820	600	669	533	1,204	1,257	667	0.90
1913	552	1,387	673	3,458	5,301	1,526	0.36
1950	439	1,921	619	4,579	9,561	2,111	0.21
1973	839	11,434	852	11,416	16,689	4,091	0.21
2003	4,392	21,218	2,160	19,912	29,037	6,432	0.68
2030	14,416	27,758	6,227	30,566	44,574	11,207	1.29
			GDP (billion, 1990 international $)				
1300	60.0	5.0	44.0	34.6	0.7	190.0	0.32
1500	61.8	7.7	60.5	44.2	0.8	248.3	0.25
1820	228.6	20.7	111.4	160.1	12.5	694.6	0.33
1913	241.3	71.7	204.2	902.3	517.4	2,733.3	0.09
1950	239.9	161.0	222.2	1,396.2	1,455.9	5,331.6	0.05
1973	740.0	1,242.9	494.8	4,096.5	3,536.6	16,023.8	0.05
2003	5,659.2	2,699.0	2,267.1	7,857.4	8,430.8	40,384.6	0.14
2030	21,019.0	3,229.0	8,848.0	12,217.0	16,217.0	91,623.0	0.23

Viva ROARS!

Grazie mille!