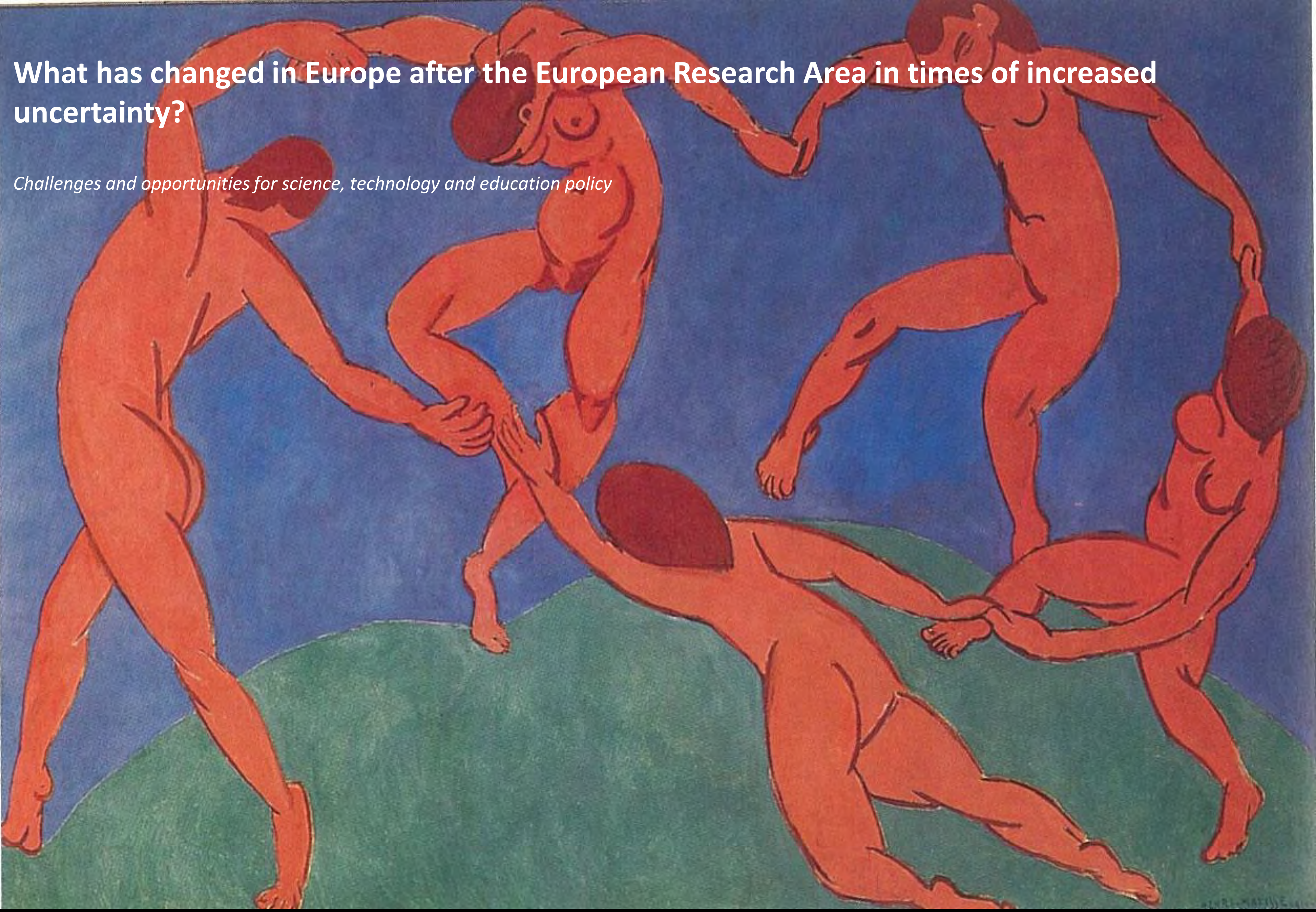
# What has changed in Europe after the European Research Area in times of increased uncertainty?

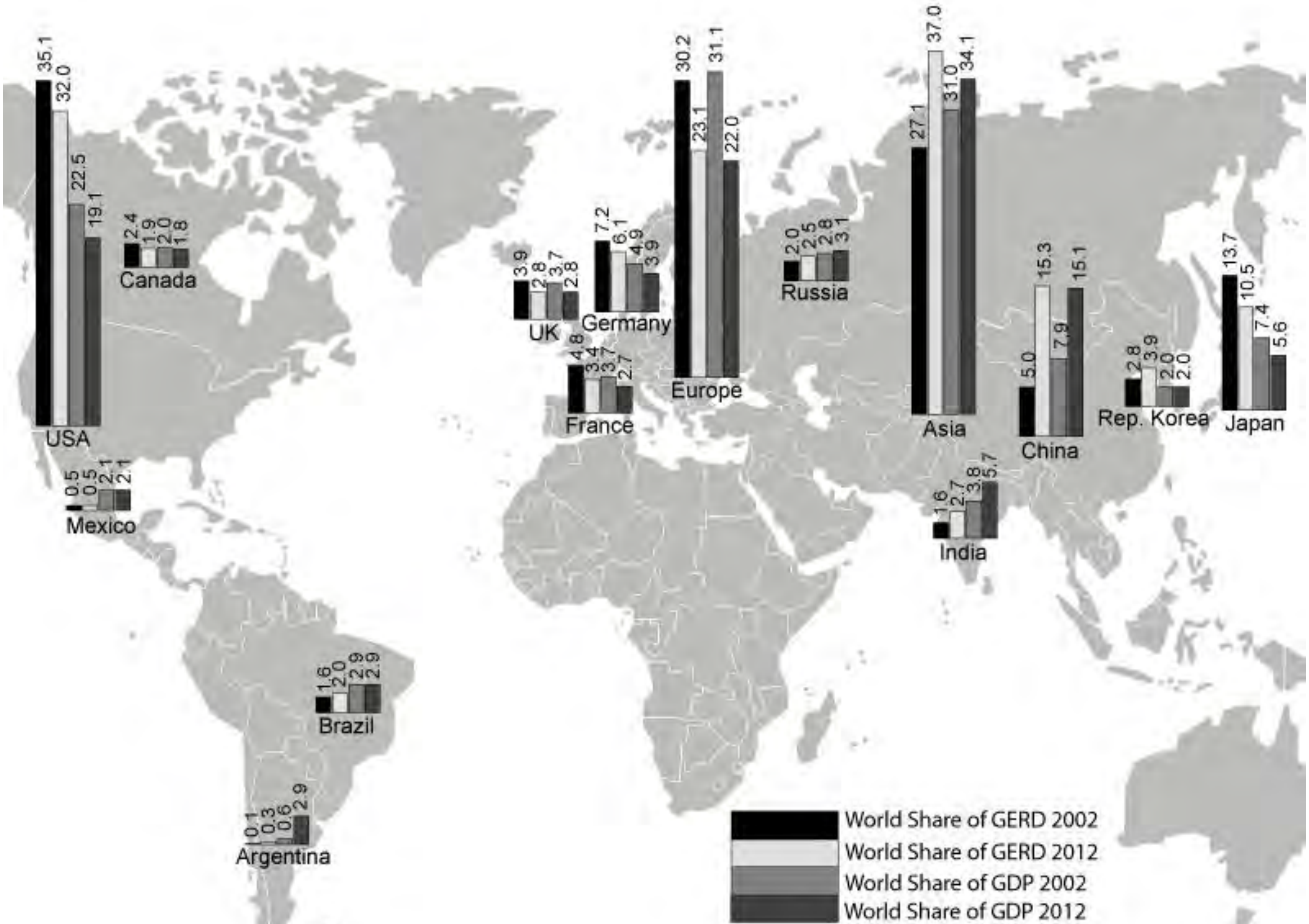
*Challenges and opportunities for science, technology and education policy*



The Dance, Henri Matisse, 1910

# World share of GDP and GERD over the last decade (2002-2012)

values in %



**Cumulative R&D expenditure, 30 years, per RESEARCHER**

(thousands U.S. Dollars 2005 constant prices and PPP)

Source: OECD Statistics.

6000

Undoubtedly **there was considerable progress** in Science, Technology and Higher Education.

…But Europe, as a whole, **has met neither its goals nor its promises in this area**.

United States    EU-28

# The Questions

In a decade hit by recession and economic and budgetary problems:

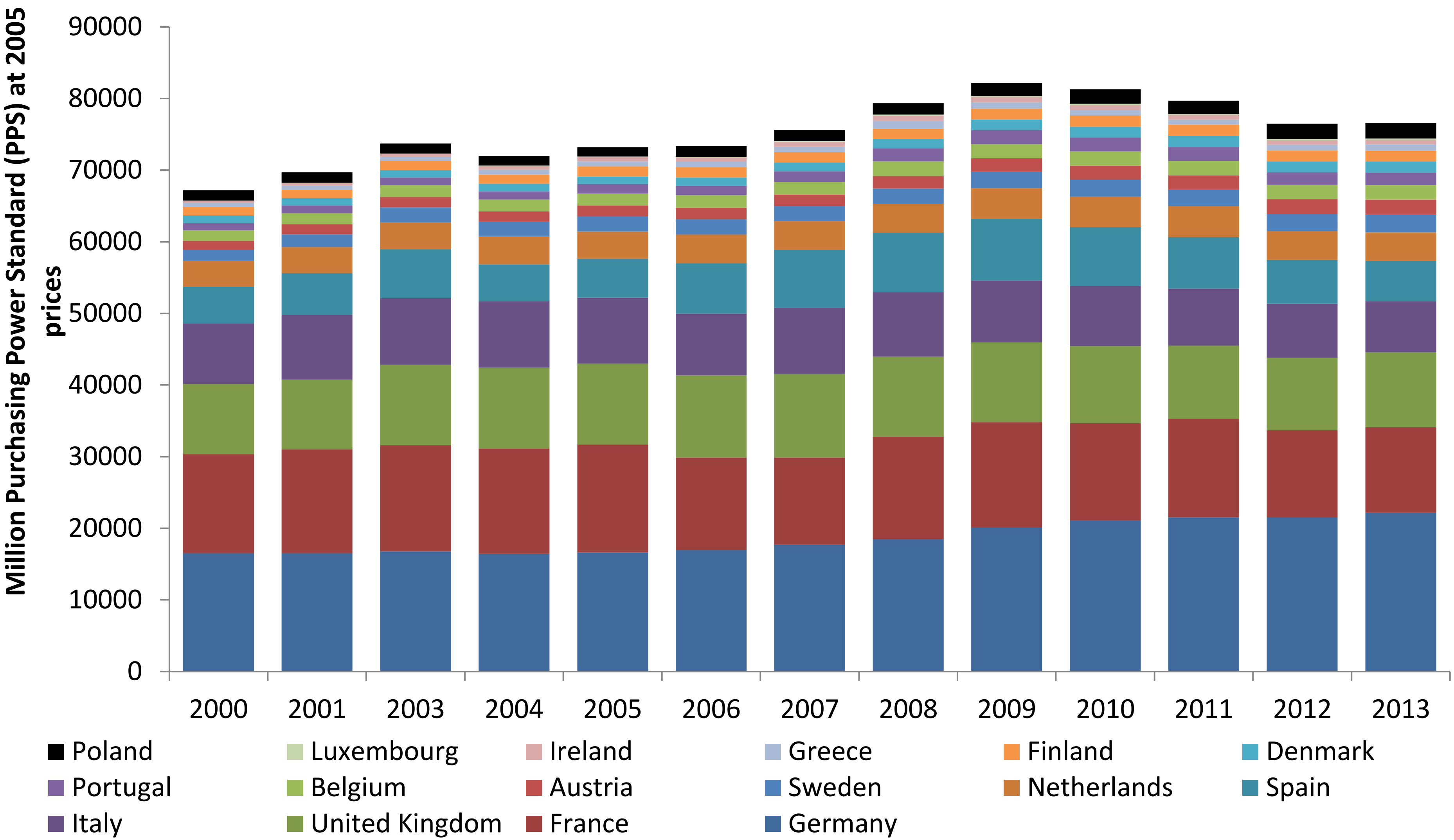
**- Which is the path of S&T funding in EU?**

**- Which public policies for science, technology and education** are necessary in the near future, both for individual member states, as well as the EU?

# Total Government Budget Appropriations or Outlays for R&D, GBAORD

**(Million Purchasing Power Standard (PPS) at 2005 prices)**

Source: Eurostat




Italy 2003 and 2004 – estimated values.

# Government Budget Appropriations or Outlays for R&D (GBOARD)

## Sample of large EU countries

(million current PPP $)

Source: OECD; Netherlands is included in the large sized countries because of the size of the budget

…the quasi stagnation of R&D public investment in Europe during the last decade hides **a major trend of internal divergence inside Europe itself**.

In the year 2000, Germany and France presented similar national R&D budgets; one decade later, Germany outpaces France by 50%. Italy budgets have declined since 2007, and in real terms are 15% lower than in 2000.

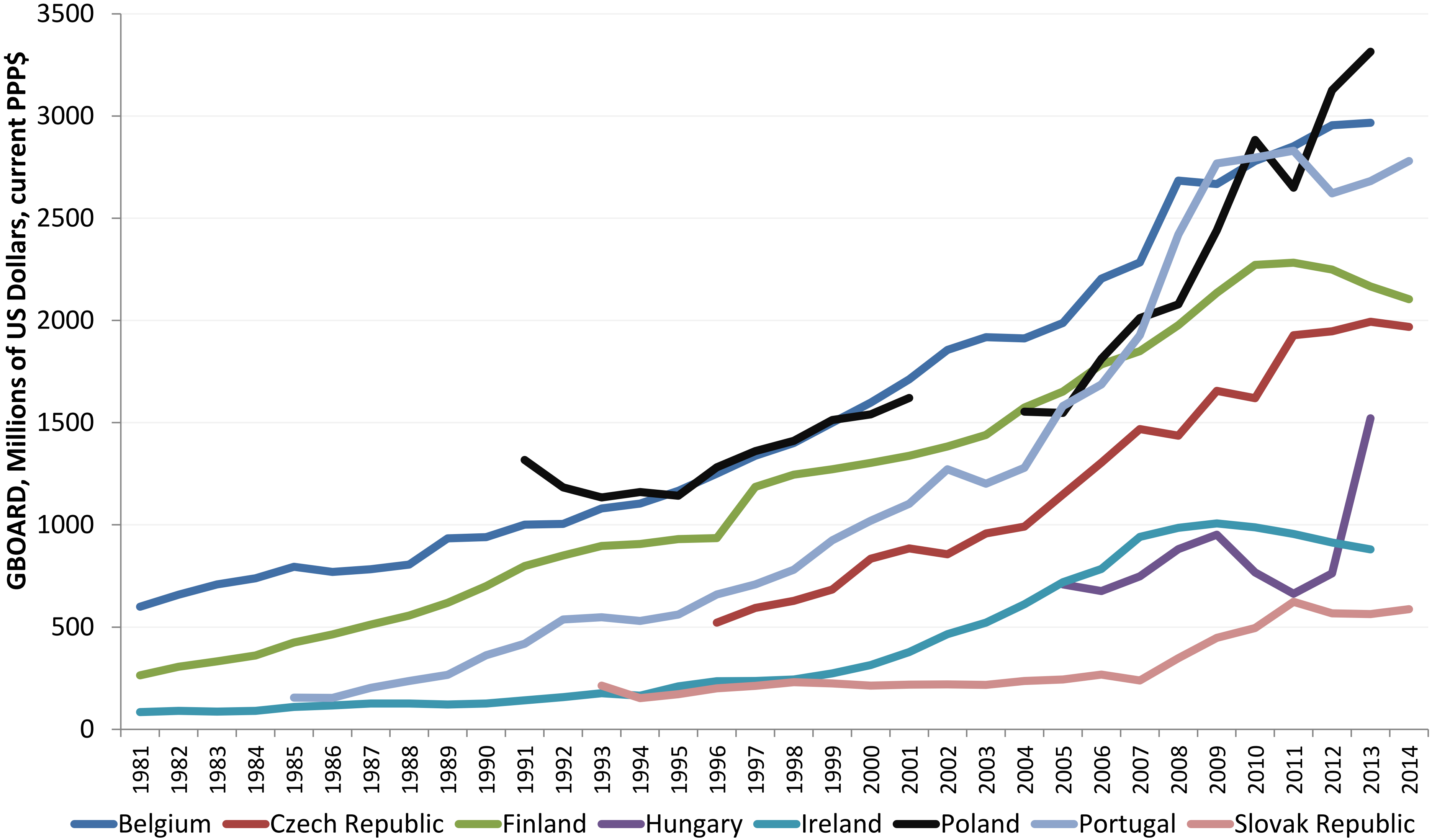
France Germany Italy Netherlands Poland Spain United Kingdom

# Government Budget Appropriations or Outlays for R&D (GBOARD)

## Sample of small and medium EU countries

(million current PPP $)

Source: OECD; Netherlands is included in the large sized countries because of the size of the budget



Observation:

In most EU countries, the decrease in public R&D and HE budgets has been justified by the need to change *policies*, including:

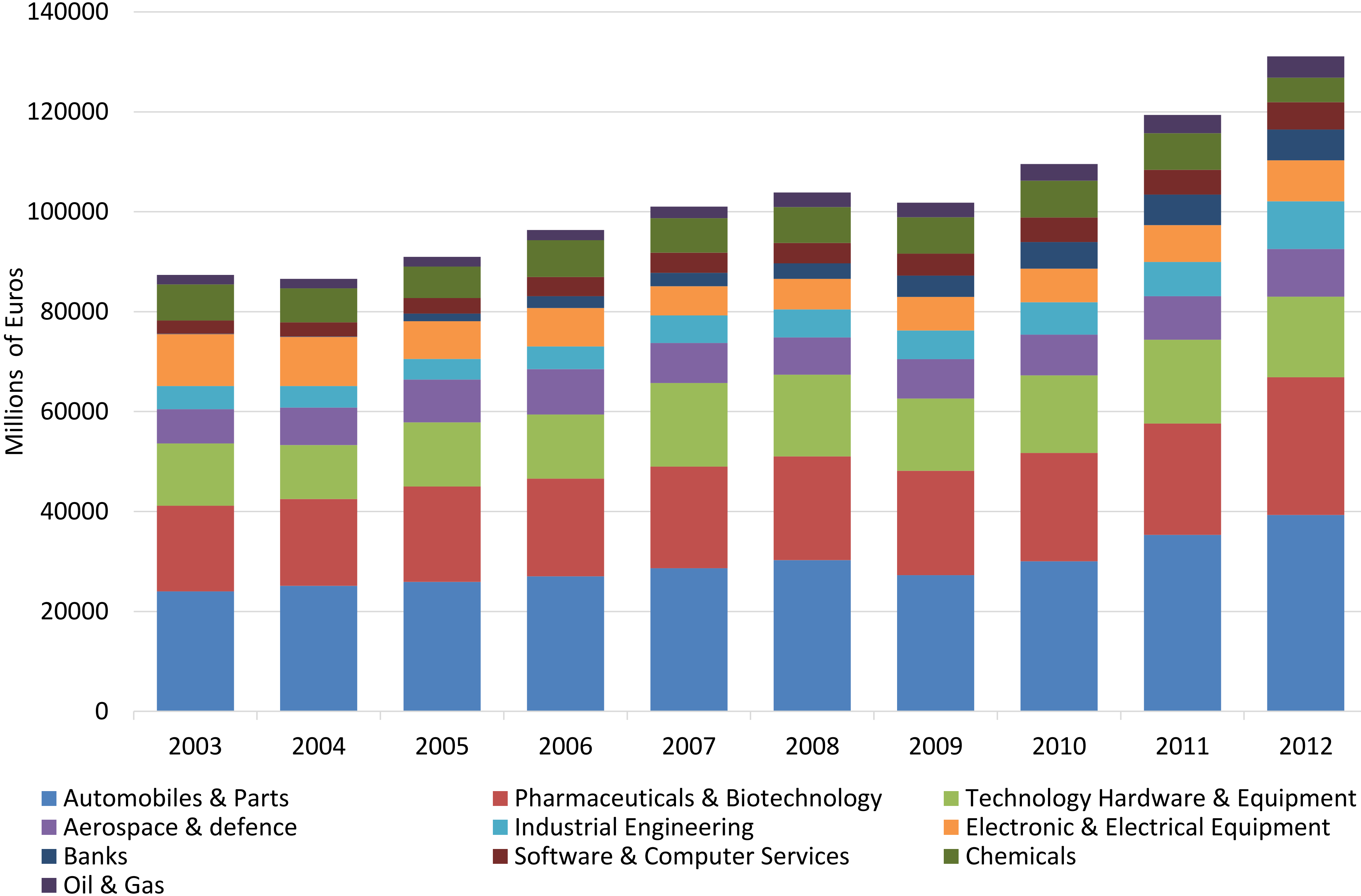
- **Increase public funding to support firms and business activities**;
- **Increase the selectivity of public funding**, decreasing public support for advanced training and scientific employment.

…the increasing concern (and involvement) of scientists and academics

ROARS
Return On Academic ReSearch

# The 500 largest EU firms investing in R&D

(Following ICB - Industry Classification Benchmark; Source: EU Industrial R&D Investment Scoreboard

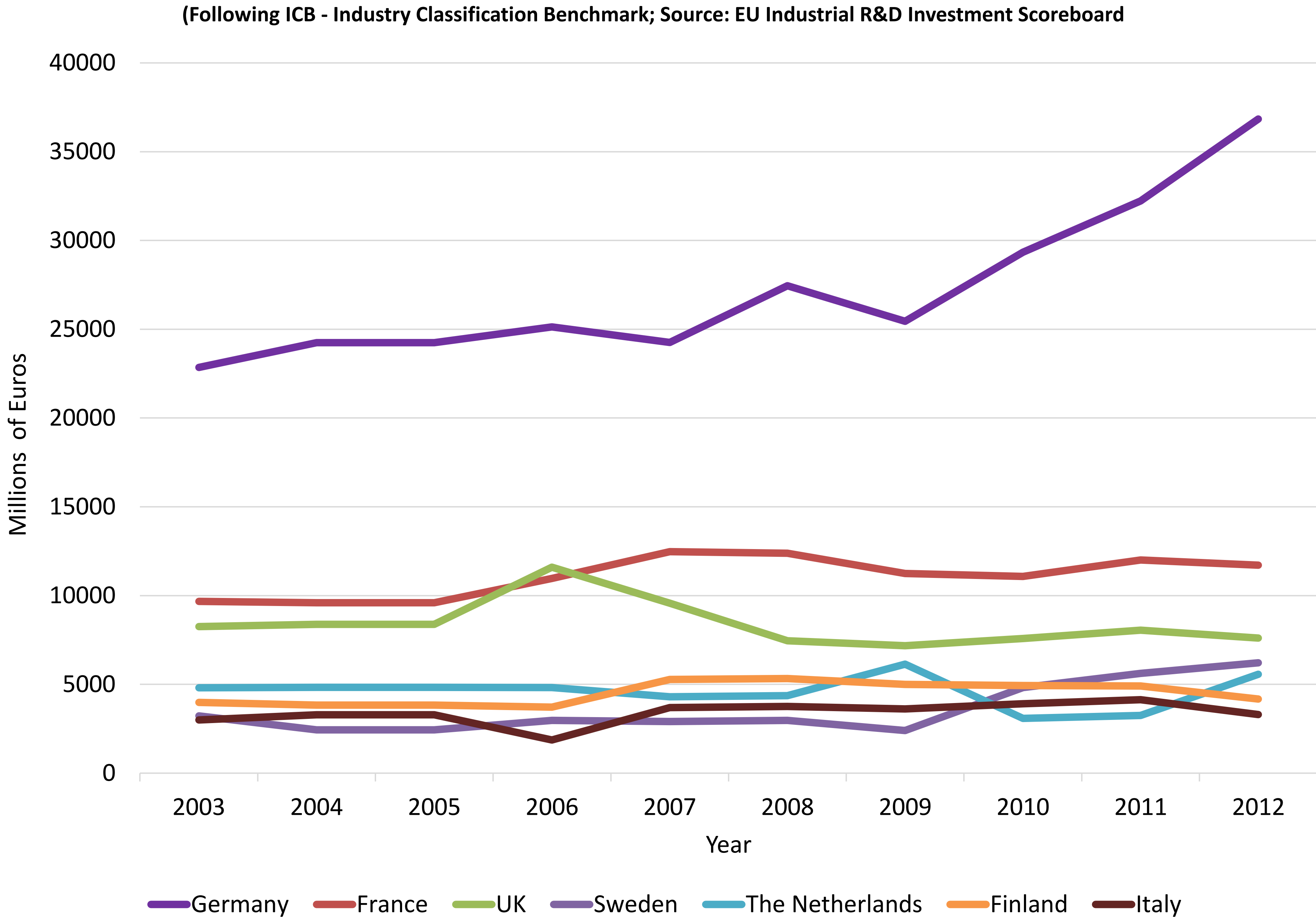


# The 20 largest EU firms investing in R&D

**Source: EU Industrial R&D Investment Scoreboard**

| Ranking 2012 | Company | Sector (ICB) | R&D Investment (millions Euros) 2012 | R&D Investment (millions Euros) 2003 | Ranking 2003 |
|---|---|---|---|---|---|
| 1 | Volkswagen | Automobiles & Parts | 9515 | 4140 | 3 |
| 2 | DaimlerChrysler | Automobiles & Parts | 5639 | 5571 | 1 |
| 3 | Robert Bosch | Automobiles & Parts | 4924 | 2650 | 8 |
| 4 | Sanofi-Aventis | Pharmaceuticals & Biotechnology | 4909 | - | - |
| 5 | Siemens | Electronic & Electrical Equipment | 4572 | 5511 | 2 |
| 6 | GlaxoSmithKline | Pharmaceuticals & Biotechnology | 4229 | 3961 | 5 |
| 7 | Nokia | Technology Hardware & Equipment | 4169 | 3978 | 4 |
| 8 | BMW | Automobiles & Parts | 3952 | 2559 | 10 |
| 9 | Ericsson | Technology Hardware & Equipment | 3863 | 3229 | 6 |
| 10 | EADS | Aerospace & Defence | 3630 | 2193 | 12 |
| 11 | AstraZeneca | Pharmaceuticals & Biotechnology | 3375 | 2736 | 7 |
| 12 | Fiat | Automobiles & Parts | 3295 | - | - |
| 13 | Bayer | Pharmaceuticals & Biotechnology | 3182 | 2414 | 11 |
| 14 | Boehringer Ingelheim | Pharmaceuticals & Biotechnology | 2795 | 1176 | 21 |
| 15 | Peugeot (PSA) | Automobiles & Parts | 2481 | 2098 | 13 |
| 16 | Alcatel-Lucent | Technology Hardware & Equipment | 2437 | 1593 | 16 |
| 17 | Volvo | Industrial Engineering | 2351 | 865 | 30 |

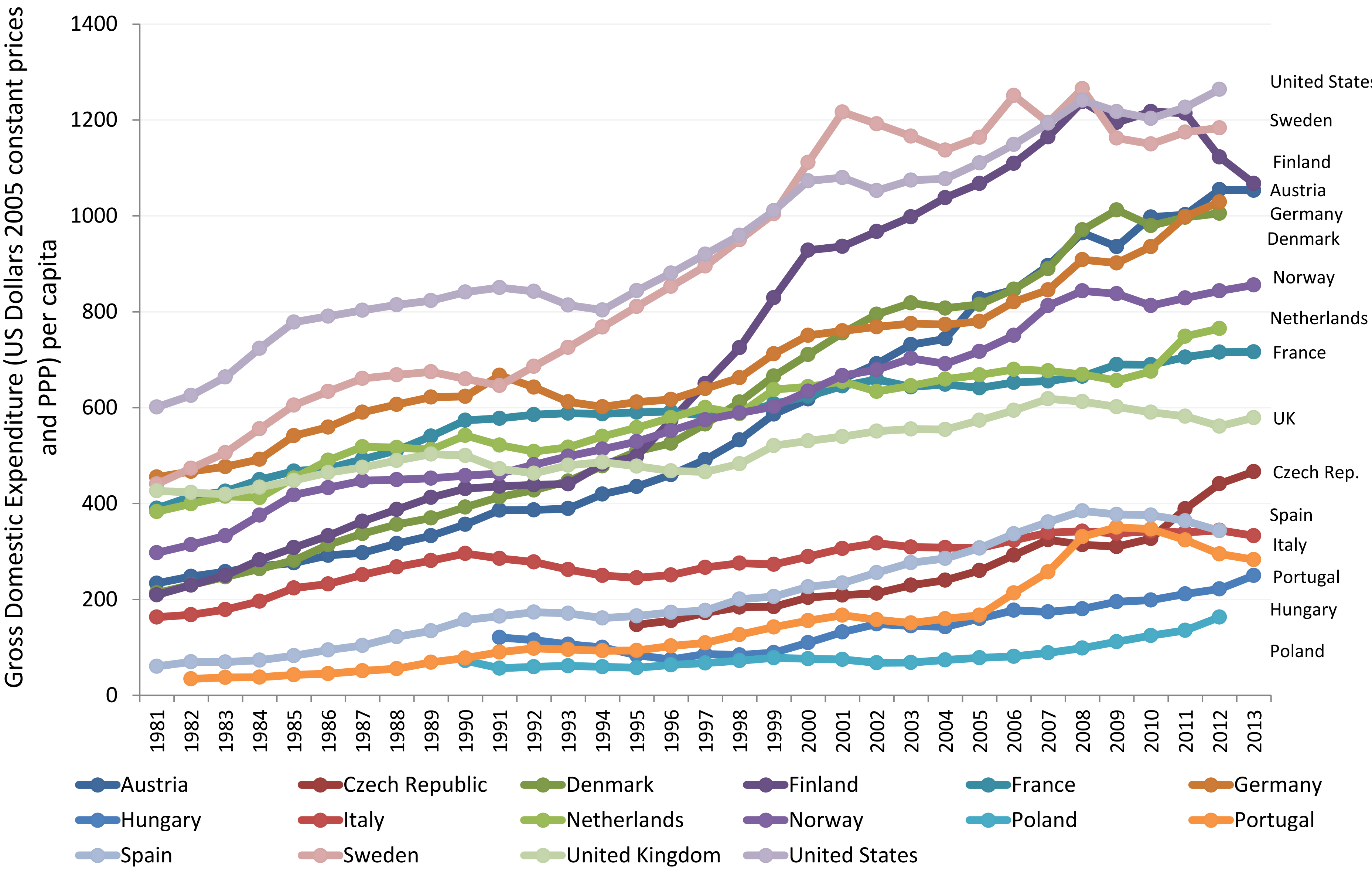
# The 20 largest EU firms investing in R&D, per country



# GERD/Capita

## (U.S. Dollars 2005 constant prices and PPP)

Source: OECD Statistics



# ...and the impact on the economy?

Client: **Quintas & Quintas SA**
Application: **Brasilian offshore platforms**

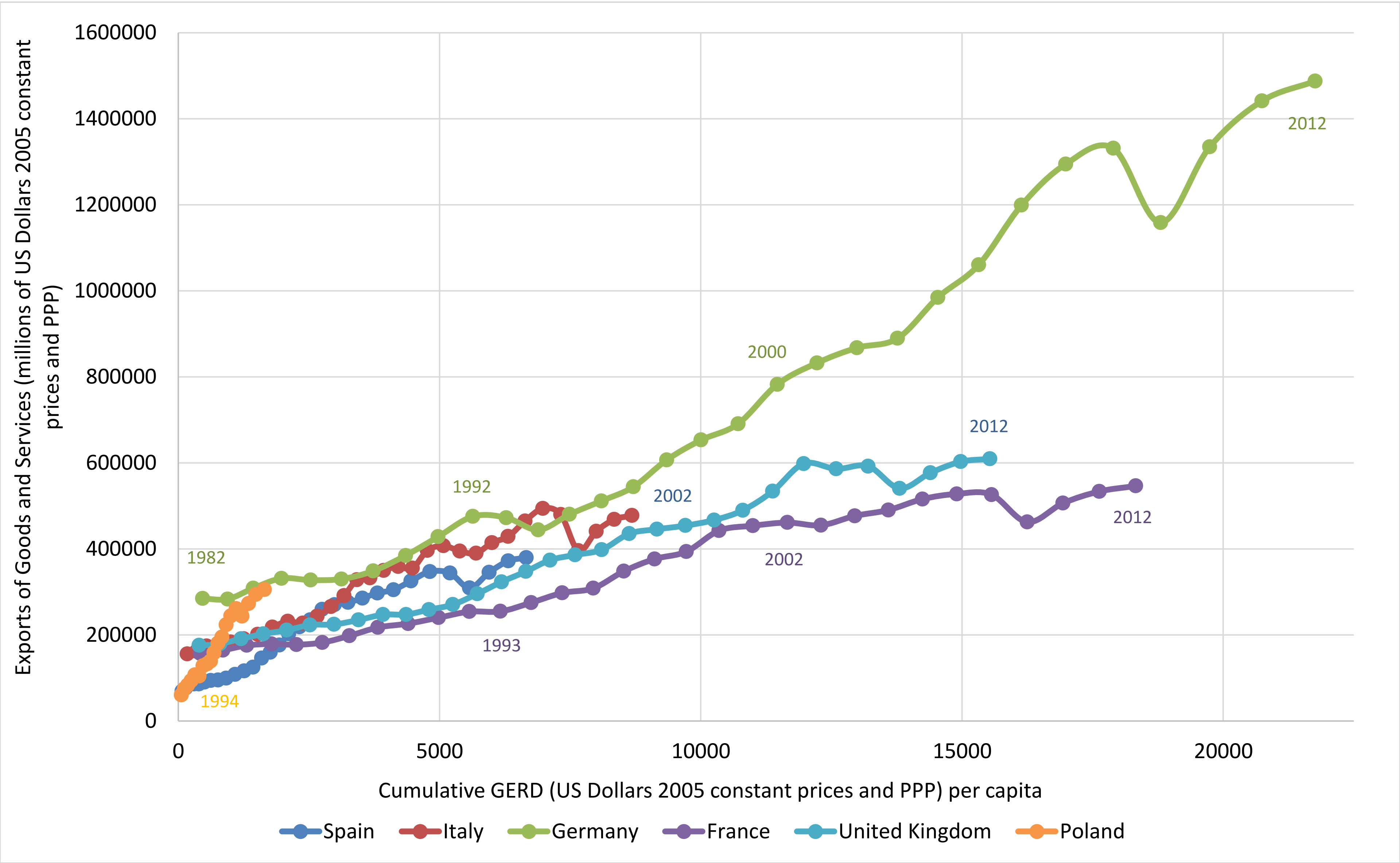
INEGI/IDMECPorto/DEMec-FEUP
designed the winding frame and the testing equipment for validation purposes

# Total exports versus R&D accumulated expenditure per capita

(millions of U.S. Dollars 2005 constant prices and PPP)

## Large countries

**Source: OECD Statistics.**



# Looking at the structure of the ecomomy: DIVERSIFICATION

(Hirshman-Herfindahl Index)

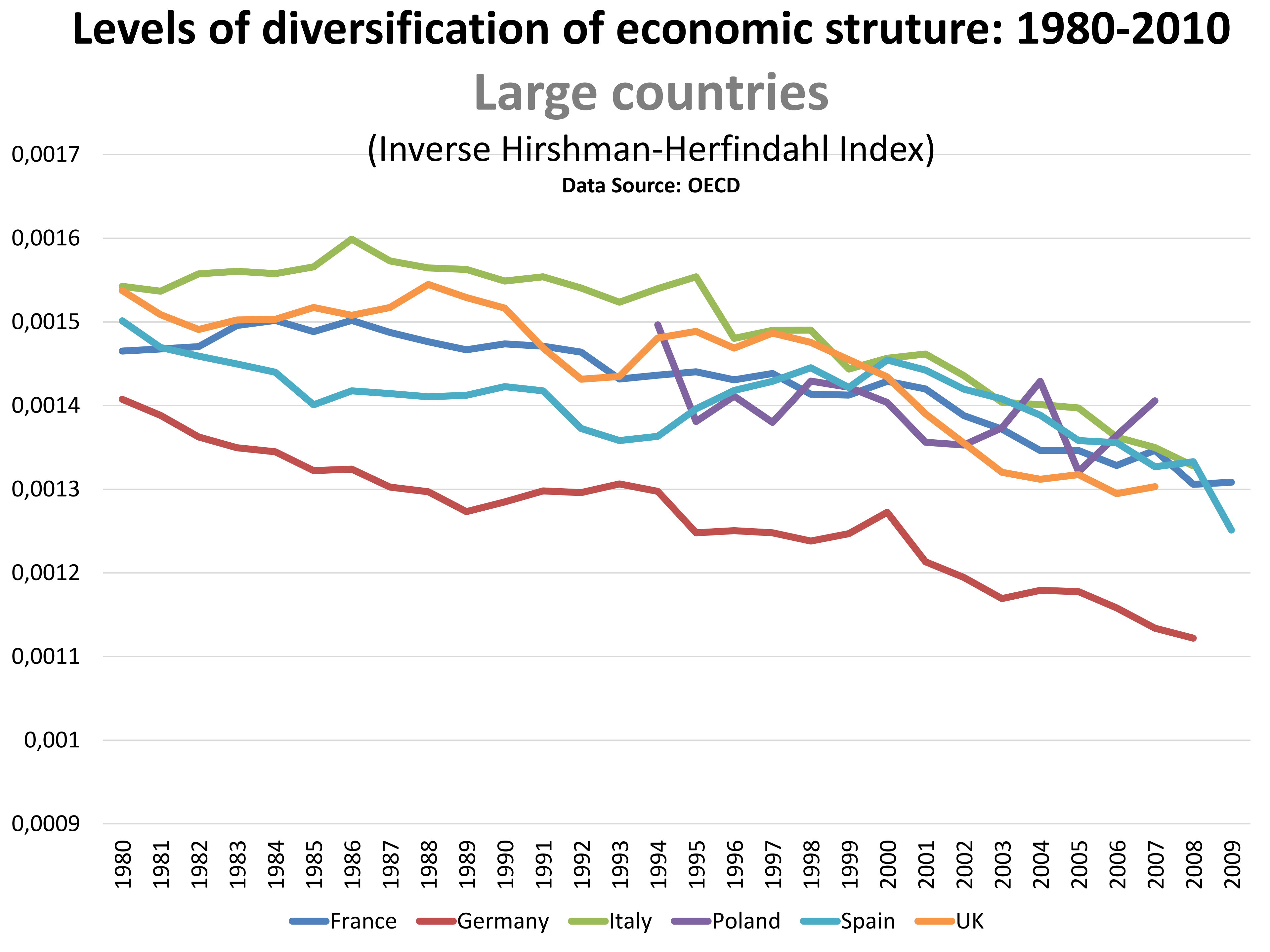
Method:

the INVERSE of the HIRSHMAN-HERFINDAHL INDEX

Pi – Value Added shares to total manufacturing

(Source: OECD Statistics - STAN tables)

| DATA: Manufacturing |
|---|
| C15 Food products and beverages |
| C16 Tobacco products |
| C17 Textiles |
| C18 Wearing apparel, dressing and dyeing of fur |
| C19 Leather, leather products and footwear |
| C20 Wood and products of wood and cork |
| C21 Pulp, paper and paper products |
| C22 Printing and publishing |
| C23 Coke, refined petroleum products and nuclear fuel |
| C24 Chemicals and chemical products |
| C25 Rubber and plastics products |
| C26 Other non-metallic mineral products |
| C27 Basic metals |
| C28 Fabricated metal products, except machinery and equipment |
| C29 Machinery and equipment, n.e.c. |
| C30 Office, accounting and computing machinery |
| C31 Electrical machinery and apparatus, n.e.c. |
| C32 Radio, television and communication equipment |
| C33 Medical, precision and optical instruments |
| C34 Motor vehicles, trailers and semi-trailers |
| C35 Other transport equipment |
| C36T37 Manufacturing n.e.c. and recycling |


Levels of diversification of economic struture: 1980-2010
Large countries
(Inverse Hirshman-Herfindahl Index)
Data Source: OECD
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2007
2008
2009
France
Germany
Italy
Poland
Spain
UK

Issue 3:

The **accumulation of R&D expenditure** over the last 30 years have allowed to **expand exports** in many countries, but still with large diversity across EU.

**Only** those countries that **increased R&D expenditure together** with further **increasing the diversity of their economy**, have guarantee a considerable direct impact of R&D on the economy

## Hypothesis:

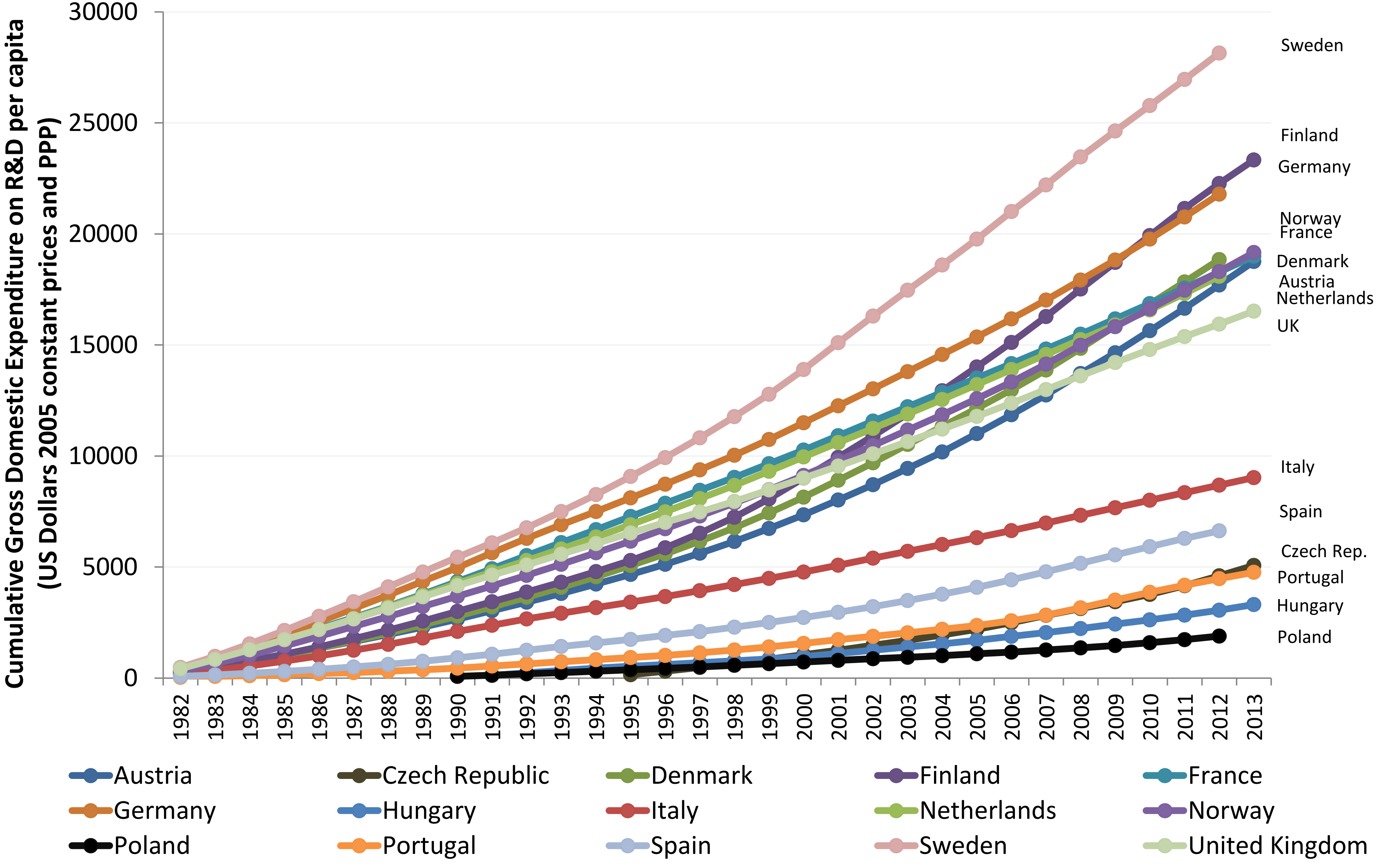
Science, its impact and the presence of innovation, result from a **cumulative, long-term, collective and uncertainty process**, involving an extensive divison of labour, which requires massifying the training of human resources and qualifying the labour force in many economic sectors, in a way that depends on the structure of the economy

…but, what can we learn form cumulative data?

# Cumulative R&D expenditure, 30 years, per capita

Cumulative GERD/capita (U.S. Dollars 2005 constant prices and PPP)

Source: OECD



Other major complementary EU vulnerabilities:

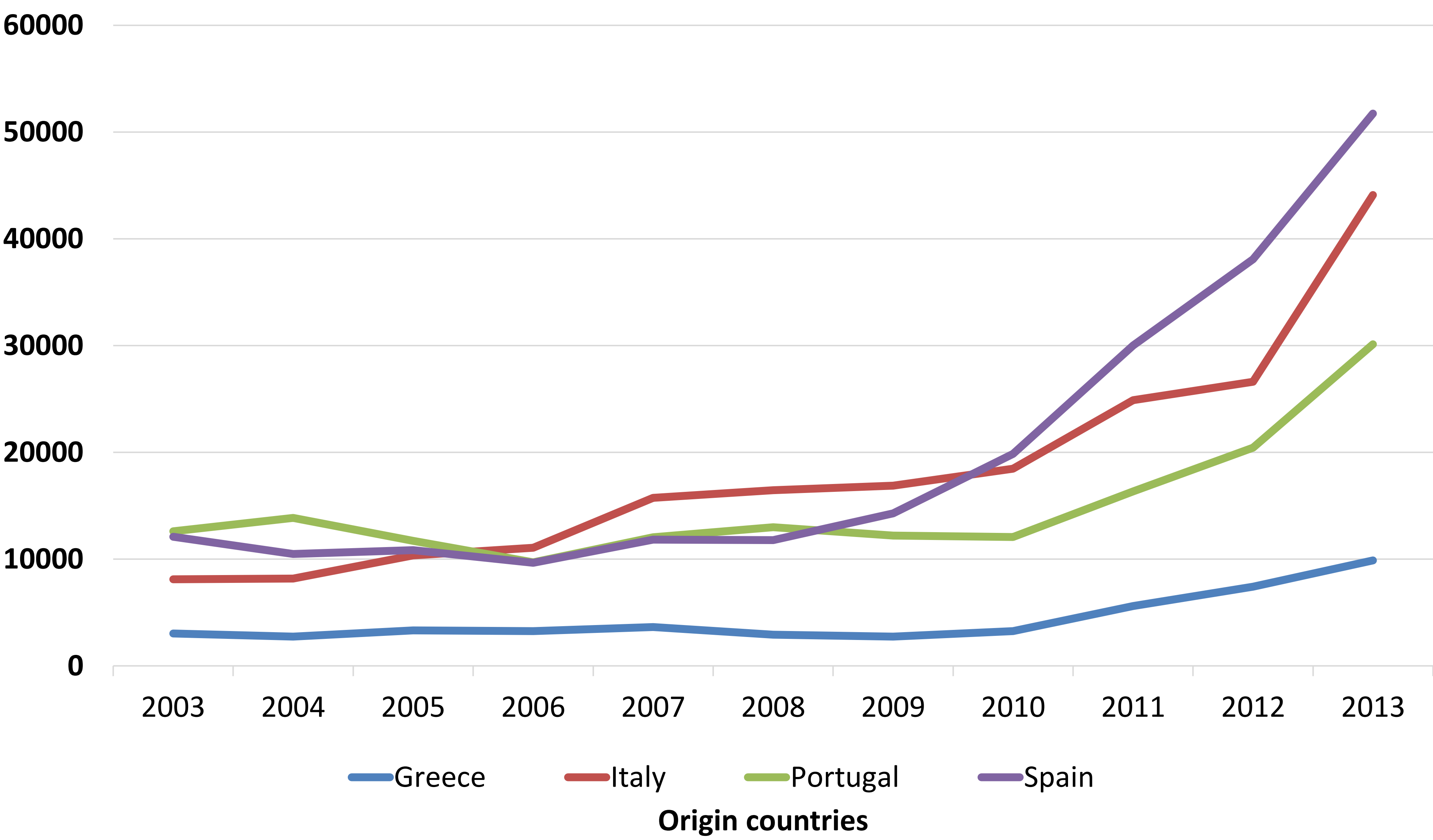
- **New migratory flows of skilled people**:
  …the growing scientific and technological capacity of ***less industrialized regions*** is now associated with, also, a growing vulnerability associated with a increasing international competition for skilled human resources.

- **High rates of young unemployment:**
  …weak new job creation in ***less industrialized regions***.

- Accelerated rate of **aging** of population…

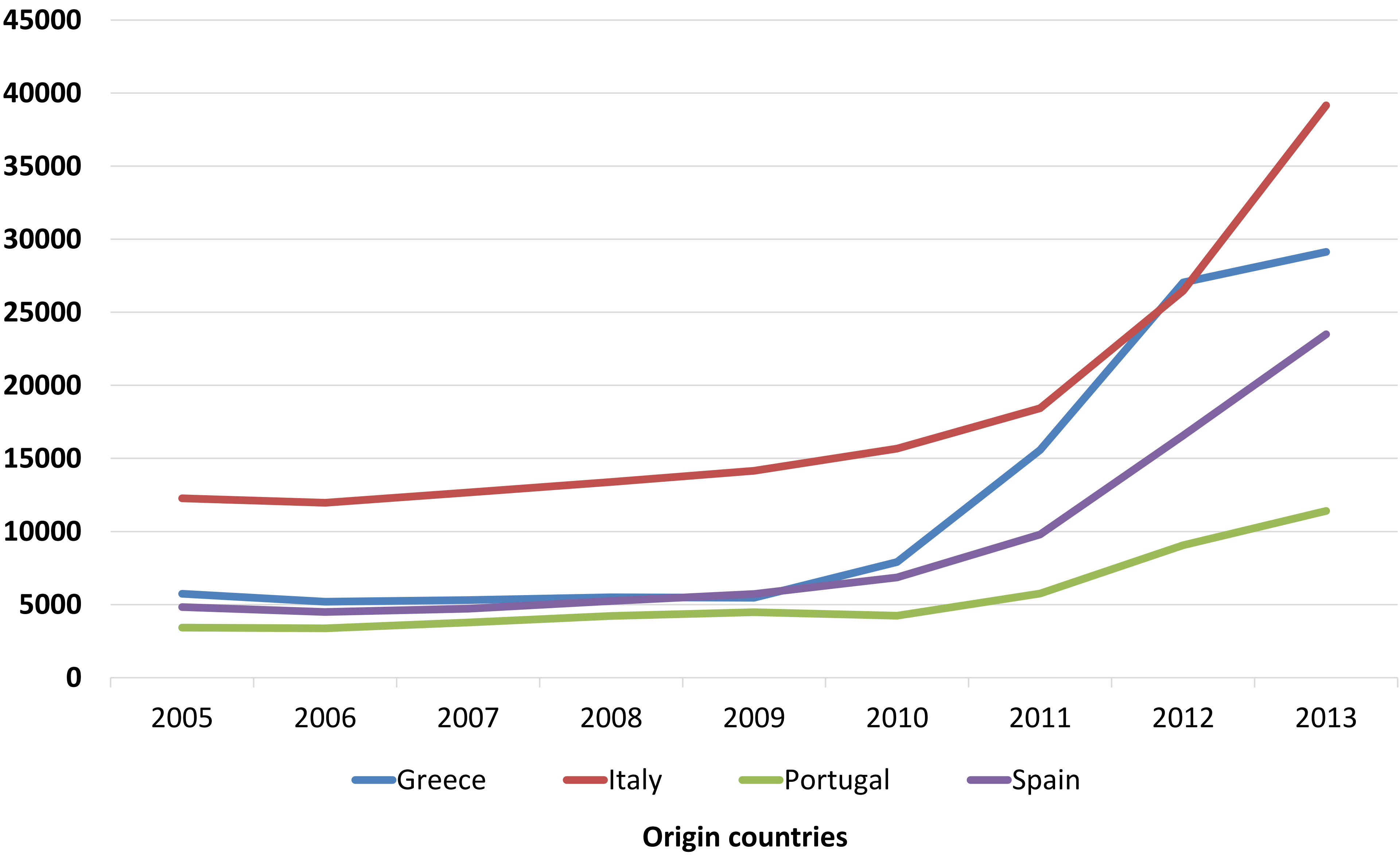
# Fluxo de gregos, italianos, portugueses e espanhóis para o Reino Unido

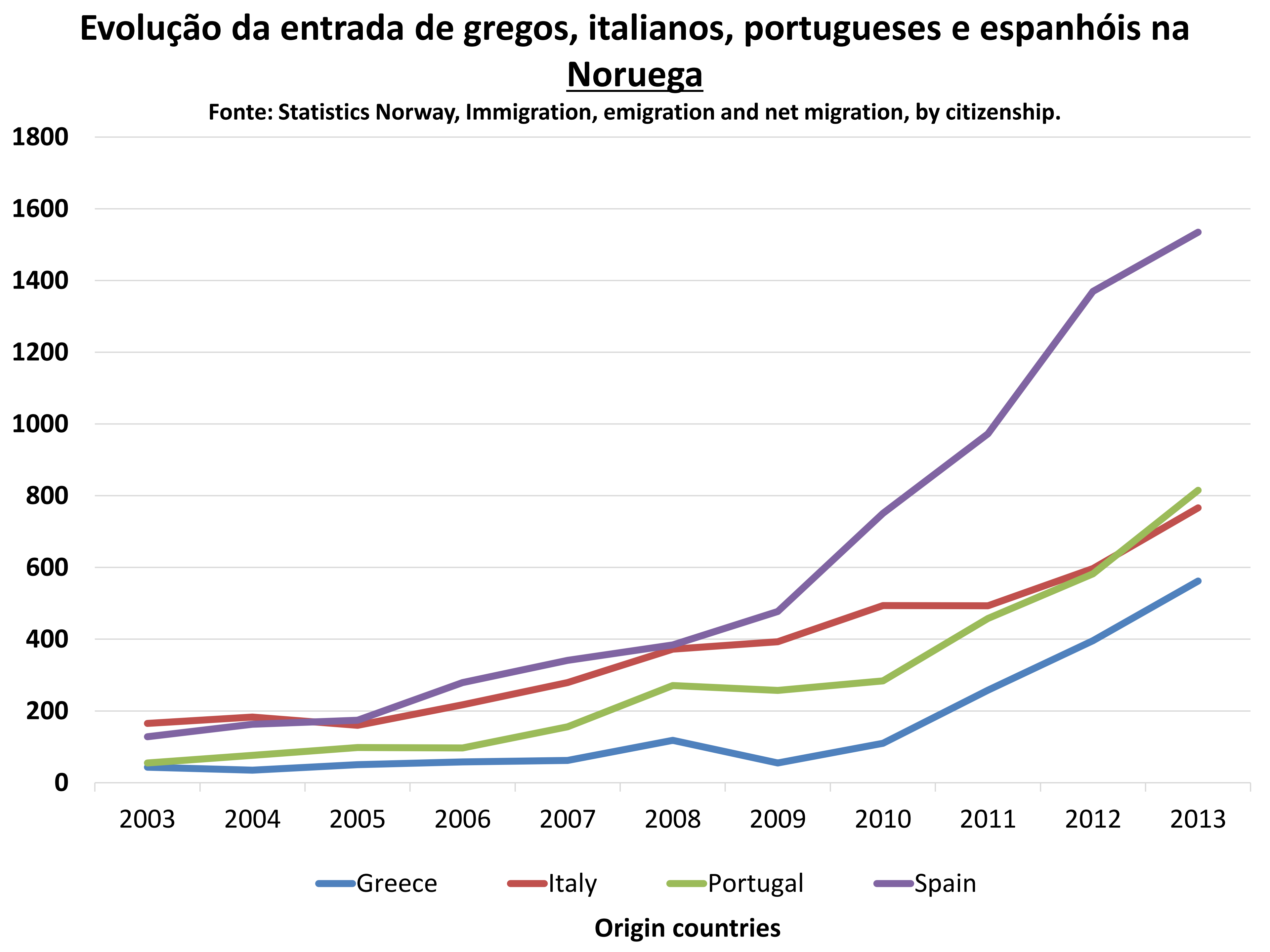
**Evolução do número de atribuições de número de registo (*National Insurance Number*) pelo Sistema de Segurança Social no Fonte:  Department for Work and Pensions UK**



# Evolução da entrada de gregos, italianos, portugueses e espanhóis na <u>Alemanha</u>

**Fonte: Statistisches Bundesamt Deutschland, Fachserie 1 Reihe 2, volumes de 2005 a 2013**



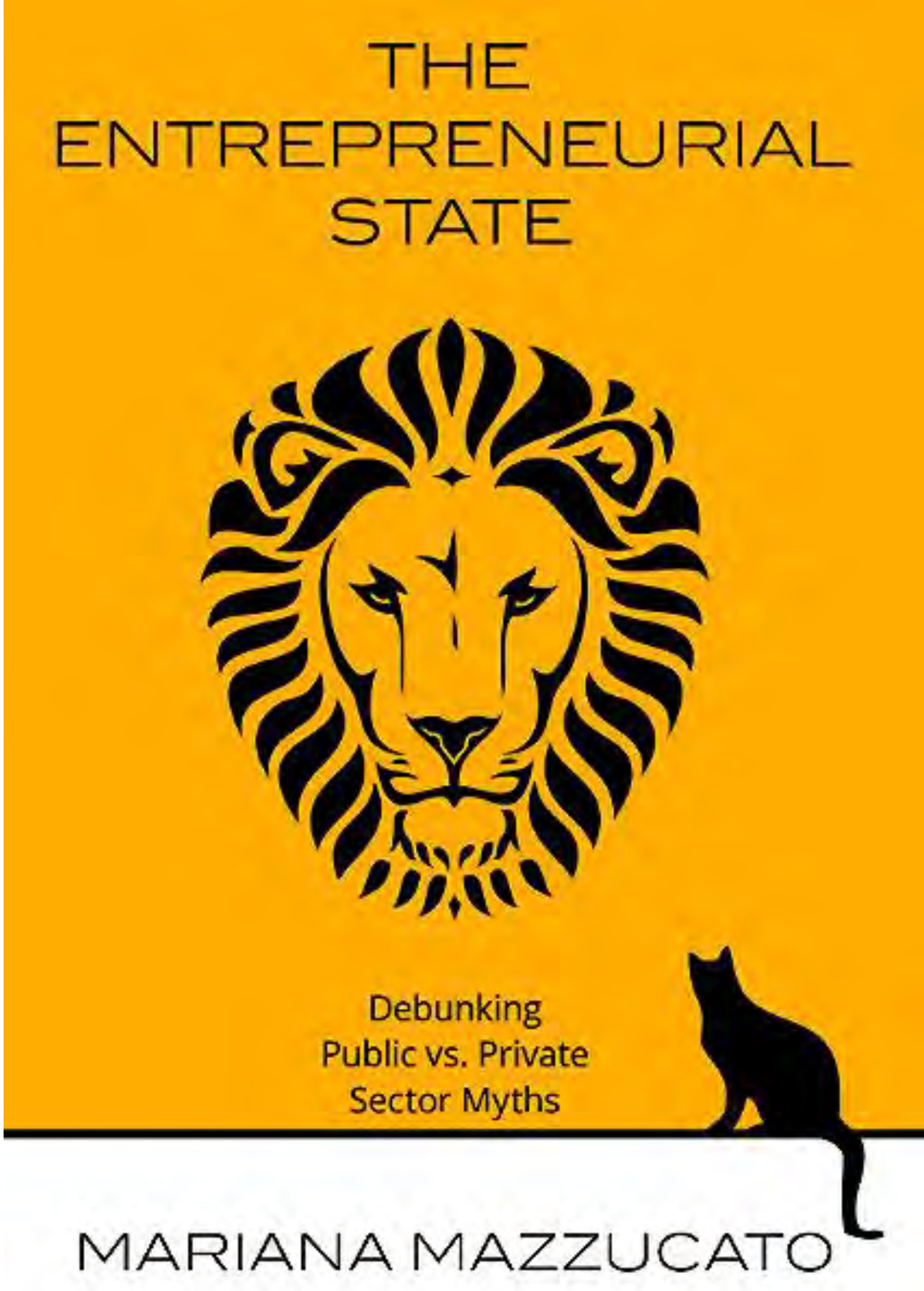

Evolução da entrada de gregos, italianos, portugueses e espanhóis na Noruega
Fonte: Statistics Norway, Immigration, emigration and net migration, by citizenship.
1800
1600
1400
1200
1000
800
600
400
200
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Greece
Italy
Portugal
Spain
Origin countries

# Which myths?

Public vs private
R&D vs innovation
Higher education vs training labor

…we live on times of increasing socialization of risks and the privatization of rewards

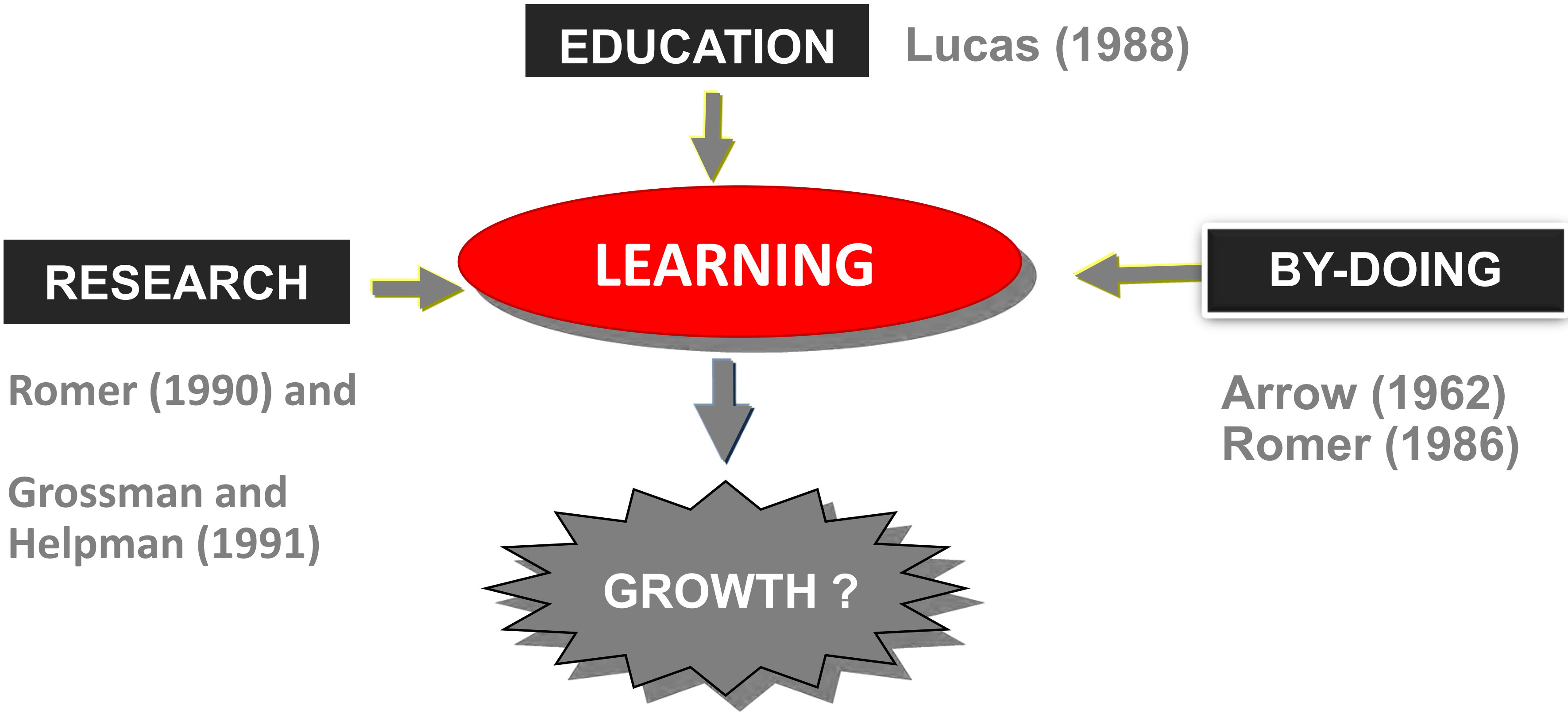
How can we effectively help debunking these myths and guarantee better policies?



# …but, what has changed?

# endogenous growth:

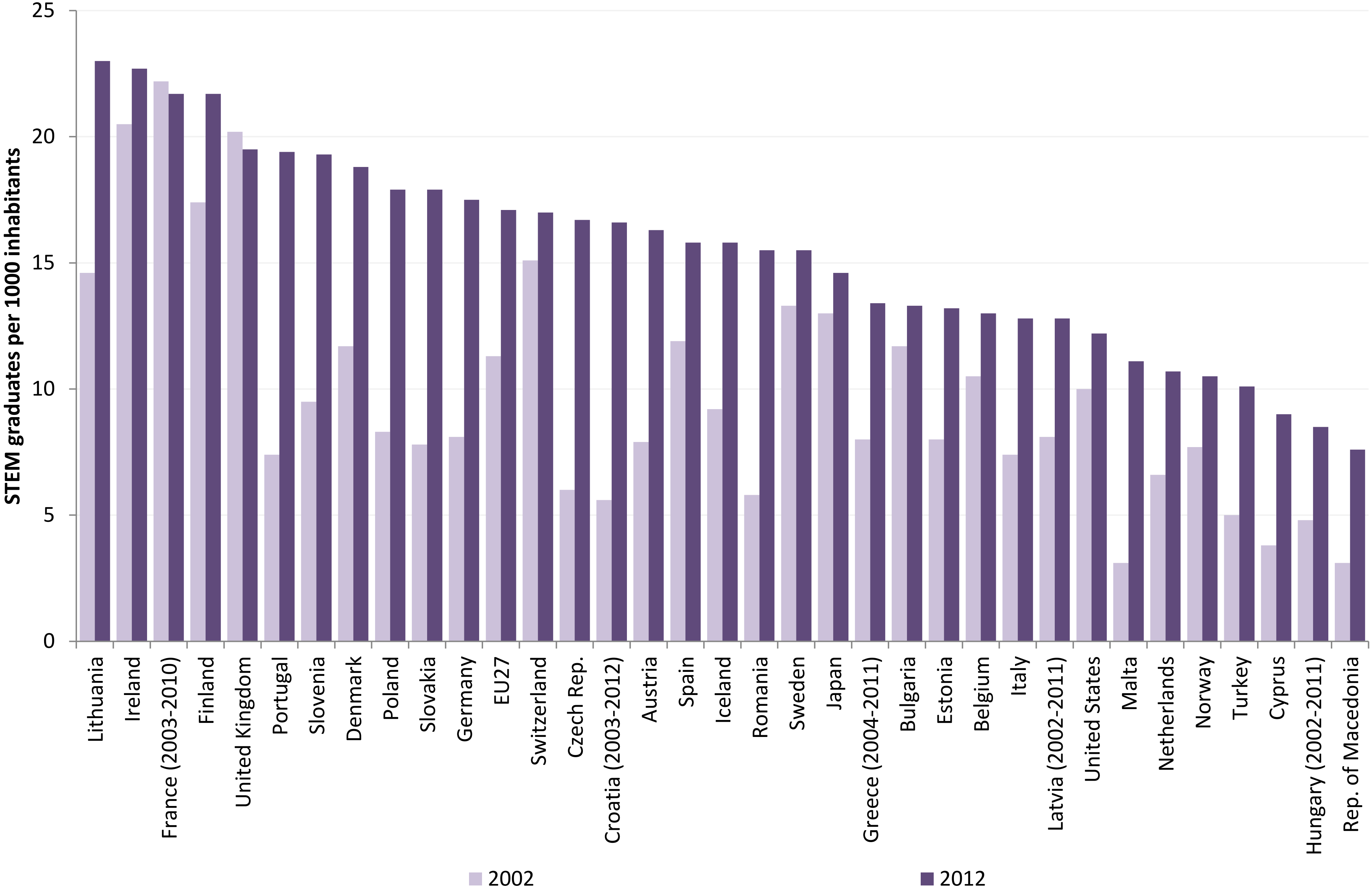
…what do we know from the theories of economy growth?




- The **learning ability** is the critical aspect for economic growth, and is associated to the skill of assimilating and transforming the current knowledge.
- "Learning refers to building new competencies and establishing new skills and not just to get access to information", Lundvall (1997).

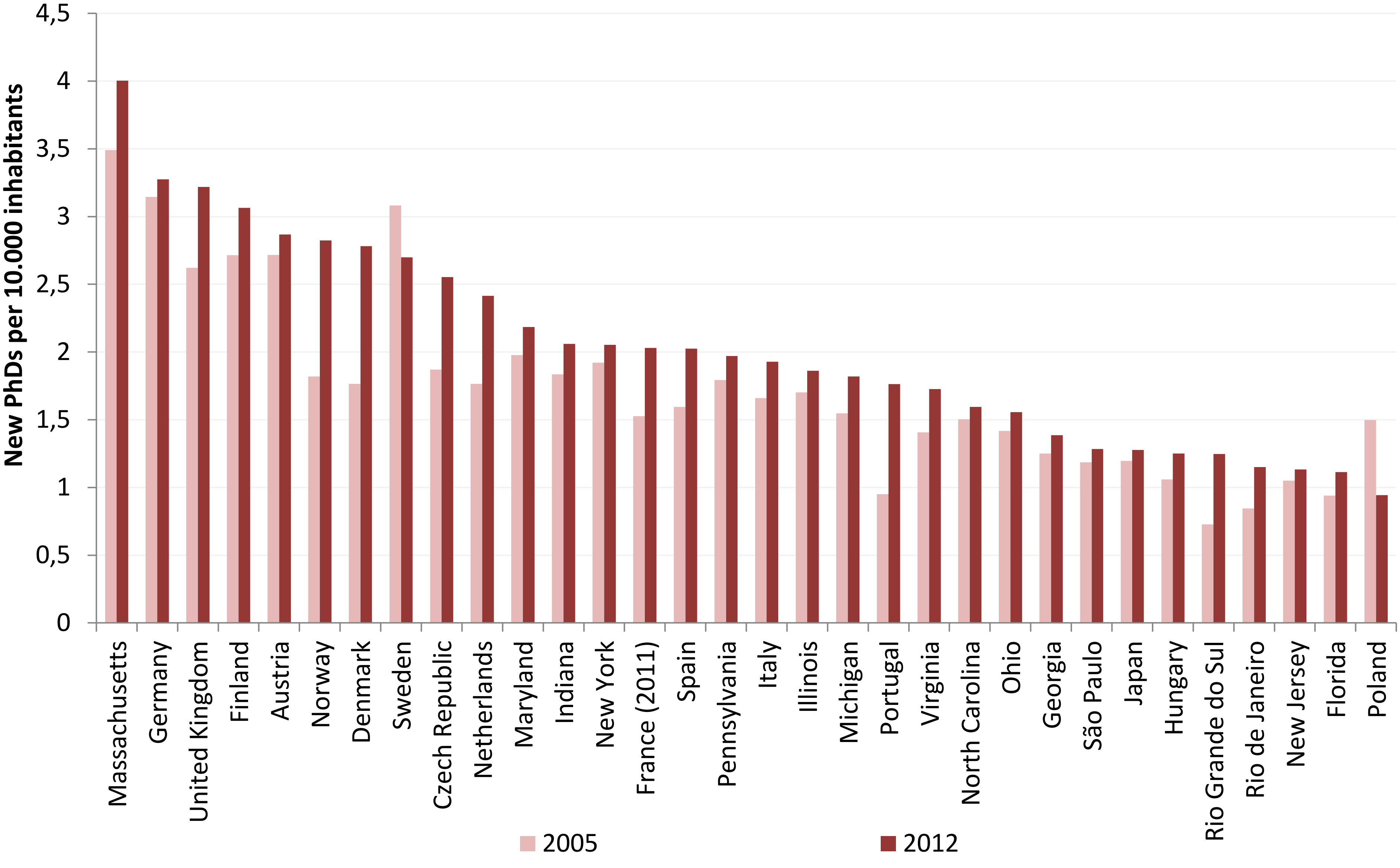
# STEM graduates per 1000 inhabitants with 20-29 years old

**Source: Eurostat**



# New PhDs per 10.000 inhabitants for 2005 and 2012

Source: UNESCO, Eurostat, INEP, CAPES, NSF, IBGE, NBS, SSB.NO.

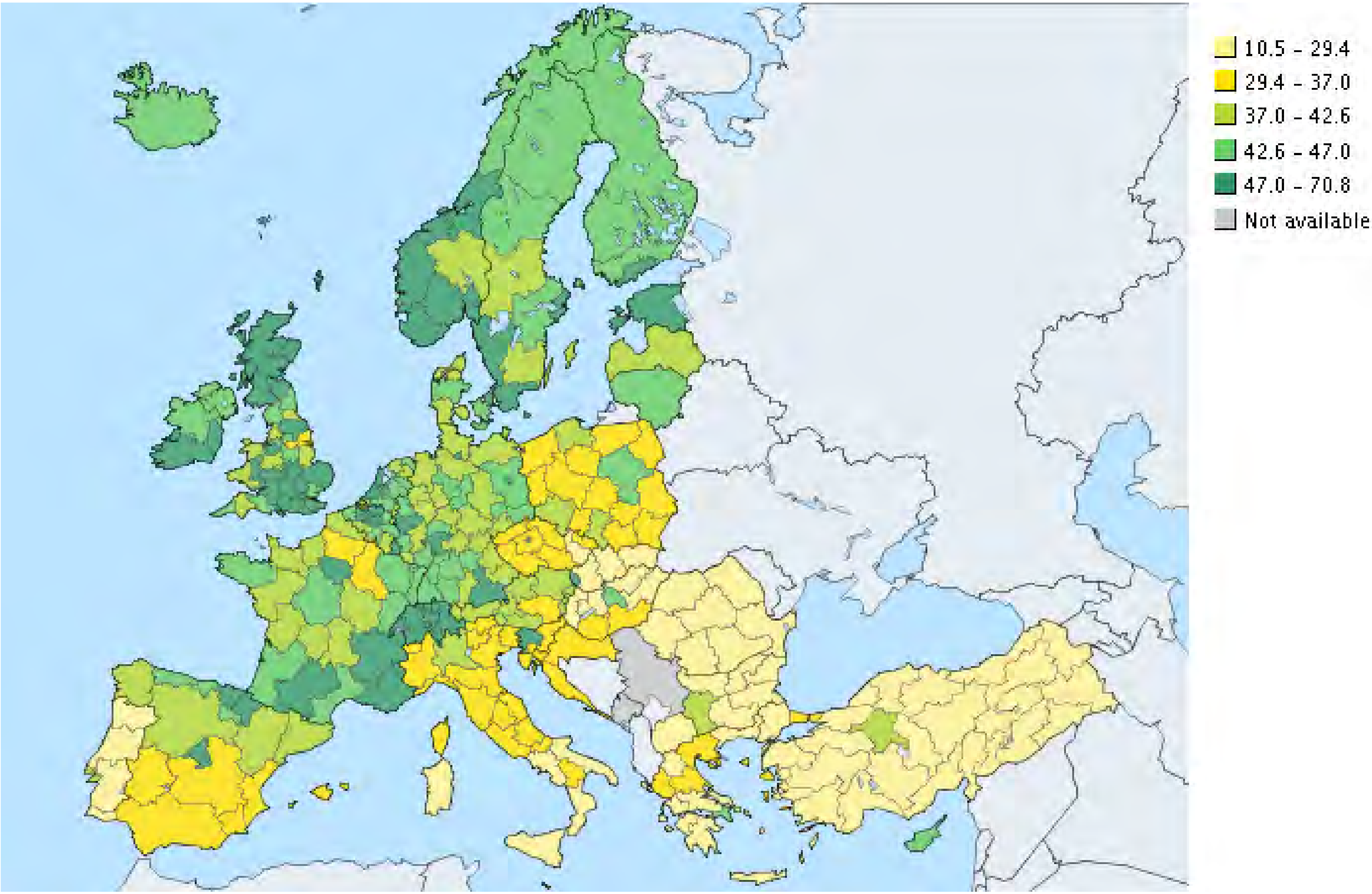


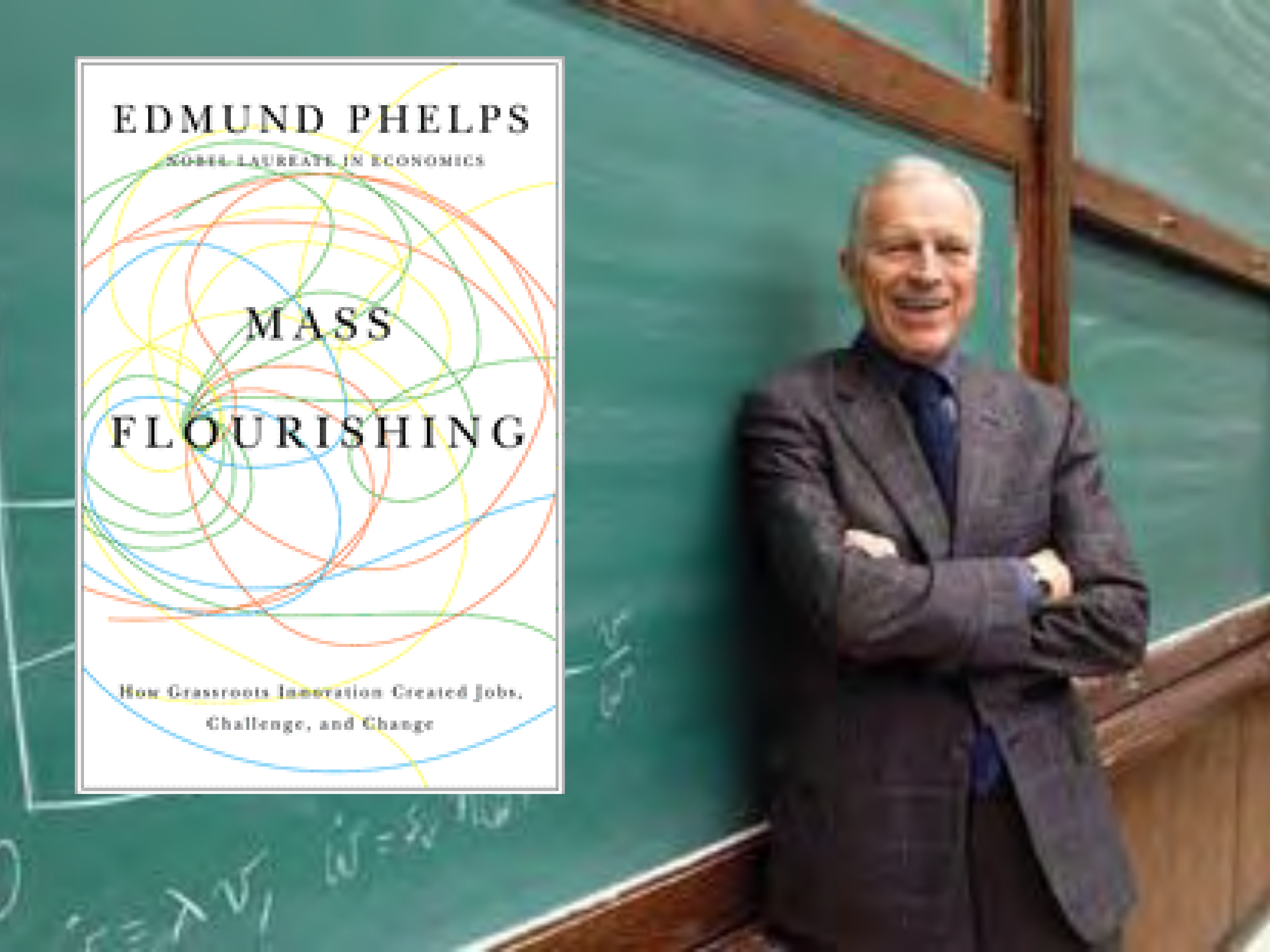

U.S data – doctorate recipients ; Brazil data – total de titulados no doutorado ; Other data – Doctor of Philosophy.

# Human Resources on S&T ("HRST") - 2013

(percentage of active population - NUTS 2)

Source: EuroStat.




EDMUND PHELPS
NOBEL LAUREATE IN ECONOMICS
MASS
FLOURISHING
How Grassroots Innovation Created Jobs,
Challenge, and Change

# …how to qualify the labor force?

see, for reference, S. Berger (2013) and Locke & Wellhausen (2014) in the US context…

## It requires mass qualified employers!

Broadening the social basis for higher education and **focusing non-university higher education in short cycles** of training and in vocational education may help…

The need to guarantee **higher education diversity** is deemed as critical, but goes far **beyond traditional science policies**: It requires adapting short cycles training and vocational education to the continuous requirements of qualifying the labor force and their development requires **complementing traditional science policy instruments with dedicated, market-driven research strategies for SMEs.**

See: S. Hasanefendic, M. Heitor and H. Horta (2014)

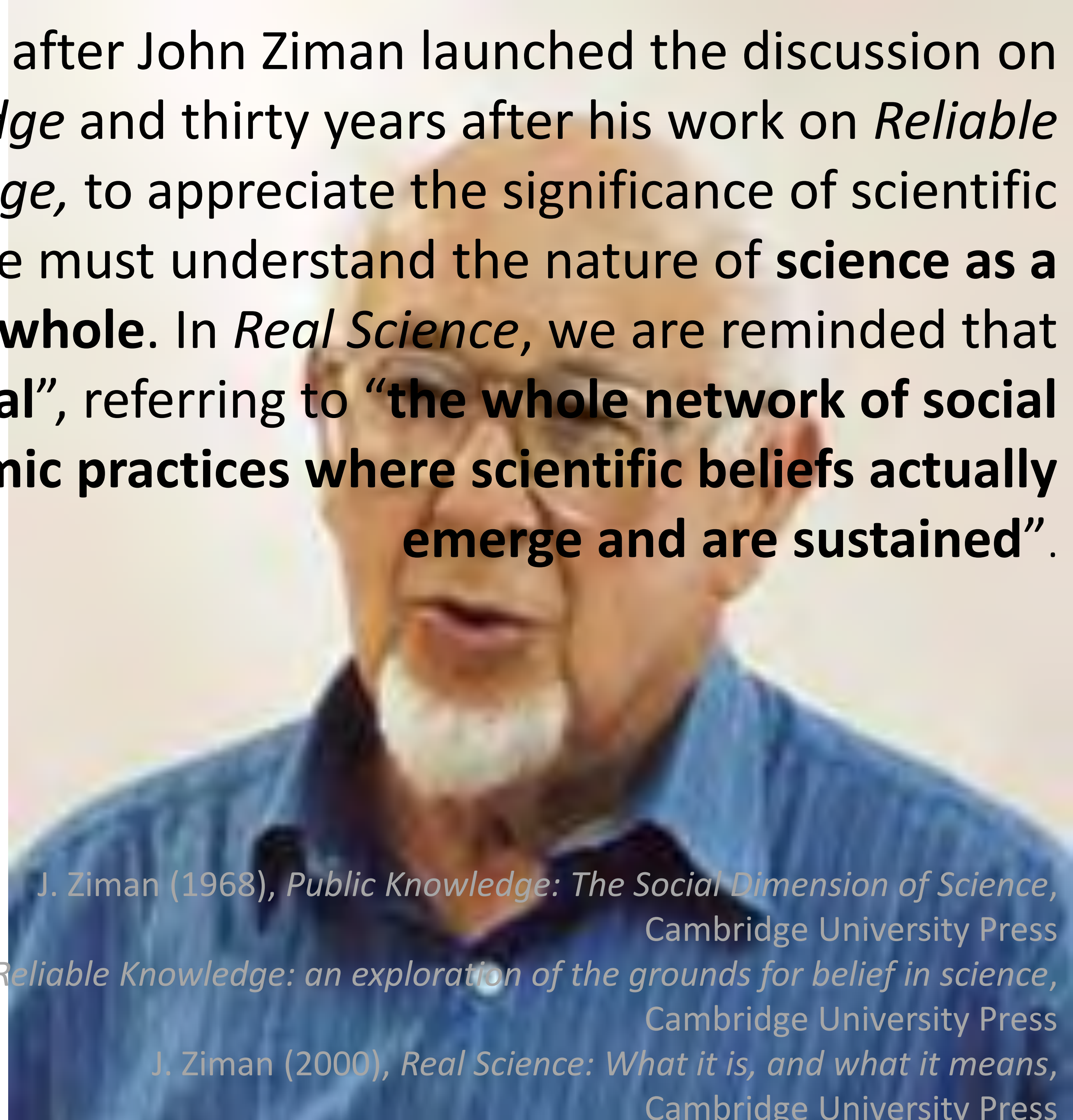
# Which questions?

- **WHAT** will these new technologies be like?
- On **WHICH** research we should invest in?
- **WHAT** engineering courses should we teach in our schools and universities?

These are relevant issues,
but the <u>wrong questions</u> …

# We can look, instead, at the process...

**How people, institutions and incentives** can be effectively oriented, transmitted and assimilated to allow societies to move towards a socially responsable, sustainable and entrepreneurial world?



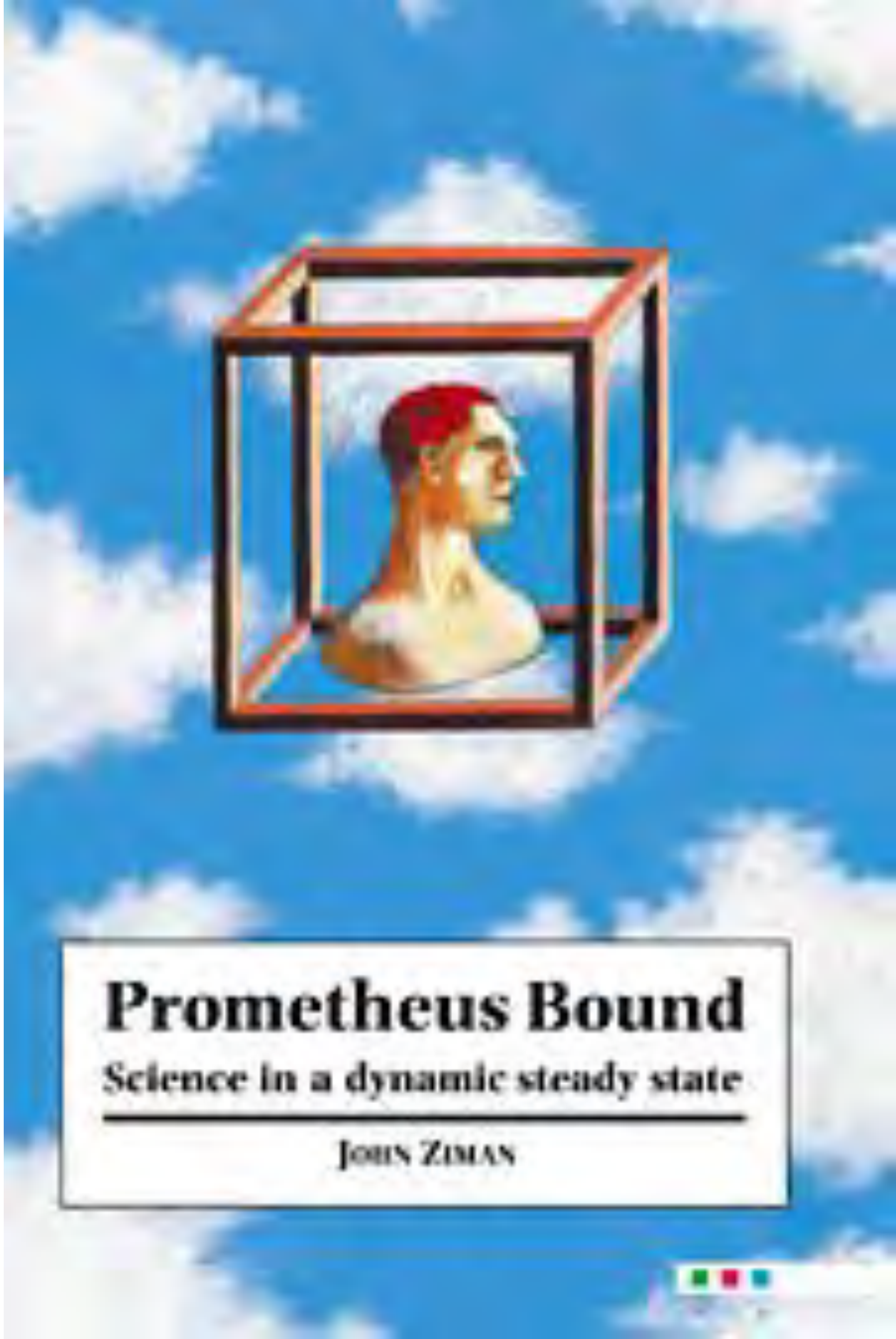
Some forty years after John Ziman launched the discussion on *Public Knowledge* and thirty years after his work on *Reliable Knowledge,* to appreciate the significance of scientific knowledge one must understand the nature of **science as a complex whole**. In *Real Science*, we are reminded that "**science is social**", referring to "**the whole network of social and epistemic practices where scientific beliefs actually emerge and are sustained**".

J. Ziman (1968), *Public Knowledge: The Social Dimension of Science*, Cambridge University Press

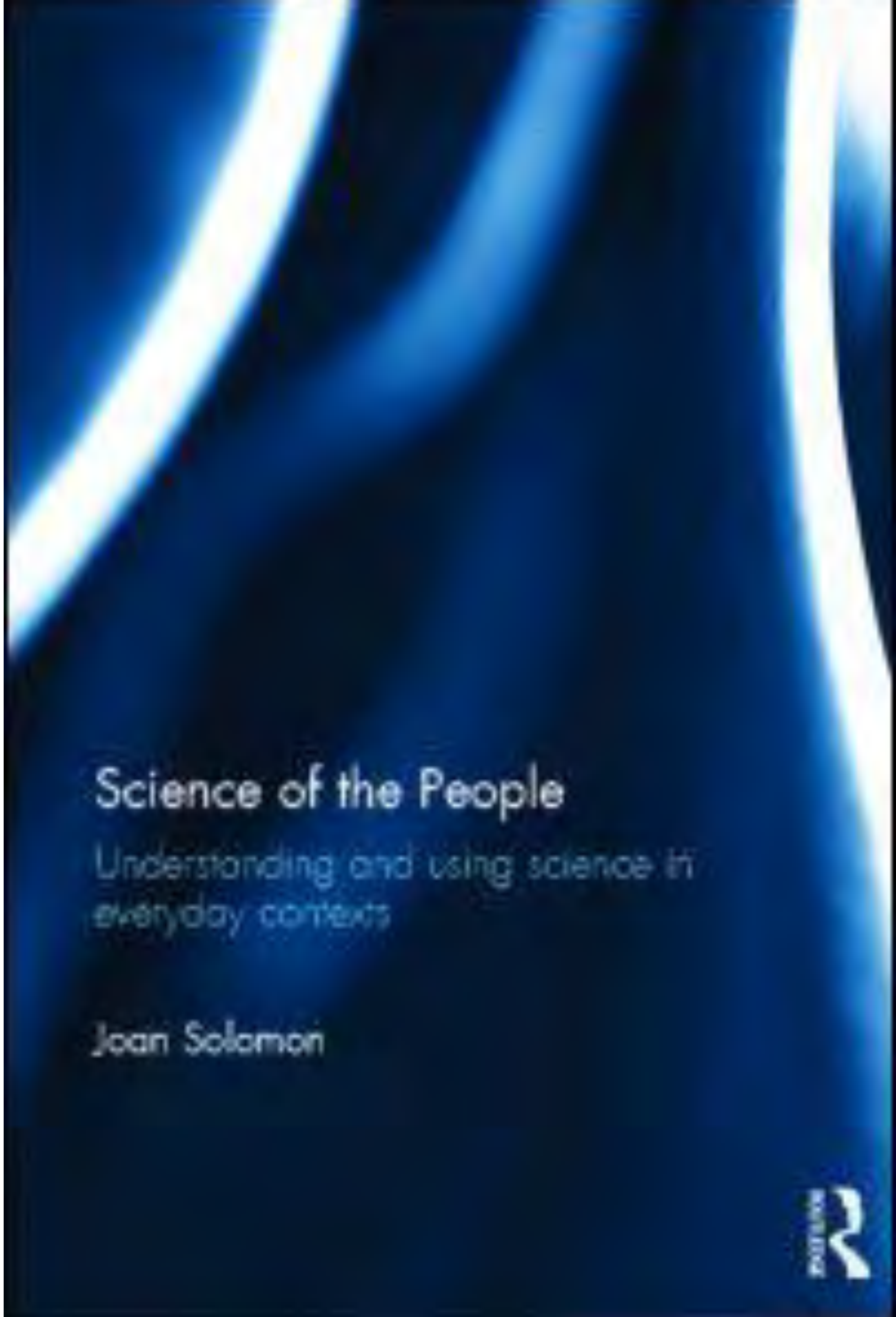
J. Ziman (1978), *Reliable Knowledge: an exploration of the grounds for belief in science*, Cambridge University Press

J. Ziman (2000), *Real Science: What it is, and what it means*, Cambridge University Press

Ziman takes government funding of science as a given, because the market cannot be trusted to allocate resources wisely and, anyway, research now costs so much that only government can pay the bill.



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?



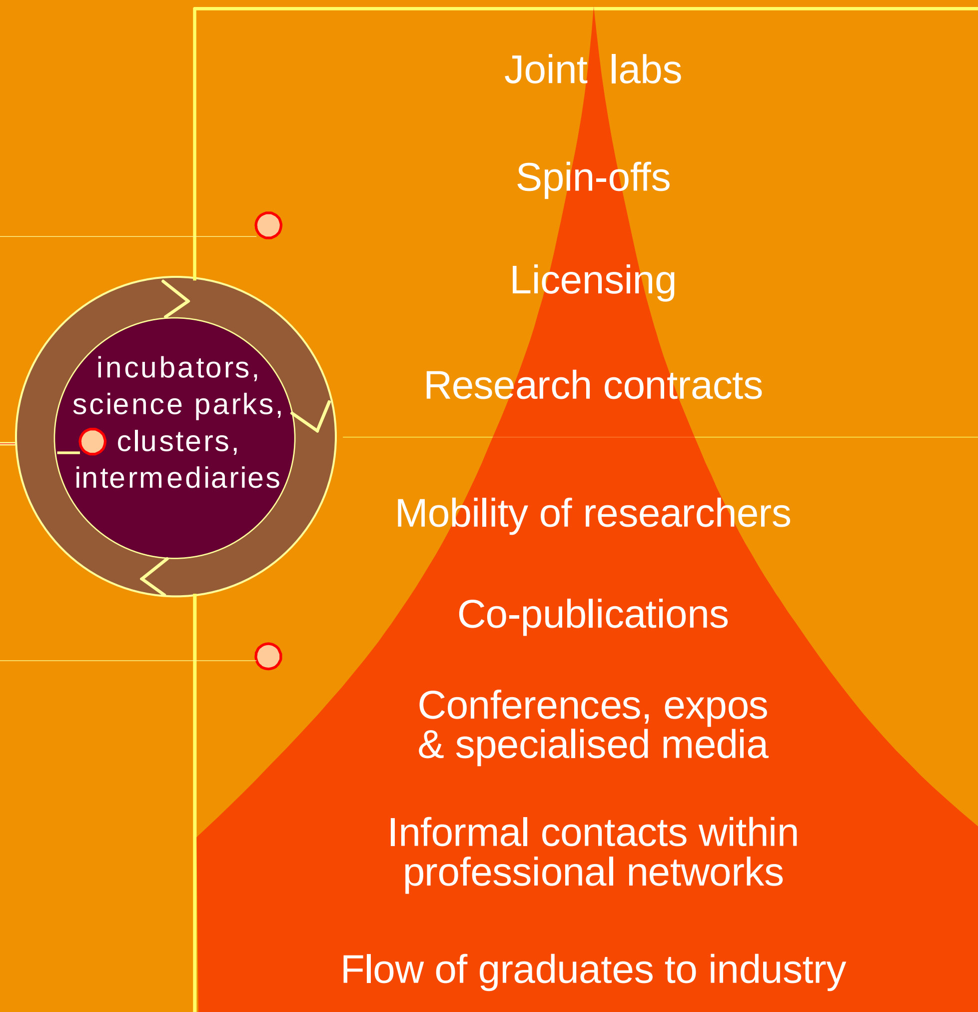
# HOW people learn?

# …HOW to foster collective learning?

# Formal mechanisms for Industry-Science Relationships: *the tip of an iceberg*

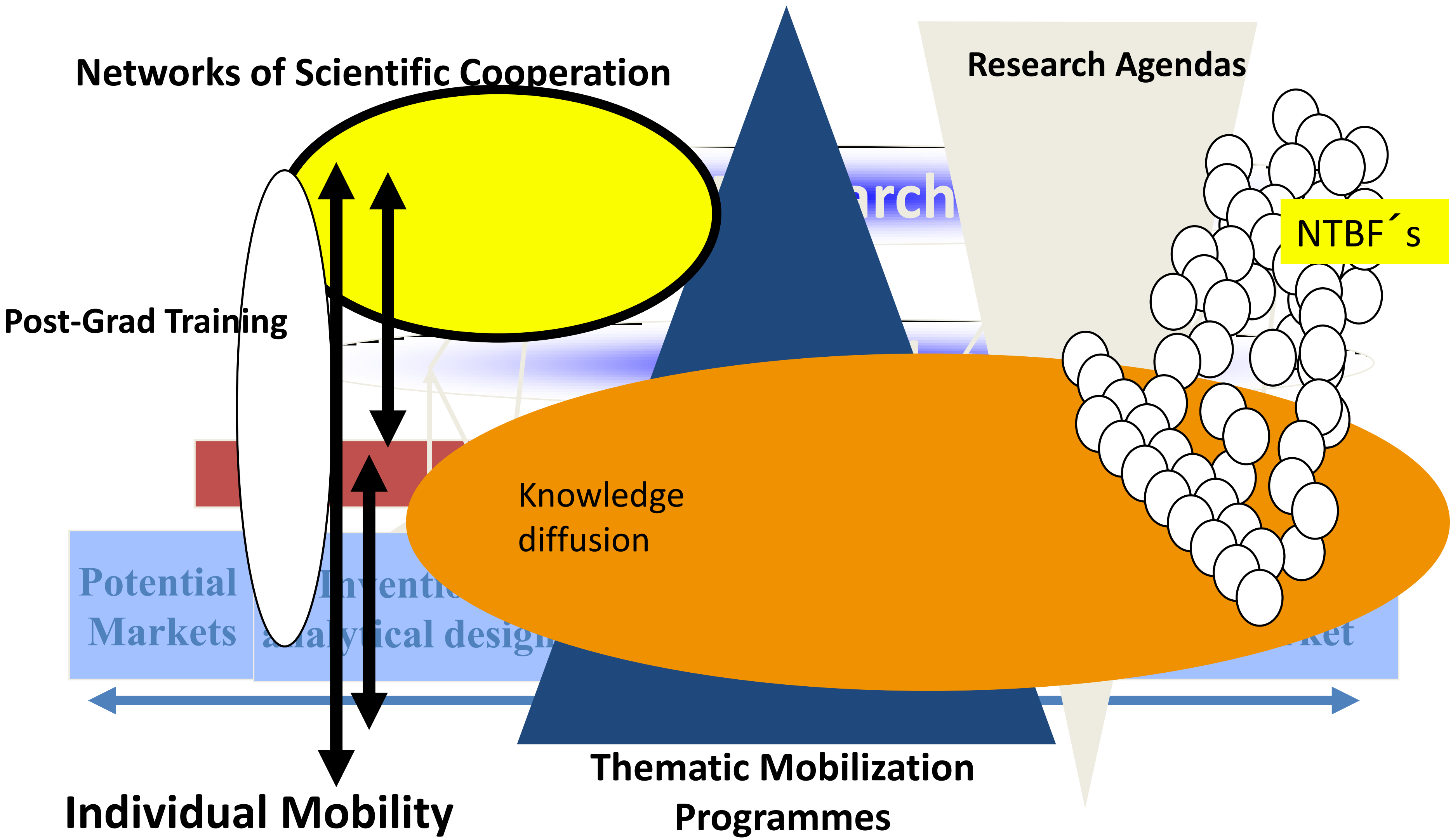
## Government policy

| Framework conditions | Support schemes |
|---|---|
| Specific regulations (e.g. IPRs) | Financial incentives to co-operative research (e.g. Framework Programme in the EU) |
| Education policy | Co-operative Research Centres (e.g. CRCs in Australia) |
| Labour market policy | Public seed capital funds (e.g. I-Source in France) |
| Public procurement | Publicly funded intermediaries (e.g. Fraunhofer in Germany) |
| Financial policies | Thematic research networks (e.g. RNRT in France) |
| Regional and urban planning policies | Promotion of researchers' mobility (e.g. TCS in the United Kingdom) |
| Competition policy | |



Promoting global ***Systems of Innovation and Competence Building***:

# ...with **diversified partnerships**



The continuous development of R&D and Higher Education requires **counter-cycle policy measures**, with emphasis on the **advanced training of human resources** and the systematic **opening of the social basis for education and science across all EU**.

**Innovation** must be considered a **collective and cumulative process**

the **process** matters!...

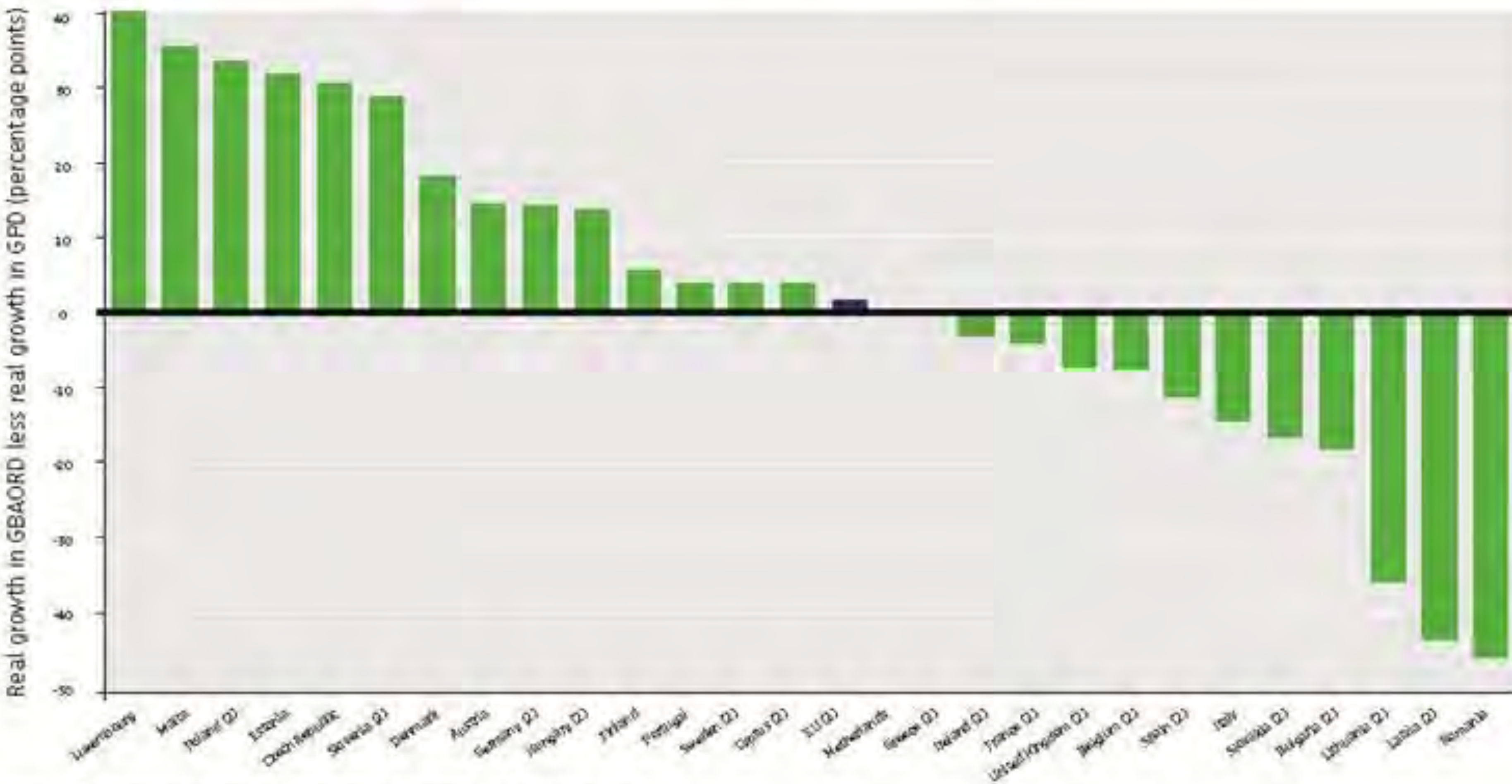
**www.step4EU.org:**

***...new horizons for science, technology and innovation?***

The Dance, Henri Matisse, 1910

Annexes: for discussion

Government investment in the future
The difference in percentage points between real growth (1) in Government budgets for R&D (GBAORD(2)) and real growth(1) in GDP, 2008-2012(3) (4)




Source: DG Research and Innovation - Economic Analysis unit

Data: Eurostat

Notes: (1) Real growth was calculated from values in PPS€ at constant 2000 prices and exchange rates.

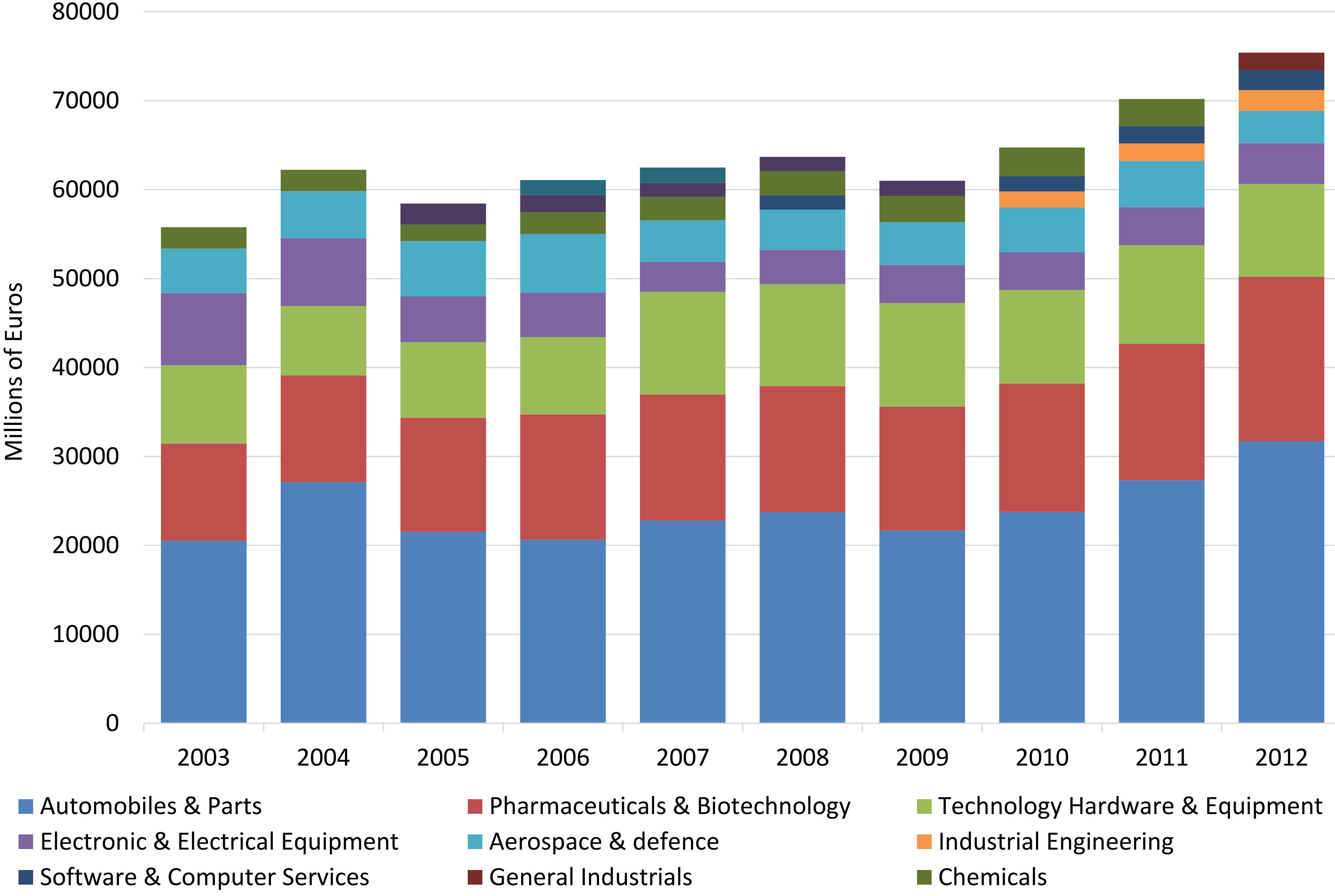
(2) Foregone tax revenues resulting from R&D tax incentives are not included.

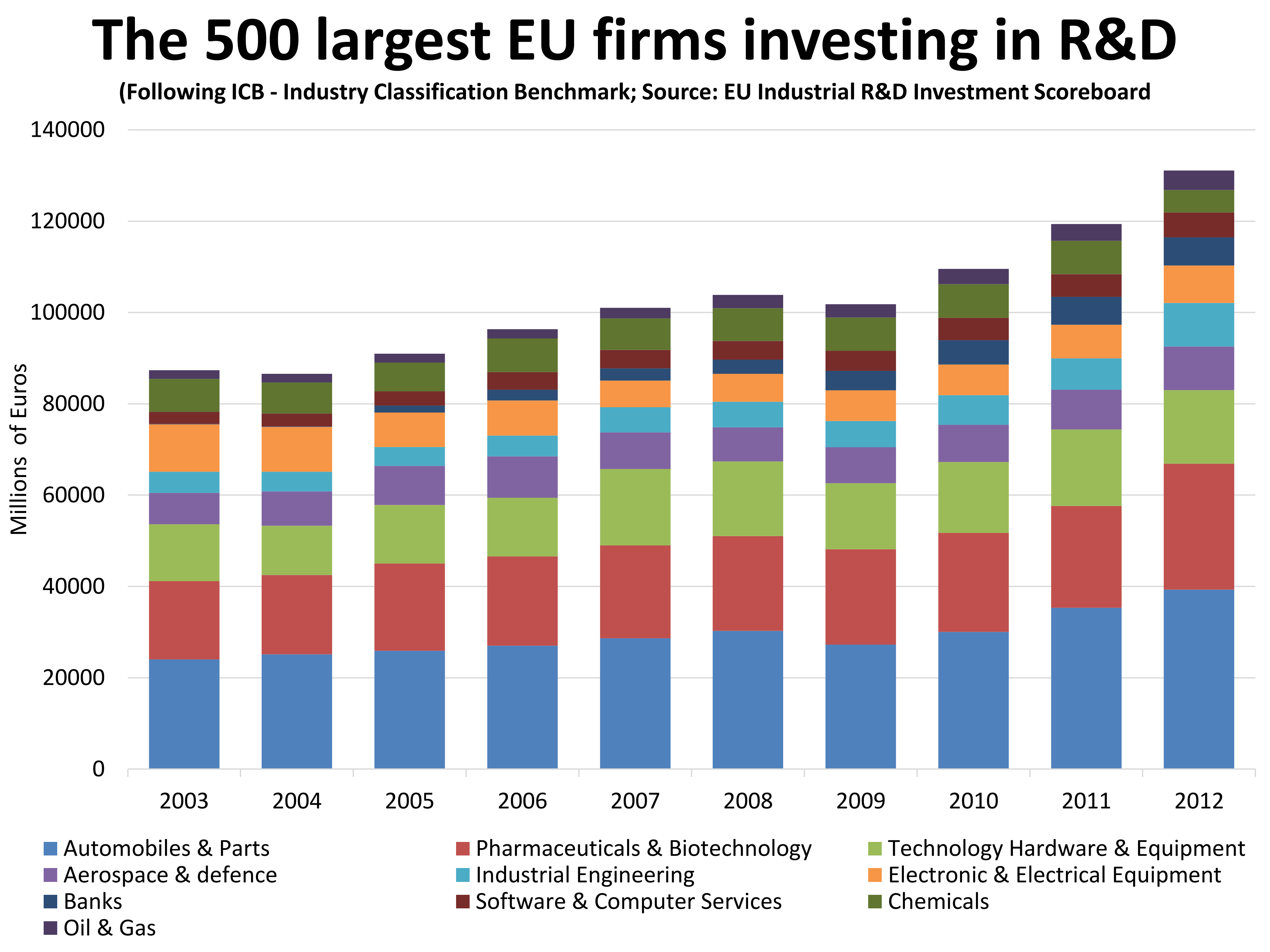
(3) EL: 2007-2008; PL: 2009-2011; BE, BG, DE, IE, ES, FR, CY, LV, LT, HU, SI, SK, SE, UK, EU: 2008-2011;

(4) Data for 2012 are provisional.

# The 20 largest EU firms investing in R&D

**(Following ICB - Industry Classification Benchmark; Source: EU Industrial R&D Investment Scoreboard**




The 500 largest EU firms investing in R&D
(Following ICB - Industry Classification Benchmark; Source: EU Industrial R&D Investment Scoreboard
Millions of Euros
140000
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60000
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20000
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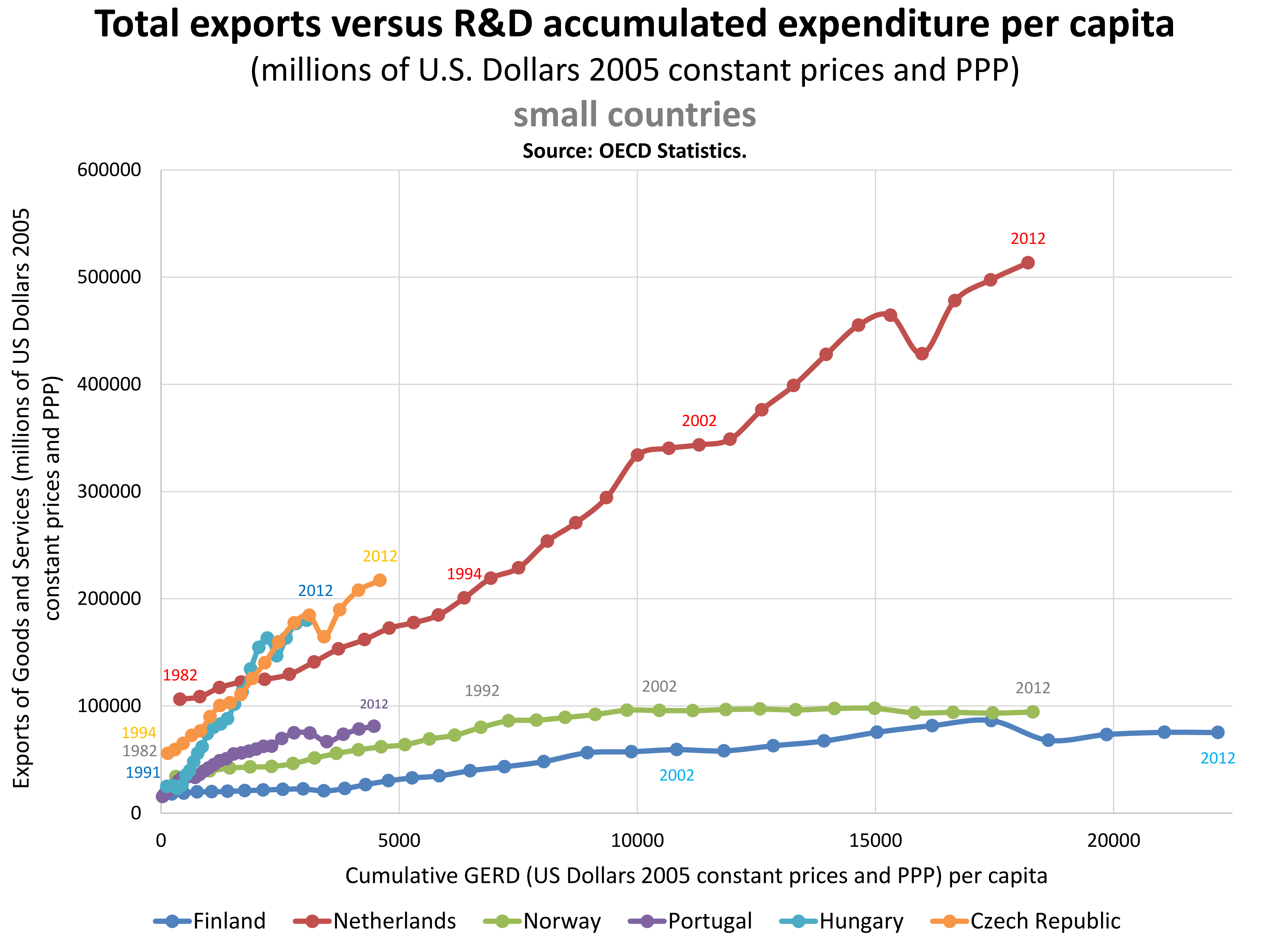
2011
2012
Automobiles & Parts
Pharmaceuticals & Biotechnology
Technology Hardware & Equipment
Aerospace & defence
Industrial Engineering
Electronic & Electrical Equipment
Banks
Software & Computer Services
Chemicals
Oil & Gas



Total exports versus R&D accumulated expenditure per capita
(millions of U.S. Dollars 2005 constant prices and PPP)
small countries
Source: OECD Statistics.
Exports of Goods and Services (millions of US Dollars 2005 constant prices and PPP)
Cumulative GERD (US Dollars 2005 constant prices and PPP) per capita
600000
500000
400000
300000
200000
100000
0
0
5000
10000
15000
20000
2012
2002
1994
1982
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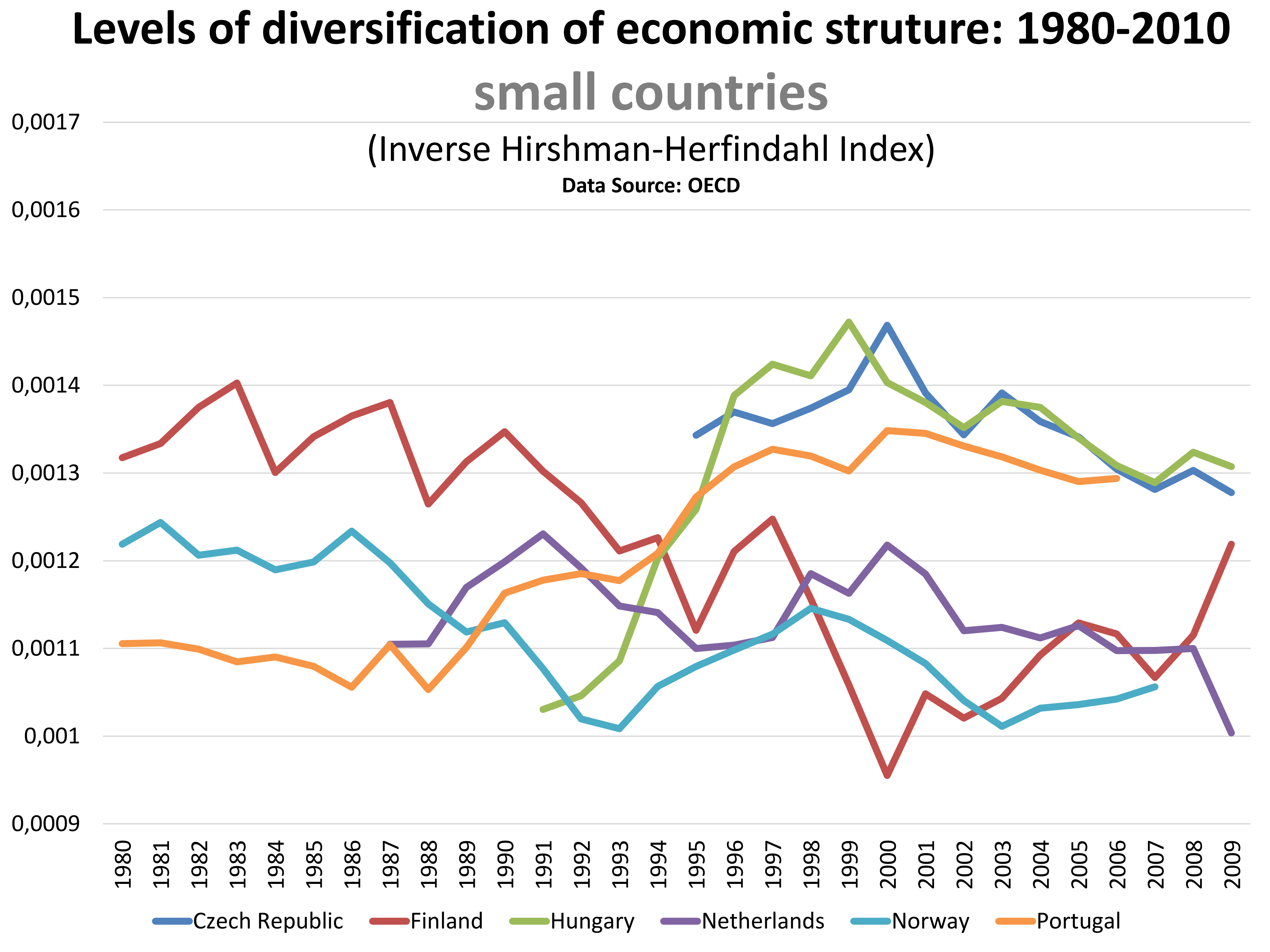
Finland
Netherlands
Norway
Portugal
Hungary
Czech Republic


Levels of diversification of economic struture: 1980-2010
small countries
(Inverse Hirshman-Herfindahl Index)
Data Source: OECD
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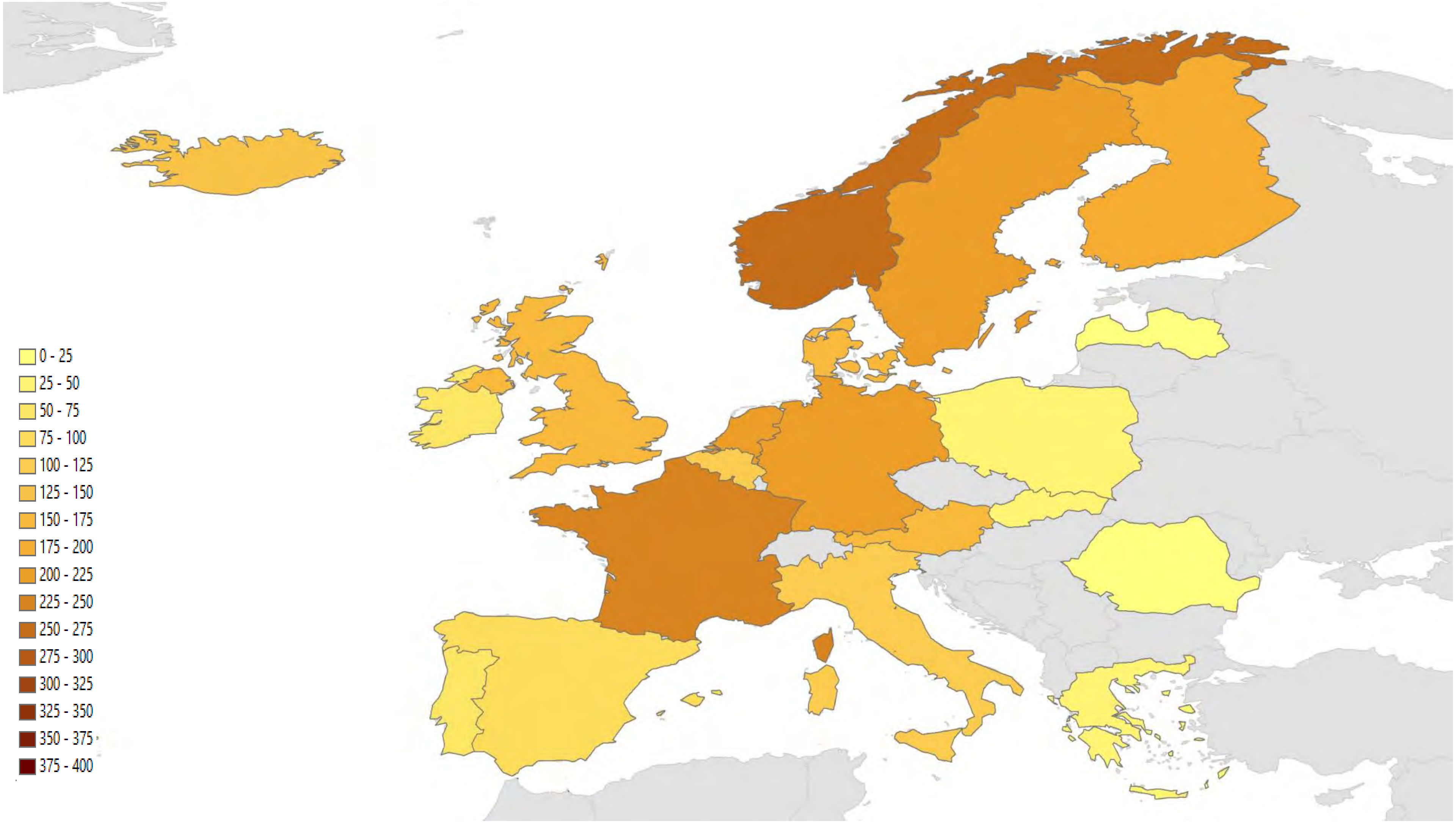
Czech Republic
Finland
Hungary
Netherlands
Norway
Portugal

# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 1995

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

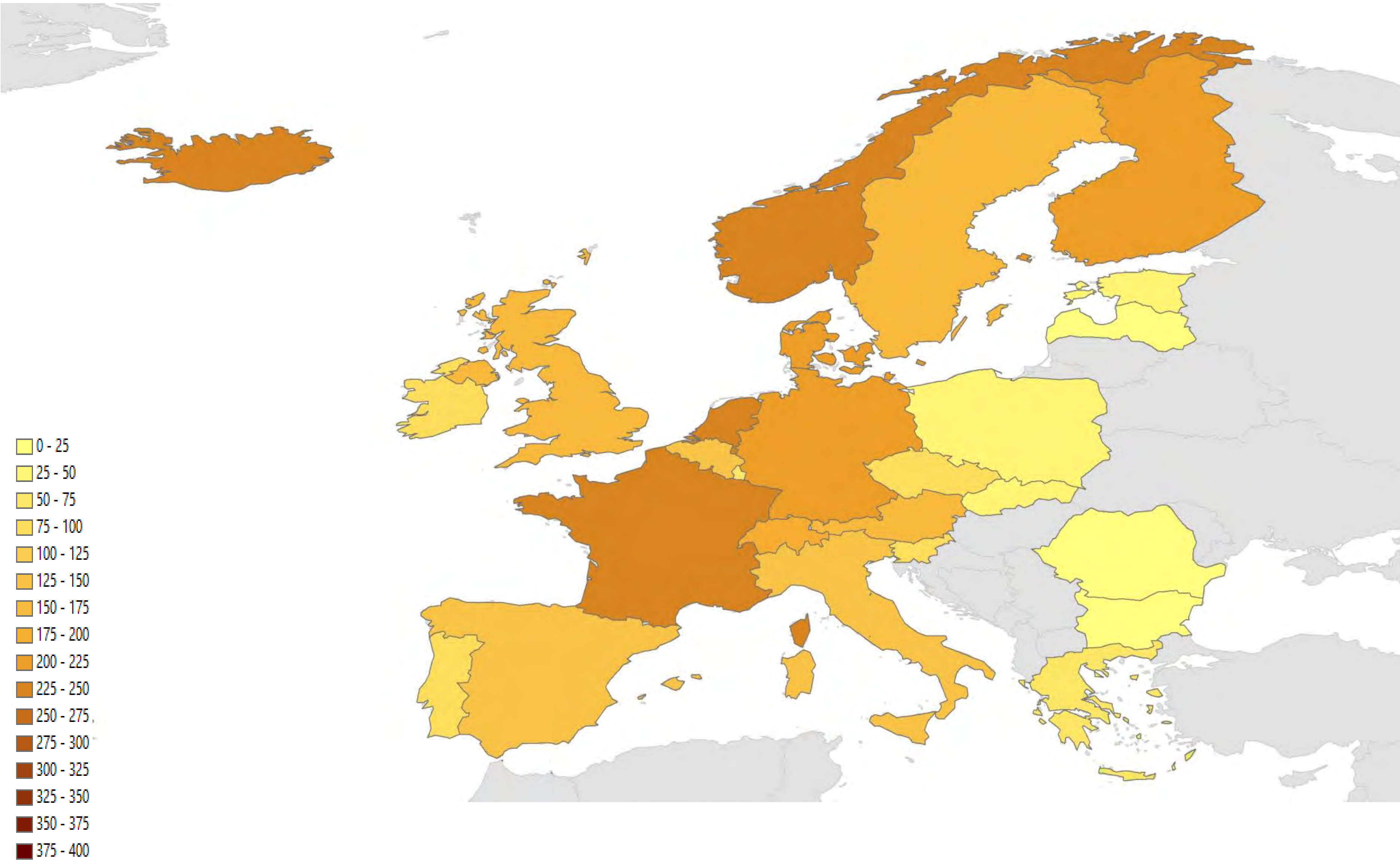
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2000

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

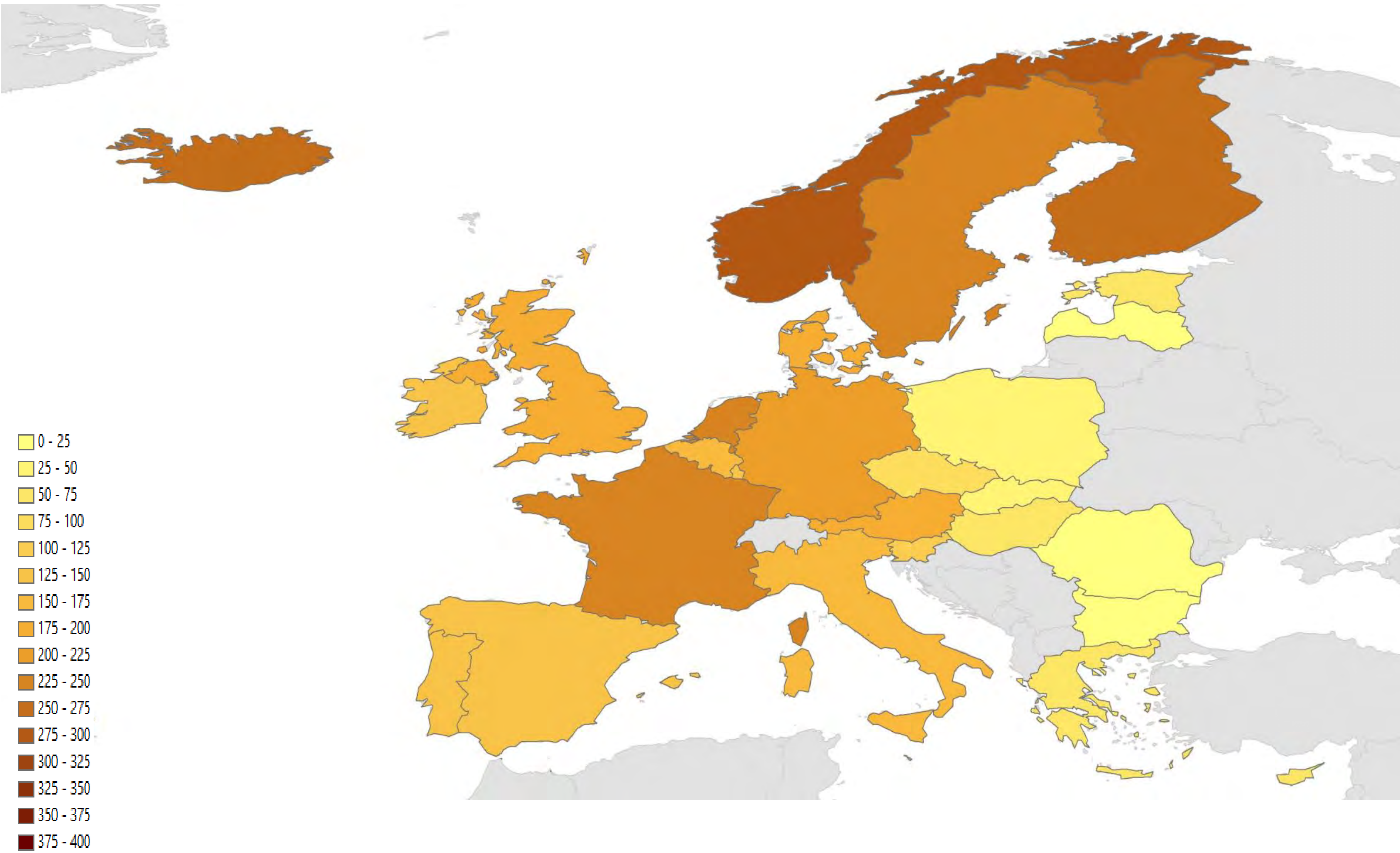
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2005

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

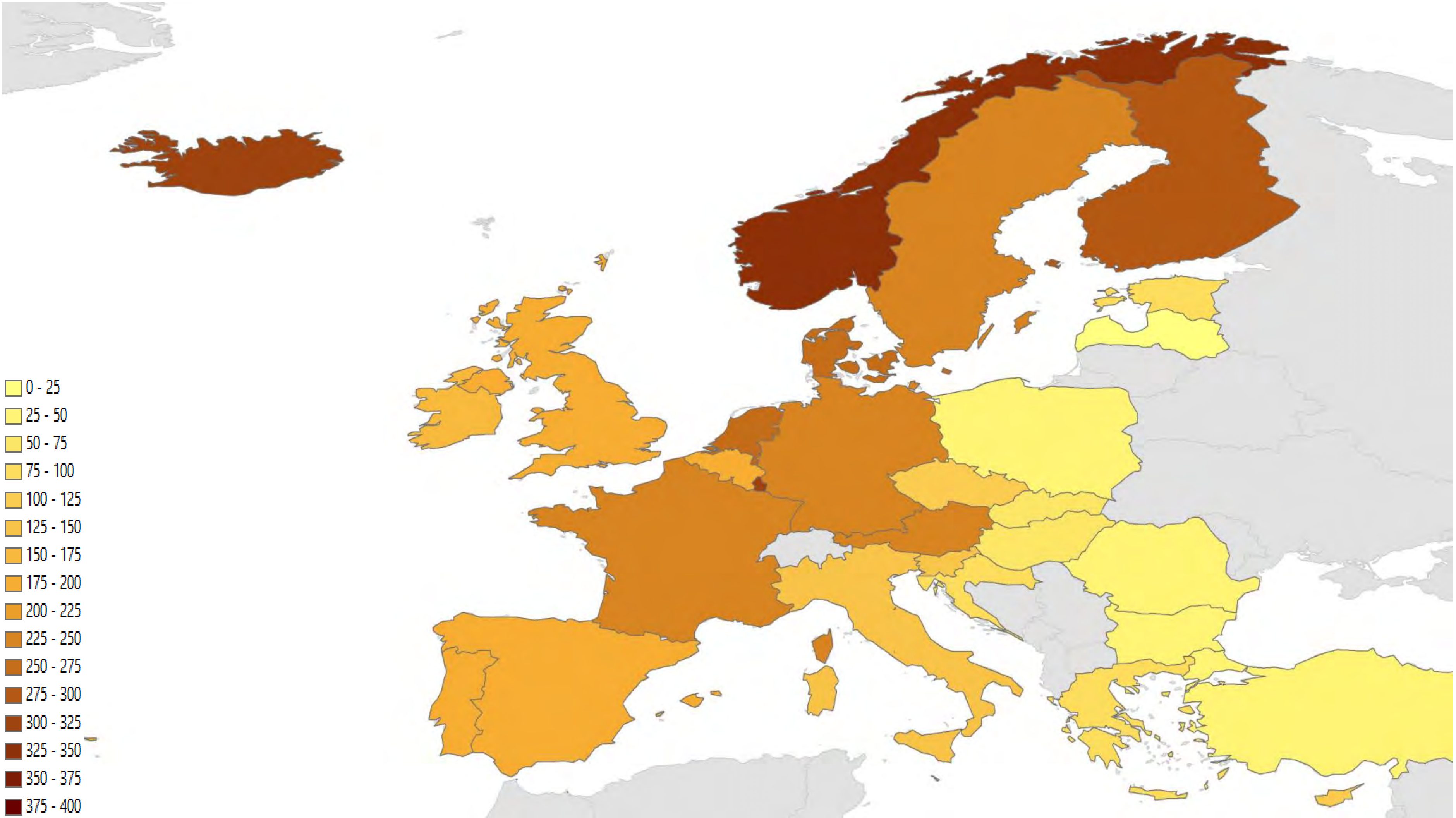
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2009

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

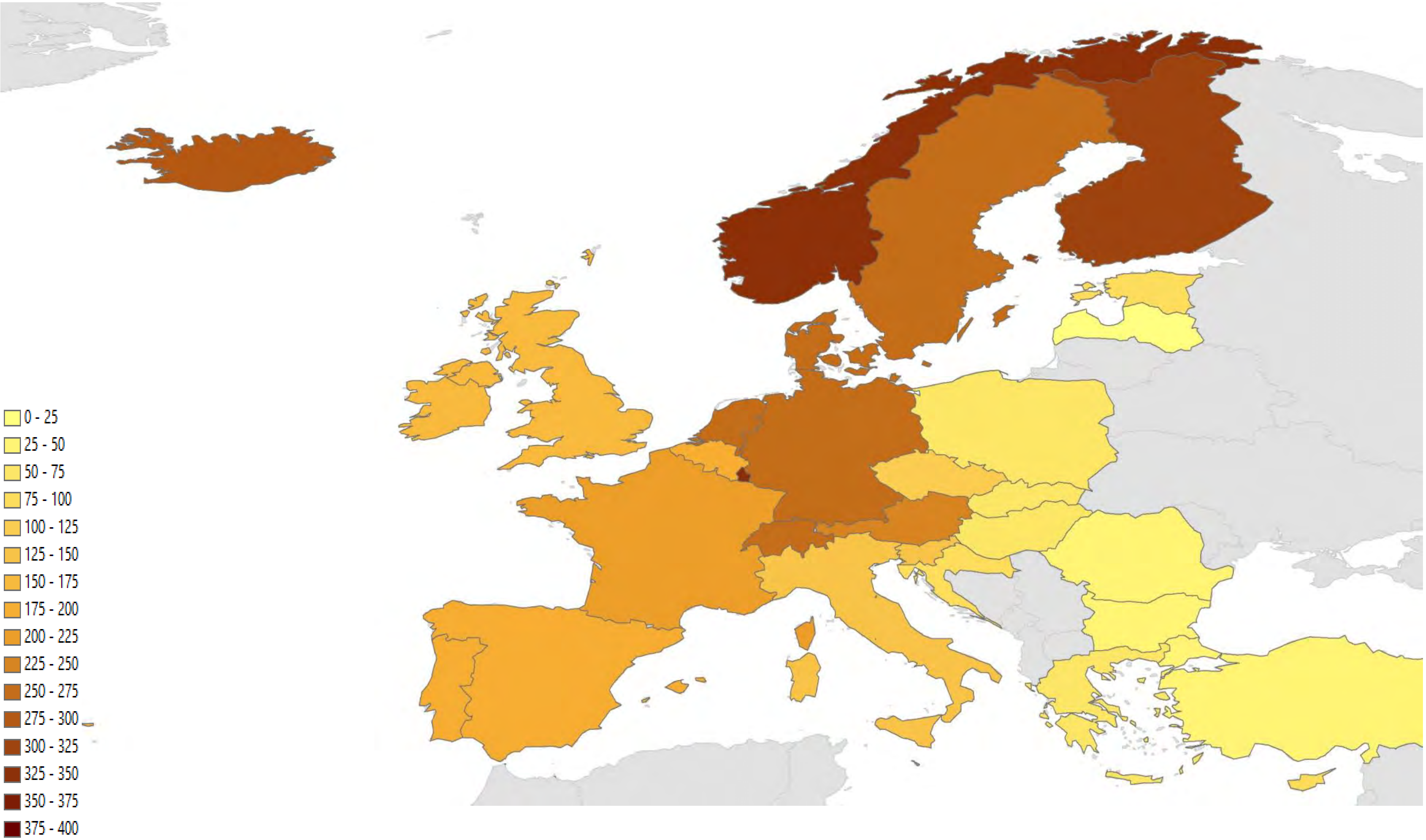
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2010

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

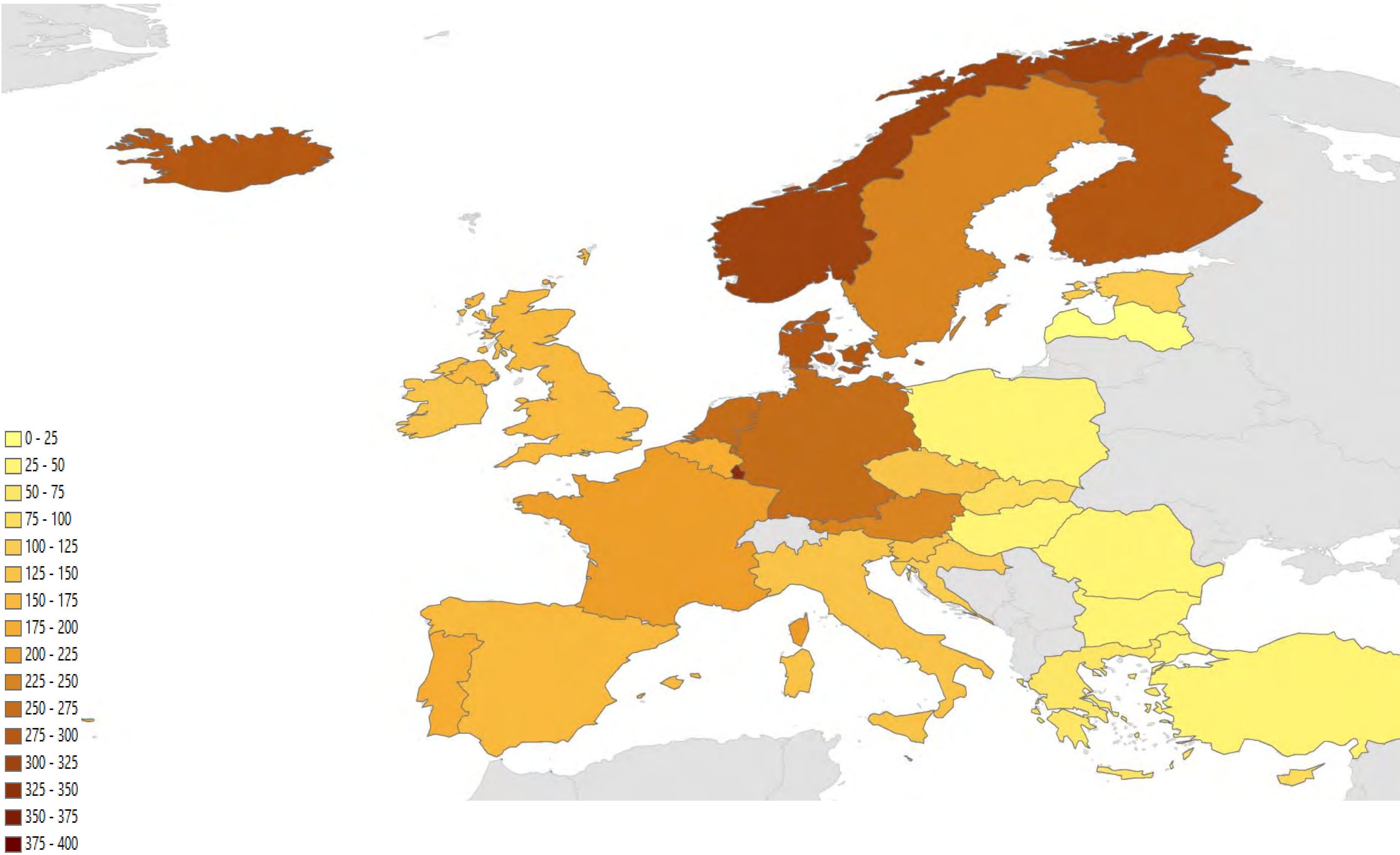
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2011

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

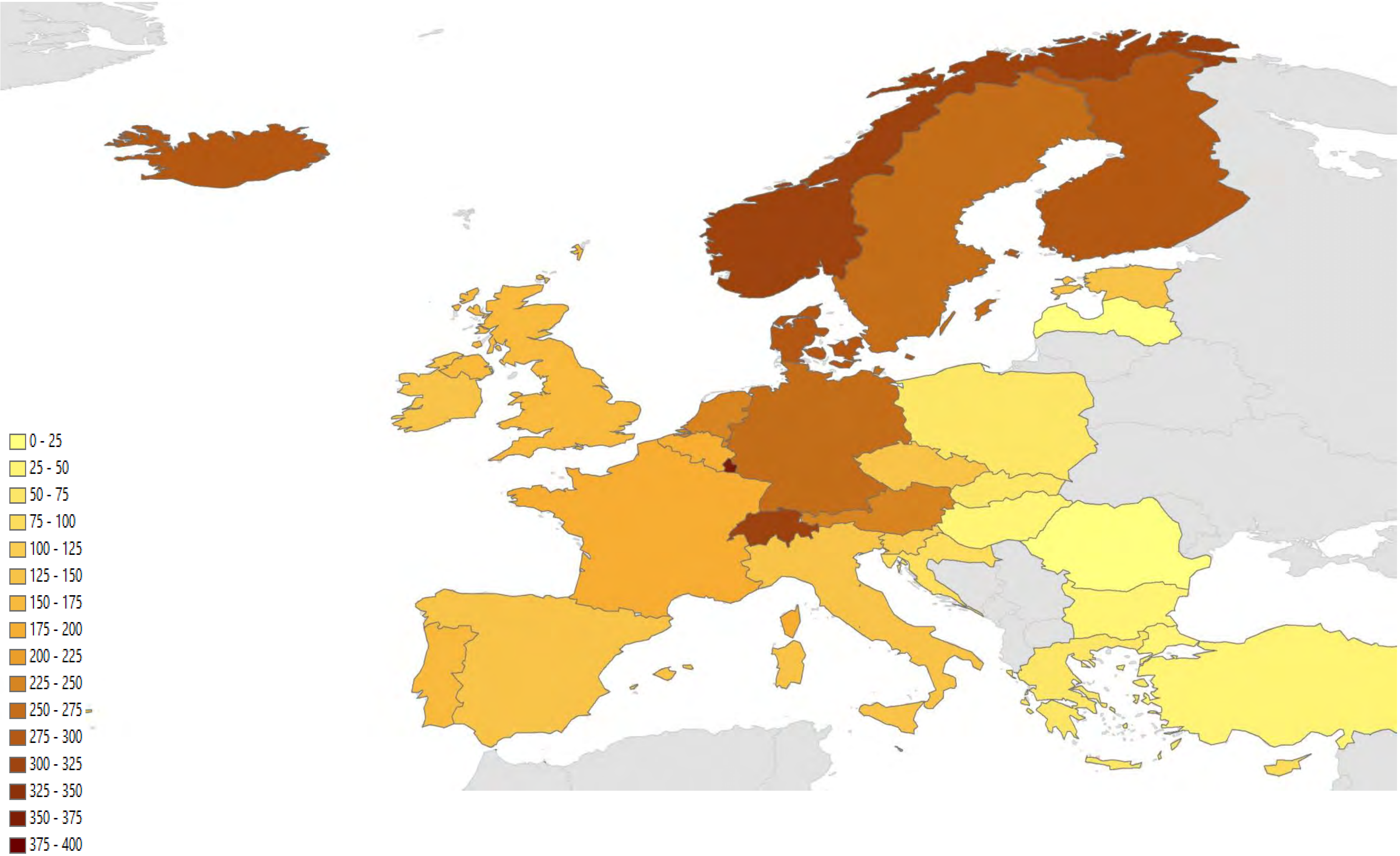
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2012

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

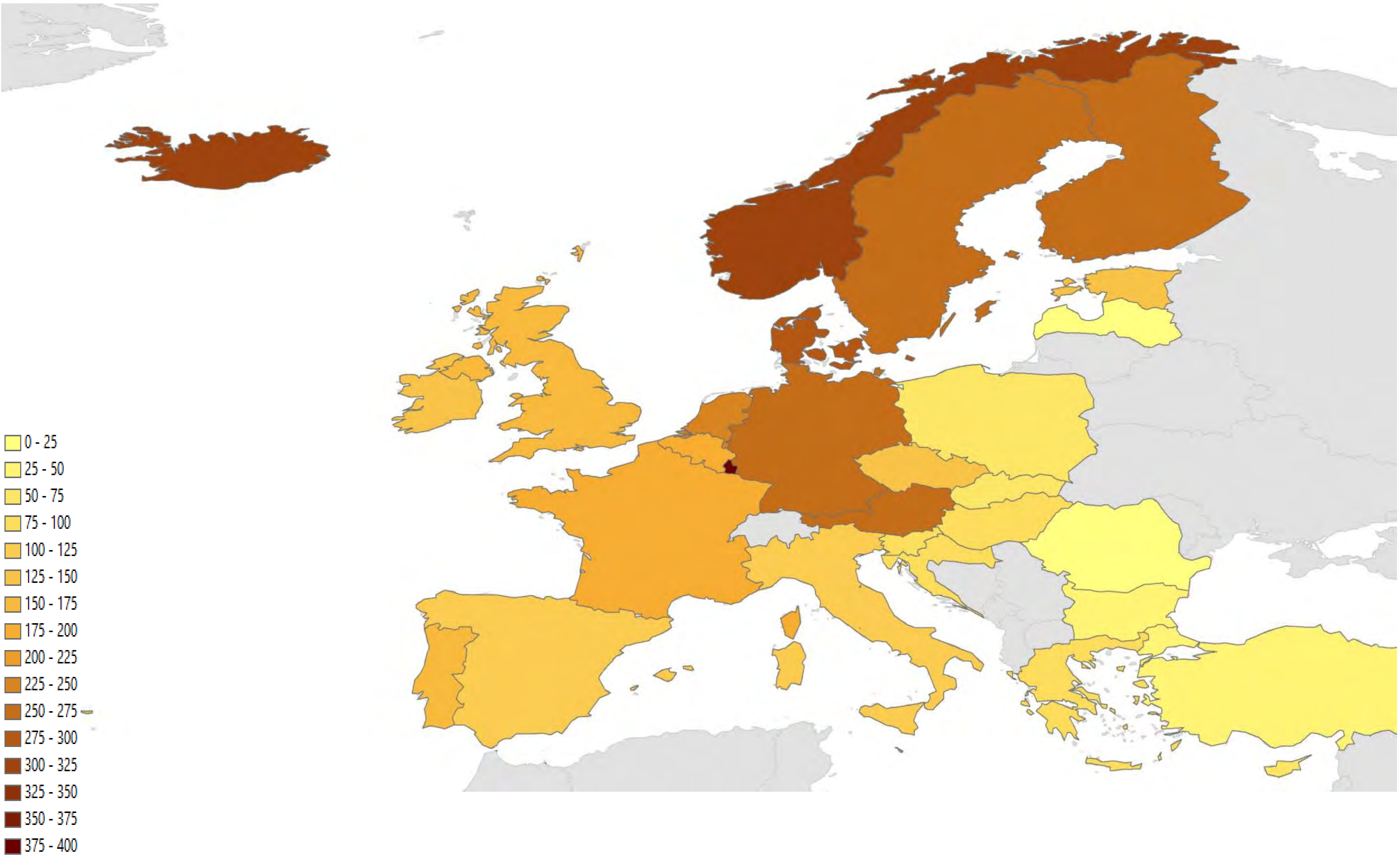
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2013

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

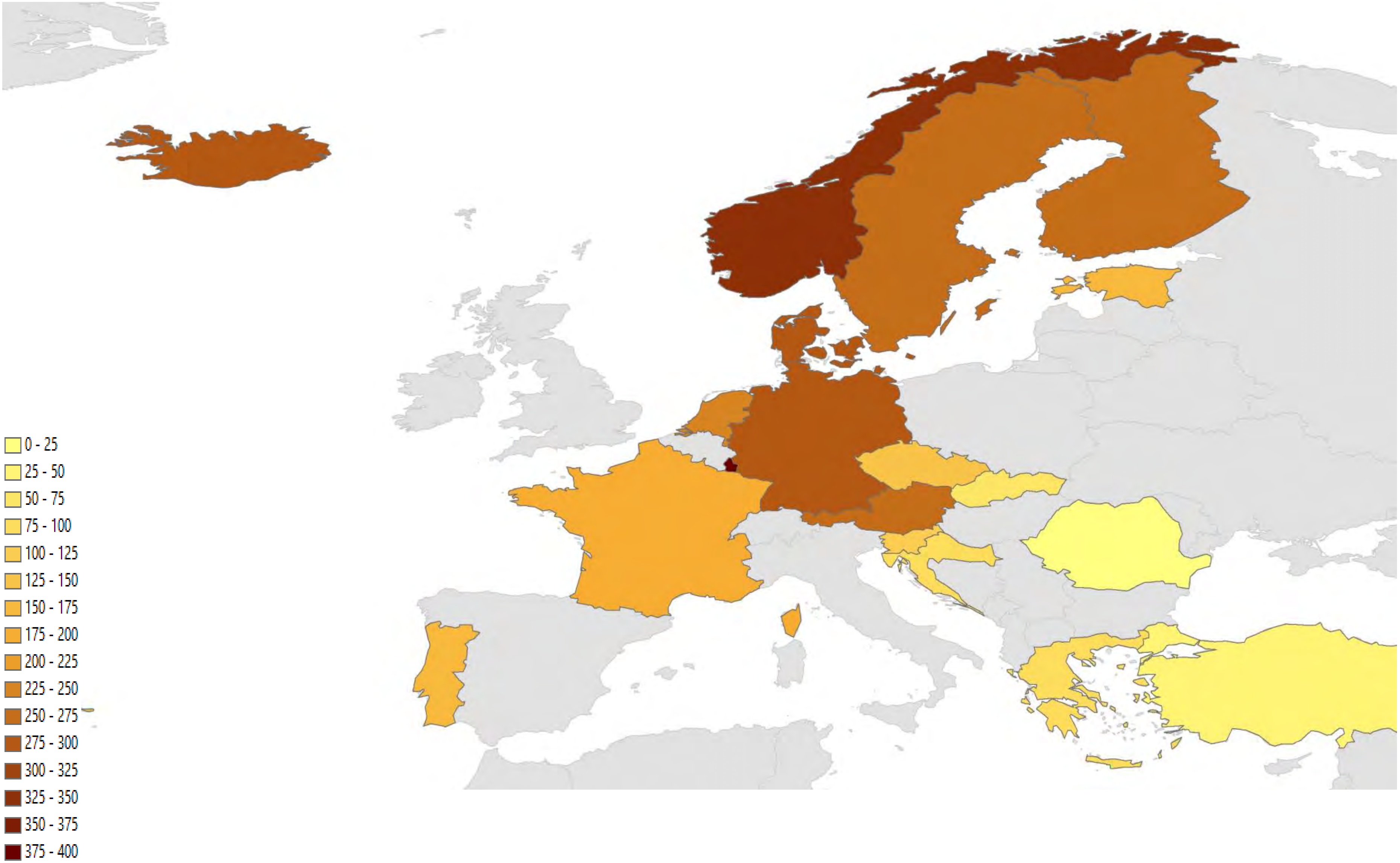
Source: Eurostat



# Government Budget Appropriations or Outlays for R&D (GBOARD)/capita - 2014

(Purchasing Power Standard (PPS) per inhabitant at constant 2005 prices)

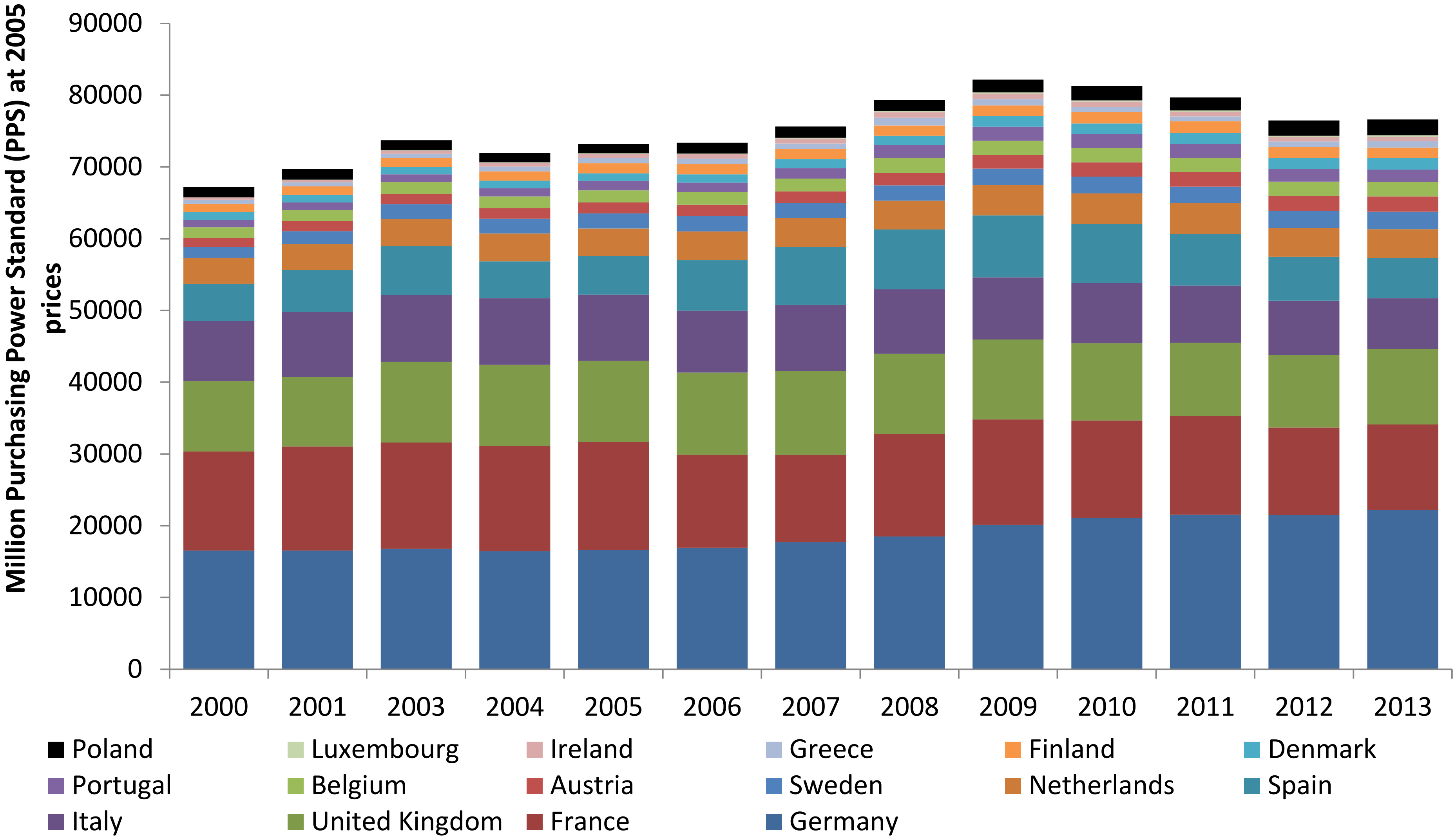
Source: Eurostat



# Total Government Budget Appropriations or Outlays for R&D, GBAORD

**(Million Purchasing Power Standard (PPS) at 2005 prices)**

Source: Eurostat

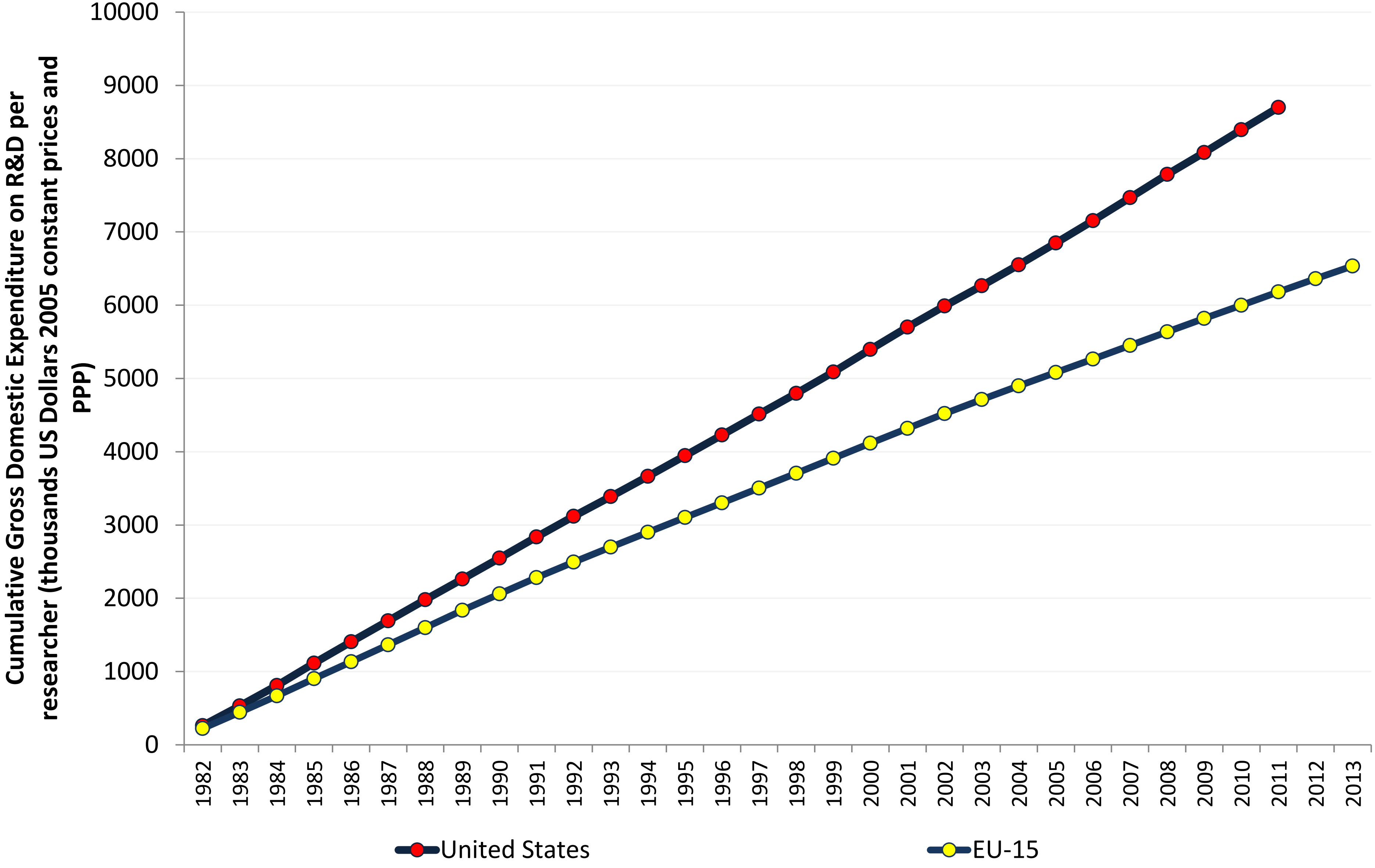



Italy 2003 and 2004 – estimated values.

# Cumulative R&D expenditure, 30 years, per RESEARCHER

(thousands U.S. Dollars 2005 constant prices and PPP)

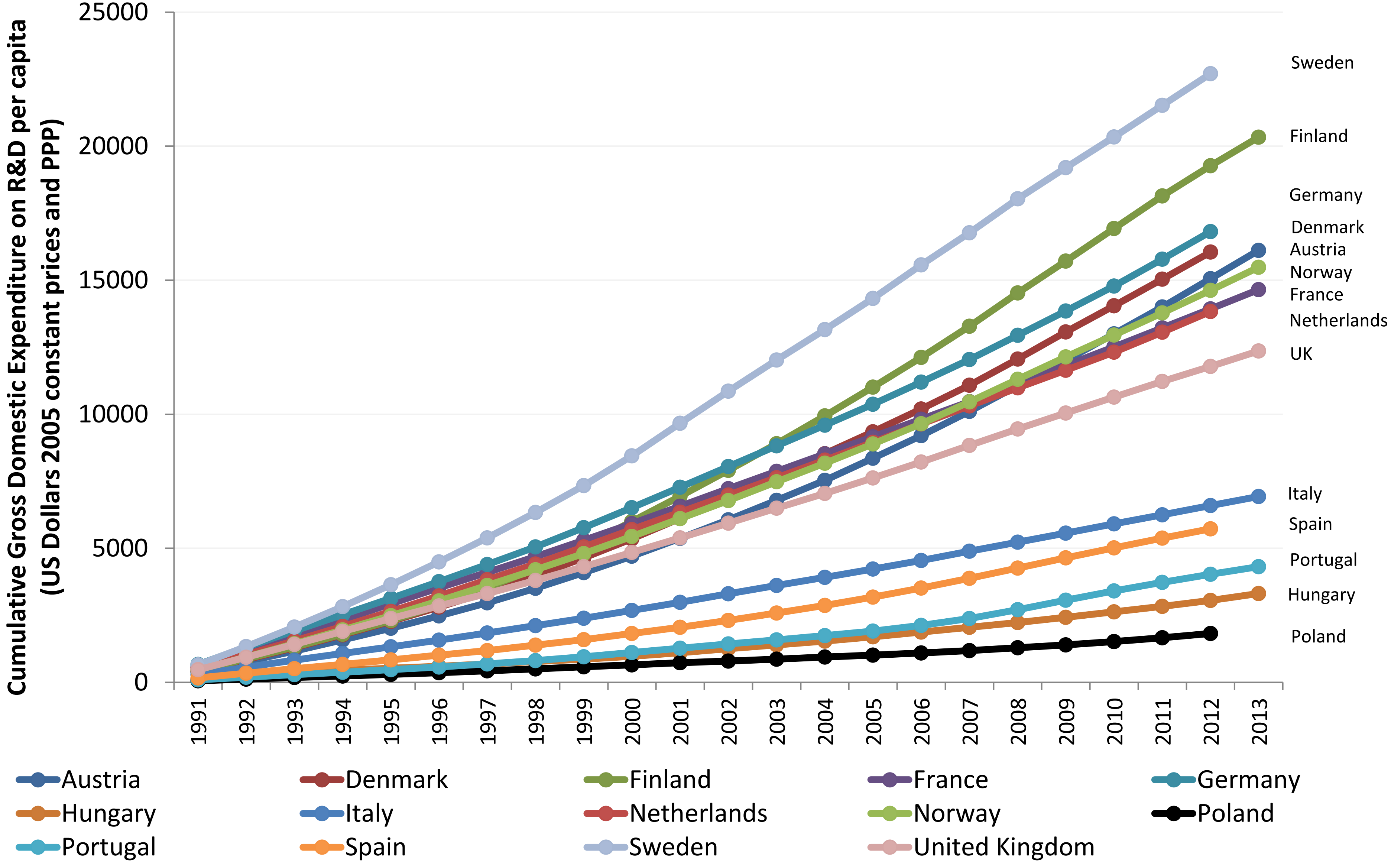
Source: OECD Statistics.



# Cumulative R&D expenditure per capita (1991-2013)

## Cumulative GERD/capita (U.S. Dollars 2005 constant prices and PPP)

Source: OECD

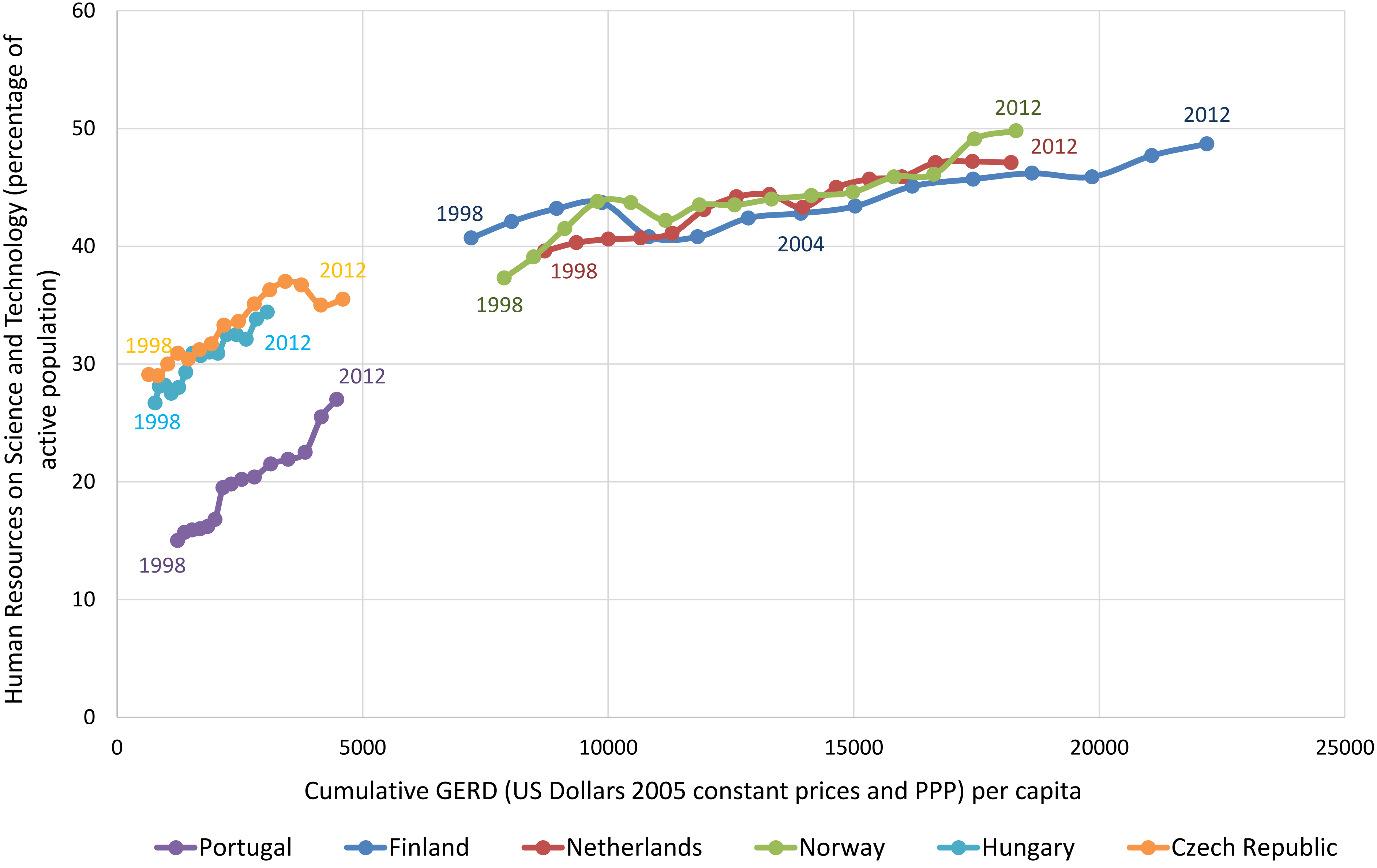


# Human Resources on S&T versus cumulative GERD (98-05)

(percentage of active population; cumulative GERD per capita in U.S. Dollars 2005 constant prices and PPP)

## small countries

**Source: OECD Statistics, EuroStat.**

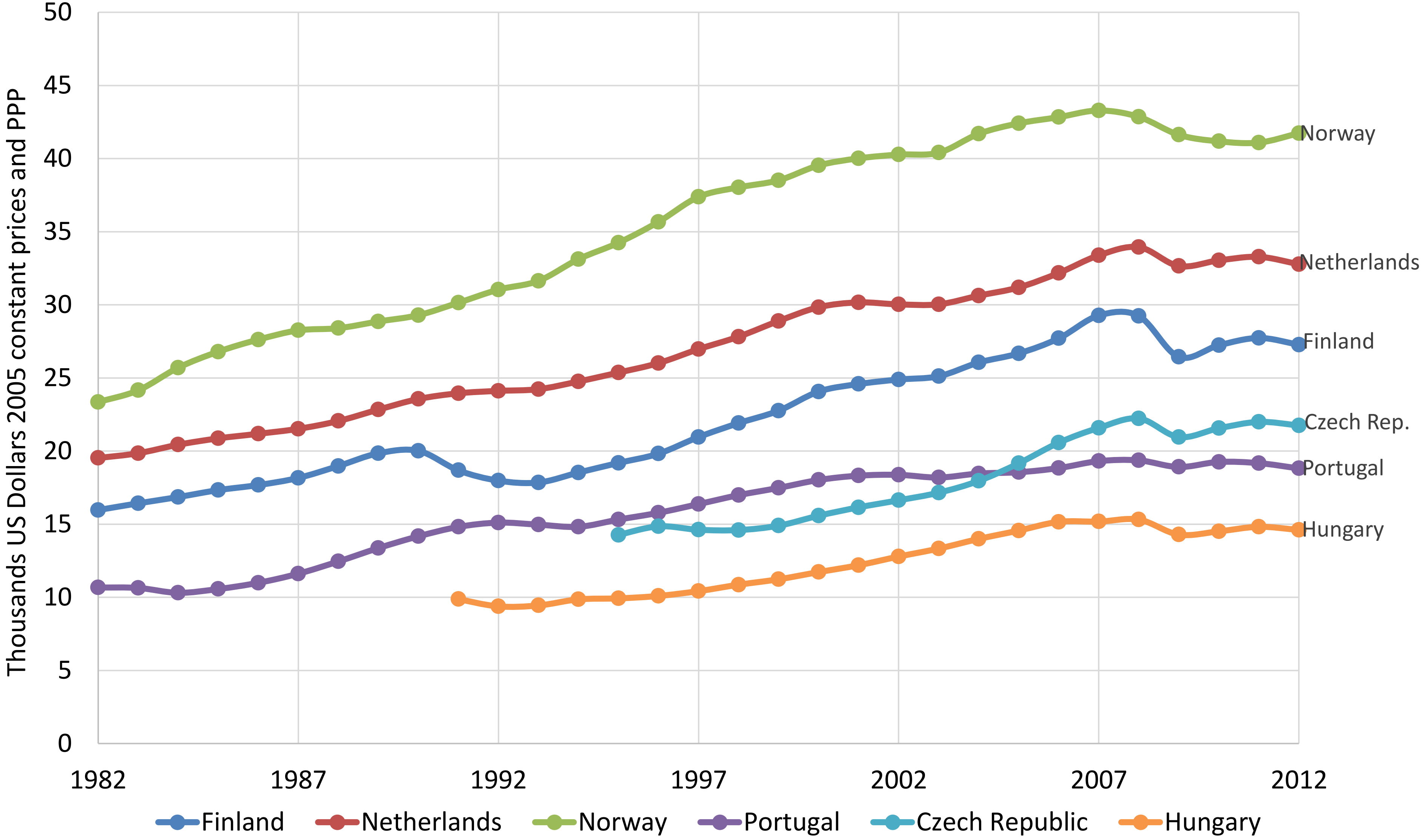


# Value Added per capita

(thousands U.S. Dollars 2005 constant prices and PPP)

small countries

**Source: OECD Statistics**

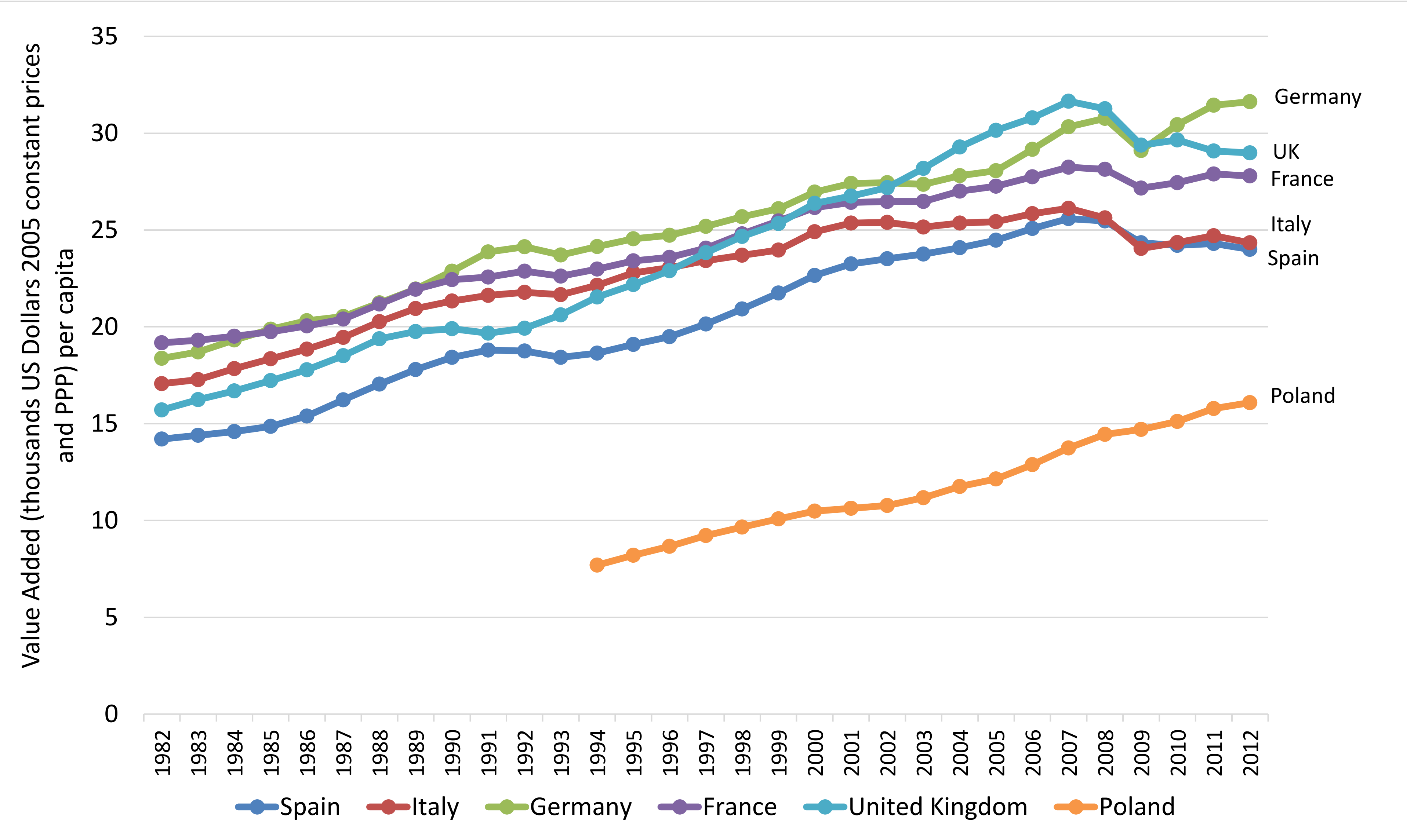


# Value Added per capita

(thousands U.S. Dollars 2005 constant prices and PPP)

large countries

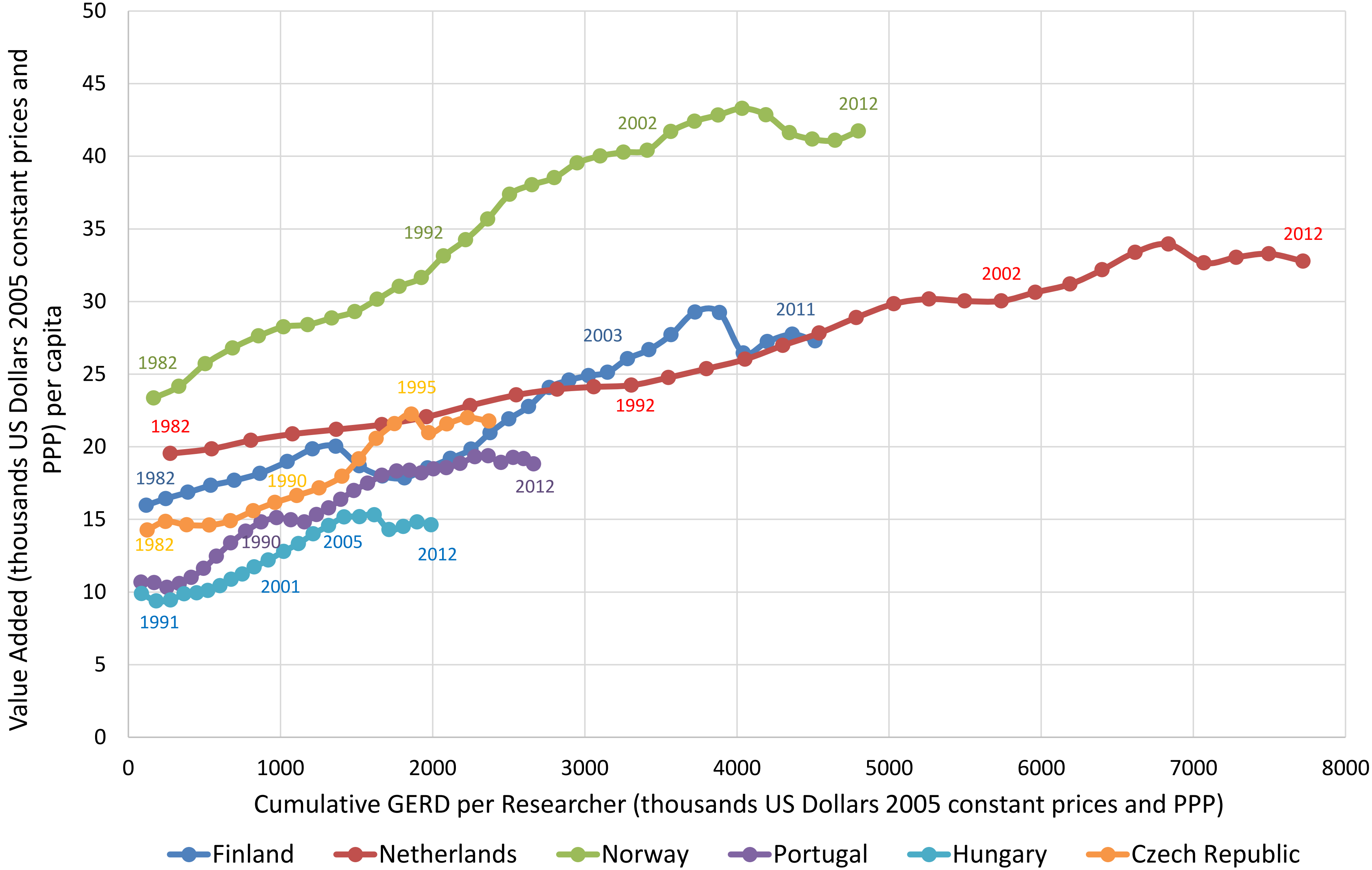
**Source: OECD Statistics**



# Value Added per capita vs cumulative GERD per Researcher

small countries

Source: OECD Statistics.



# Value Added per capita vs cumulative GERD per Researcher

large countries

Source: OECD Statistics.