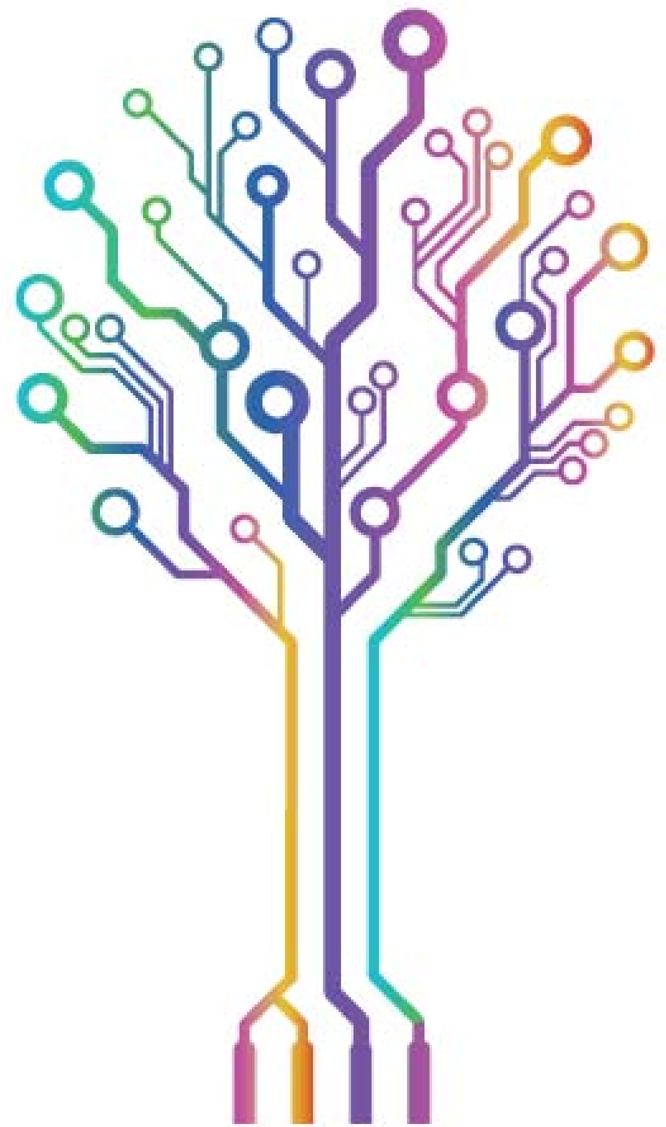
Global trends and challenges in science governance

UNESCO Science Report

(2015)



Global trends:
A steep rise in research input and output

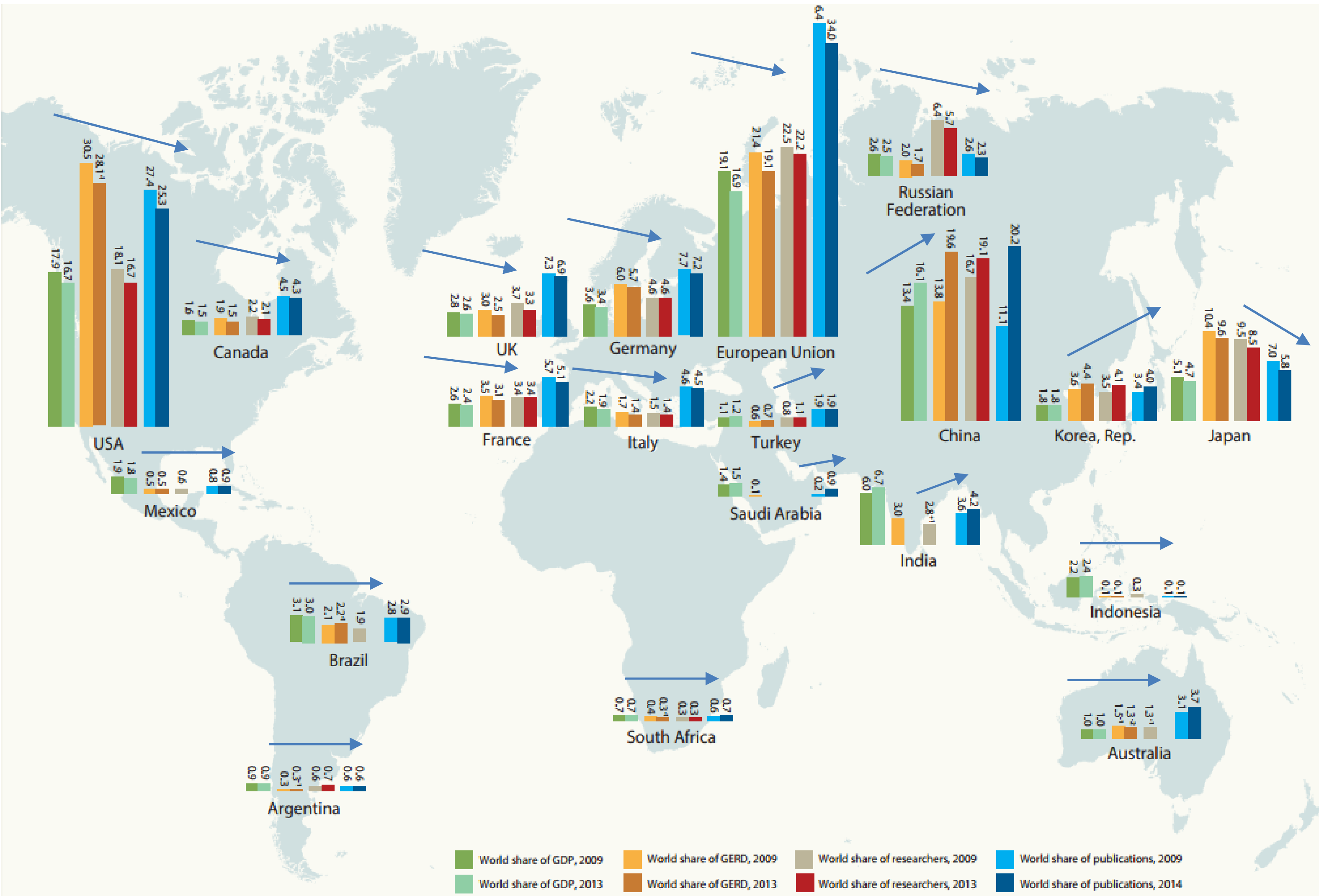
Research spending progressed faster (+30.5%) than the economy (+20.1%) and global population (+7.3%) between 2007 and 2013

- research expenditure (+30.5%)
- the number of researchers (+21%, FTE)
- scientific publications (+23%)

The G20 accounts for 64% of the global population and 92% of research spending

G20: World shares of GDP, research spending, researchers and publications, 2009 and 2013 (%)

Strong growth in the world shares of China and Rep. Korea, little change in the Southern Hemisphere



Why the steep rise in research spending, despite the crisis?

In many high-income countries struggling with austerity measures:

the drop in public commitment to research was compensated by business research expenditure. Businesses sought to conjugate the crisis by maintaining or increasing investment in R&D.

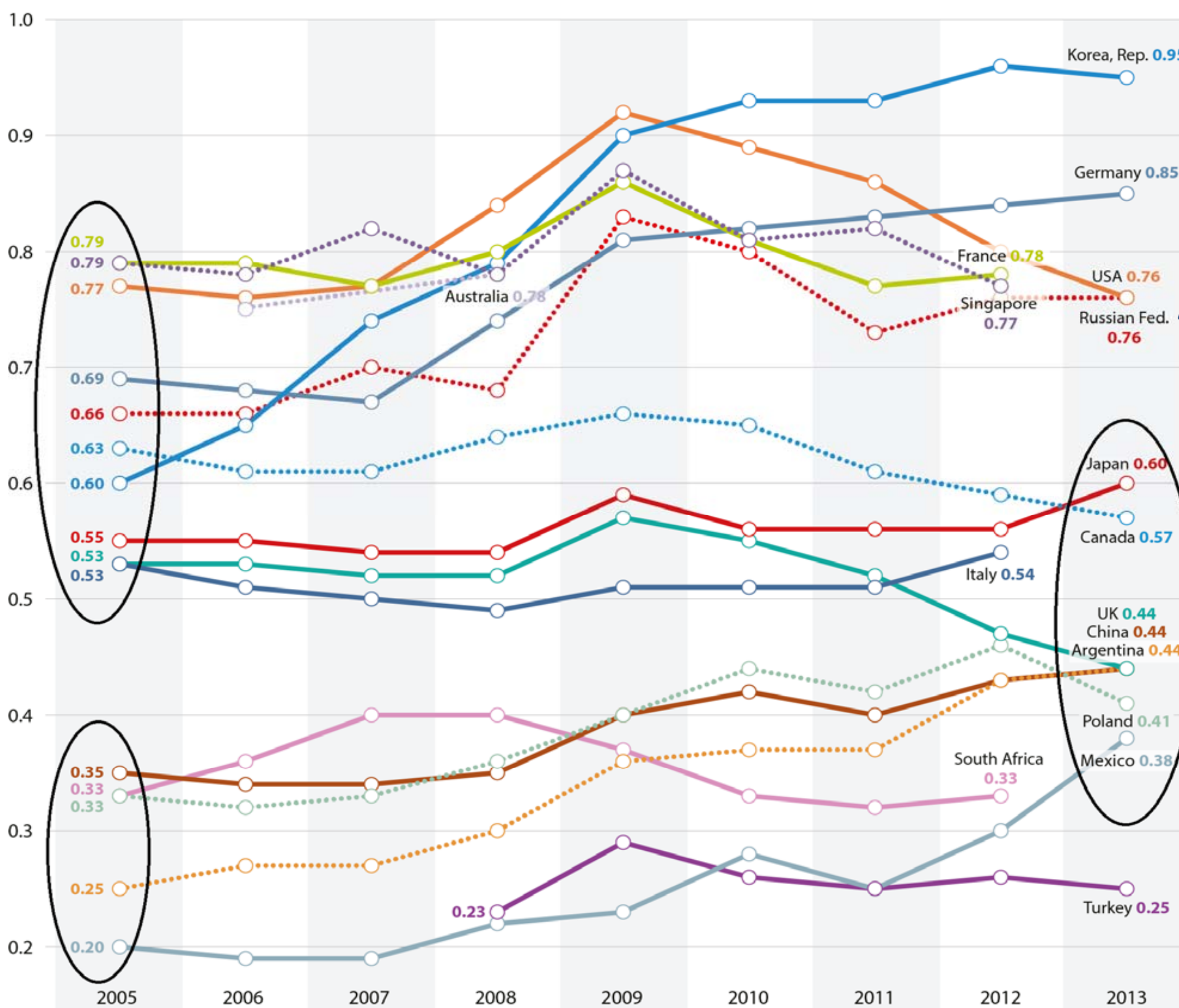
In many lower income countries (e.g. Argentina, Ethiopia, Kenya, Mali, Mexico), growth fuelled by the commodities boom enabled:

a rise in public commitment to research – but business spending on research remains low or not measured. (China's stimulus package fostered investment in infrastructure, urbanization, maintained strong demand for commodities.)

Consequently, a greater convergence in public commitment to research for some developed and developing countries.
Ex: research = 0.44% of GDP in Argentina, China and United Kingdom

Between developing and developed countries, a greater convergence in public commitment to R&D

GERD financed by government as a share of GDP, 2005–2013 (%)



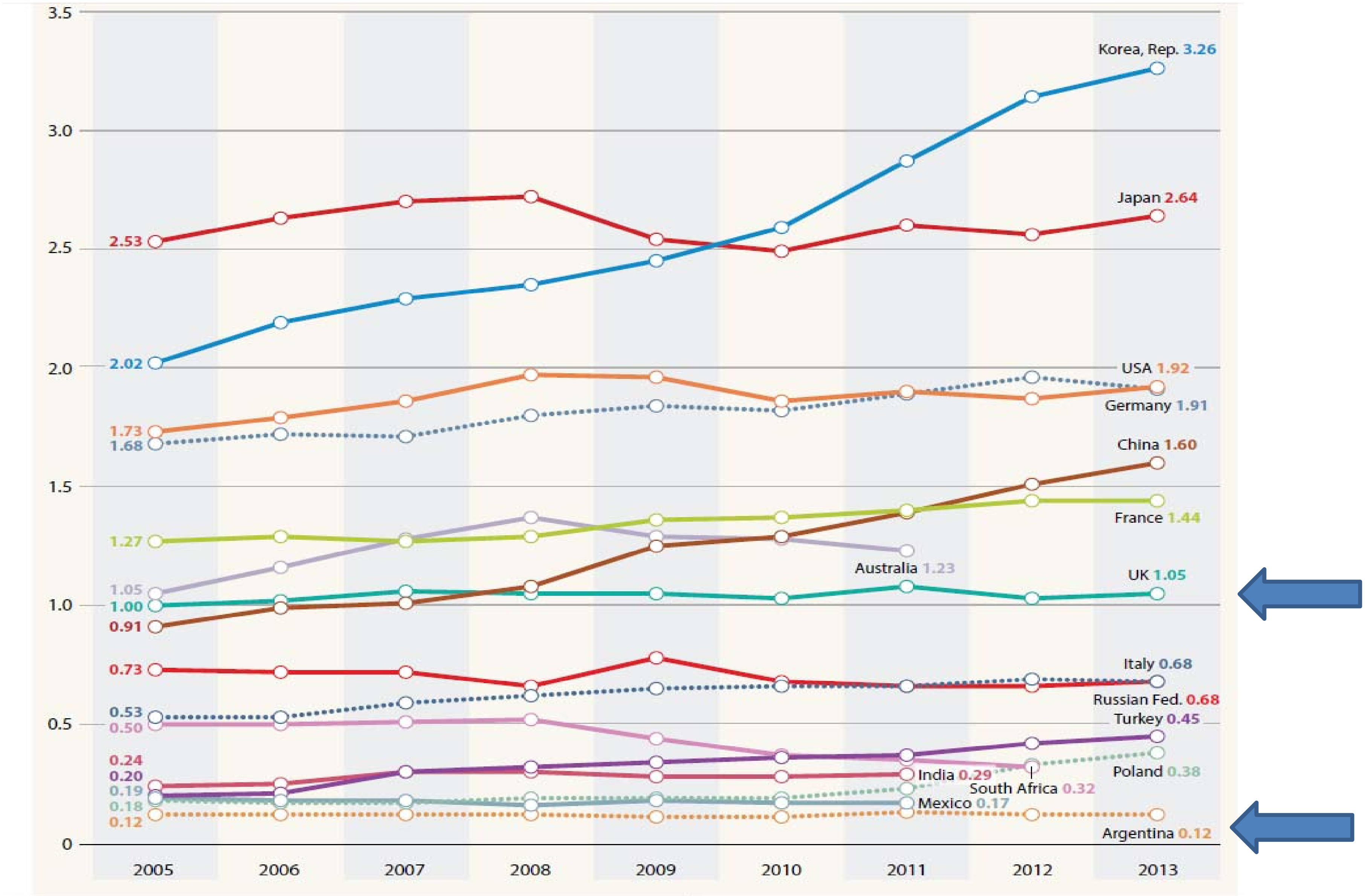
Convergence between USA and Russian Federation

China, Argentina, Poland and Mexico approaching Japan, Canada, Italy and UK,

But a persistent divergence in business expenditure on research

(exception: China)

GERD financed by business as a share of GDP, 2005–2013 (%)



Business spending still dominated by a minority of countries (with some reshuffling)

Figure: Percentage shares of business R&D, 2001–2011 (in PPP$)

China and India : 20%
steep rise since 2008

Former Soviet states: 2.6%

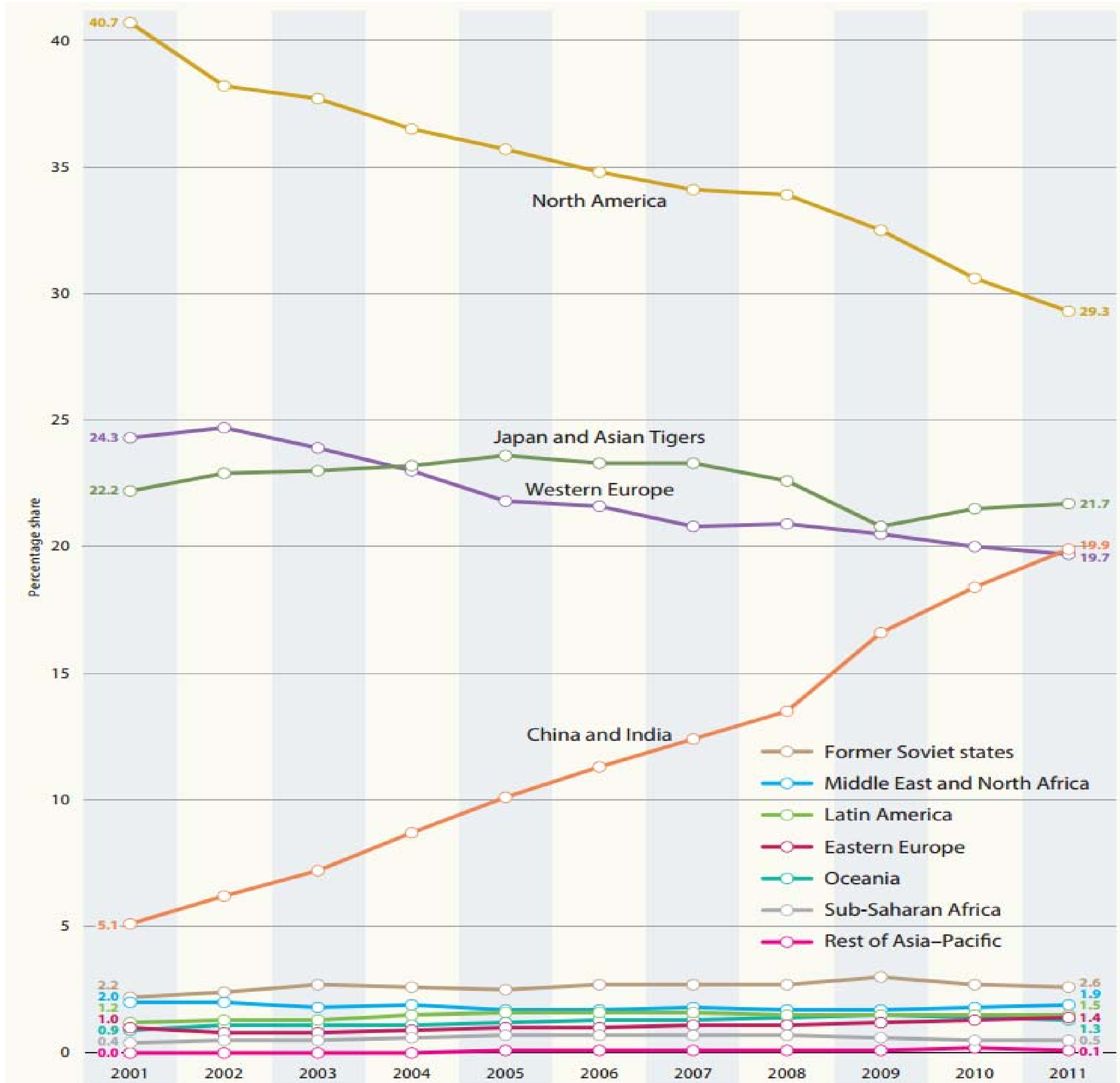
Middle East and Africa : 2.4%

Latin America: 1.5%

Few Latin American countries have used the commodities boom to embrace technology-driven competitiveness .

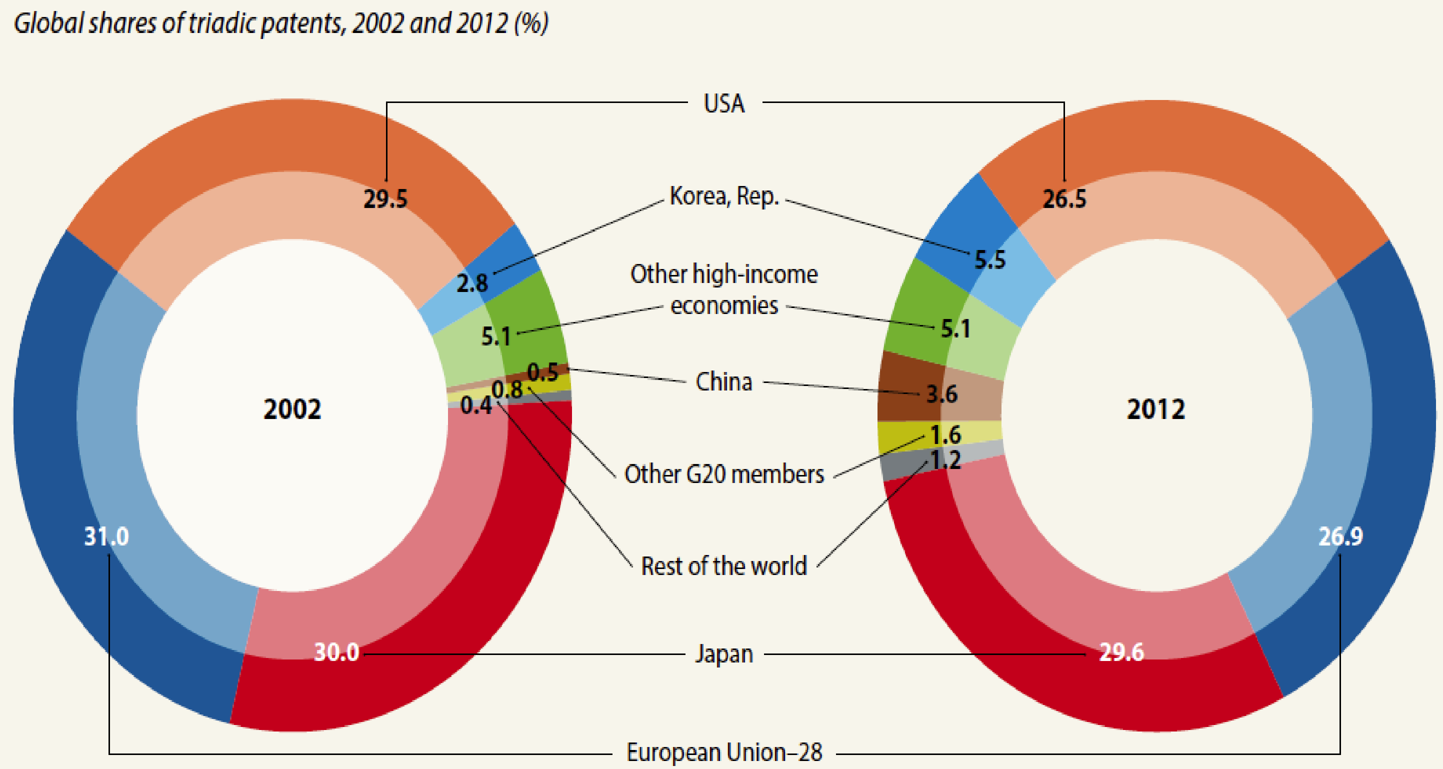
Japan and Asian Tigers stable: 22%

N.B. Here, Asian Tigers encompass Taiwan of China, Hong Kong (China), Indonesia, Malaysia, Philippines, Rep. Korea, Singapore, Thailand and Viet Nam



Patents still dominated by a minority

Taken together, the European Union, China, Japan, Republic of Korea and USA hold nine out of ten triadic patents.



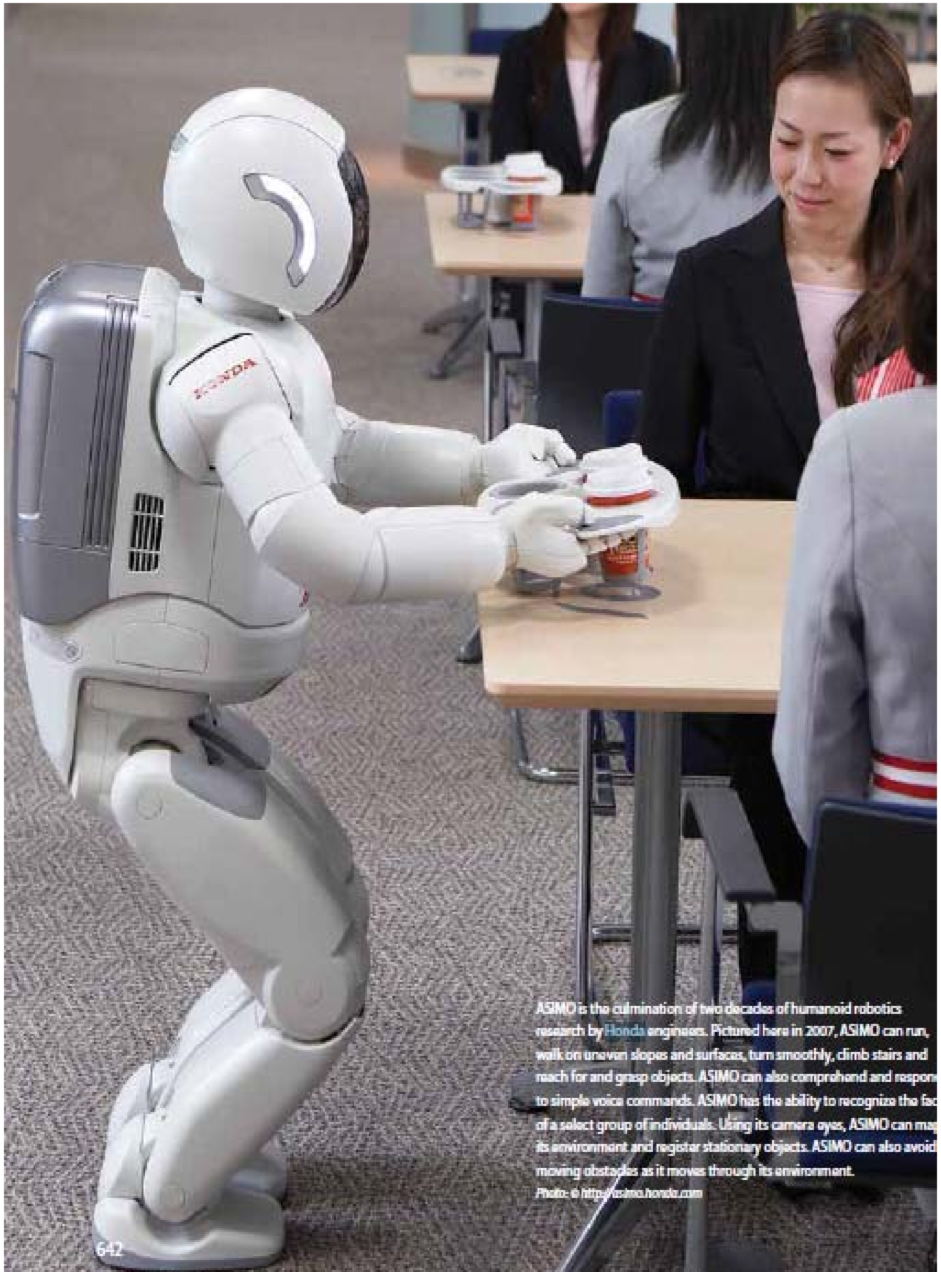
Note: Nowcasting triadic patents of countries in the USPTO database, 2002, 2007 and 2012; triadic patents are a series of corresponding patents filed at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO) for the same invention, by the same applicant or inventor.

Source: UNESCO Institute for Statistics based on OECD online database (OECD.Stat), August 2015

Challenges for innovation in the USA and European Union

USA: Public research budgets stagnating, even as industrial research recovers from recession

EU: to kick-start sluggish economic recovery, biggest 7-year research programme ever, *Horizon 2020* (€80 billion), strong focus on innovation but 17% of budget for basic research



Challenges for Japan

Chronic low growth has affected investor confidence. Japanese firms reluctant to raise research spending or staff salaries and averse to risk-taking.

Government's *Comprehensive Strategy for STI* (2013): using Japanese industry's technological strength by prioritizing system-oriented 'smartization', 'systemization' and 'globalization.'

Priority cross-cutting areas: ICTs, nanotechnology and environmental technology.

Challenges for innovation in the BRICS countries: Brazil

Brazil: In the latest innovation survey, all firms (public and private) reported a drop in innovation activity since 2008 (IBGE, 2013).

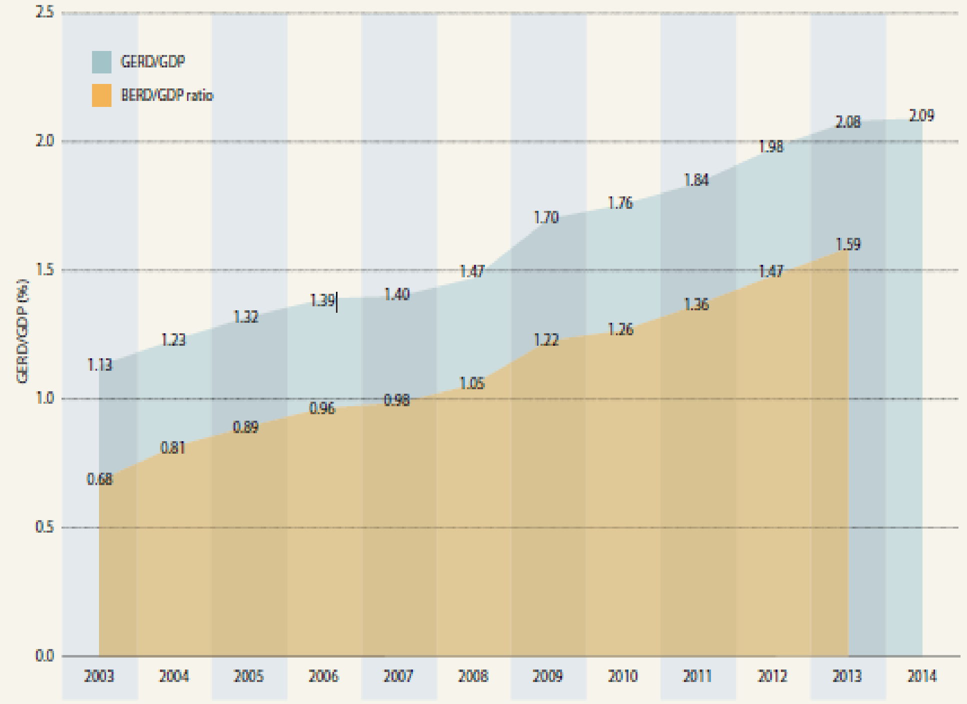
Industry has been affected by the 2008 global crisis and worsening economic situation in Brazil since 2011.

Challenges for innovation in the BRICS countries: China

UNESCO SCIENCE REPORT

China is on track to devote 2.5% of GDP to research by 2020 *but* companies still reliant on foreign core technologies, despite massive public investment in research.

Figure 23.2: **Chinese GERD/GDP ratio and BERD/GDP ratio, 2003–2014 (%)**

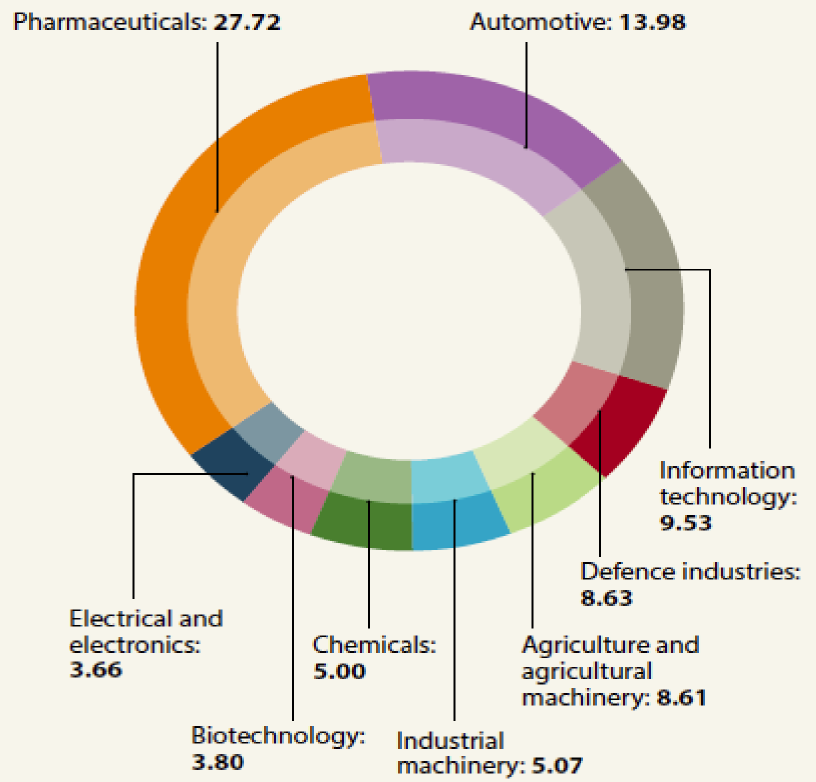


Source: National Bureau of Statistics and Ministry of Science and Technology (various years) *China Statistical Yearbook on Science and Technology*

Challenges for innovation in the BRICS countries: India

India needs to broaden its innovation culture, in order to develop its manufacturing sector: pharma, automotive and IT account for more than half of business research expenditure

Figure 22.3: **India's main industrial performers, 2010 (%)**
In terms of R&D expenditure



Note: Percentages may not add up to 100 on account of rounding.
Source: DST (2013)

Challenges for innovation in the BRICS countries: Russian Federation

The oil curse?

The commodities boom *encouraged* imports of advanced technologies and *discouraged* **Russian** businesses from investing in innovation:

business spending down from 33% to 28% of research funding (2000-2013)

Challenges for innovation in the BRICS countries: South Africa

South Africa: private sector's investment in research fell from 0.50% to 0.32% of GDP between 2008 and 2012.

The government launched a Sector-Specific Innovation Fund in 2013 to help raise the country's research effort to at least 1% of GDP. Fund supports industrial research through a co-funding arrangement.

Singapore plans to become Asia's innovation capital

Government helping to develop home-grown innovation by supporting start-ups with disruptive potential (for their more established competitors) through incubators:

Example: National Research Foundation (NFR) launched incubator in 2013 with Innosight Ventures Ptd Ltd, a Singapore-based venture capital firm: 85% of funding comes from NRF and the rest from incubator.

Regional economic communities are fostering scientific integration

More regional communities are emulating European Union model:

a) striving to create a higher education area (East African Community)

b) fostering regional centres of excellence in training and research (e.g. West African Economic and Monetary Union funded some for 2 years (2012-2014);

c) adopting regional STI policies and protocols, examples:

- ***ECOWAS Science and Technology Policy (2011)*** **calls on 15 member states to devote 1% of GDP to research,**
- ***STI Protocol*** **(2008) of Southern African Development Community entered into force in June 2017,**
- **Association of Southeast Asian Nations developed** ***ASEAN Plan of Action on STI for 2016-2020.***

Caribbean Common Market: embracing greater regionalism

‘It is evident… that our region would find it more difficult by far to address its immense current and prospective challenges, unless its governments and peoples embrace strongly a more mature, more profound regionalism.’

Ralph Consalves, President of Saint Vincent and the Grenadines, former chair of the Caribbean Common Market (Caricom), 2013

- CARICOM *Energy Policy* (adopted 2013): 20% renewable sources by 2017
- CARICOM *Sustainable Energy Roadmap and Strategy* (2013)
- *Strategic Plan for the Caribbean Community to 2019* (2014): ICTs, tourism, air/maritime infrastructure, value-added products, energy efficiency and diversification

Israel's dilemma: are its universities prepared for tomorrow?

"The Israeli economy is driven by industries based on electronics, computers and communication technologies, the result of over 50 years of investment in the country's defence infrastructure. […]

However, the next waves of high technologies are expected to emanate from other disciplines, including molecular biology, biotechnology and pharmaceuticals, nanotechnology, material sciences and chemistry, in intimate synergy with ICTs.

These disciplines are rooted in the <u>basic research laboratories</u> of universities rather than the defence industries."

Daphne Getz and Zehev Tadmor, authors of chapter on Israel, *UNESCO Science Report*

A ‘cultural revolution’ in Rep. Korea

Its ‘catch-up technology’ development model is no longer suited to global markets

Plans to revitalize manufacturing by:

- making country more entrepreneurial and creative,
- stronger linkages between basic sciences and business at new International Science Business Belt (Korea’s Silicon Valley), with National Institute for Basic Science on site,
- spending more on basic research: from 13% to 18% of total research spending
- spending more than anyone on all research: 5% of GDP by 2017 (4.2% in 2013).
- Doubling investment in green technology (between 2008 and 2012).

Fourth Industrial Revolution: digitalizing industry to revitalize manufacturing

Advanced manufacturing, artificial intelligence

Examples: 3D printing of objects (Including buildings), lightweight manufacturing , Google's self-driving car, next-generation robotics, cybersecurity systems, medical systems

Germany's Industry 4.0 programme
France's Industry of the Future programme
Chinese Internet of Things Centre
USA's Advanced Manufacturing Partnership
Indian Cyberphysical Systems Innovation Hub

Creative industries are increasingly web-based: e.g. France, Netherlands, Republic of Korea, Japan.

Challenge for EU: none of top 15 public internet companies European (11 US, 4 Chinese) in 2014. Digital Agenda for Europe to develop digital single market (*Europe 2020 strategy*).

A growing priority: green technologies

Value of patent applications by **EU28** to European Patent Office for environment-related technologies rose by 50% between 2005 and 2011.

In **Japan**, after 2011 Fukushima earthquake, government fostered solar energy: introduced system mandating utilities to purchase electricity from renewable energy producers at fixed prices (plus deregulation and tax benefits).

Green cities planned for **Morocco, Gabon, Rwanda, United Arab Emirates**, etc.

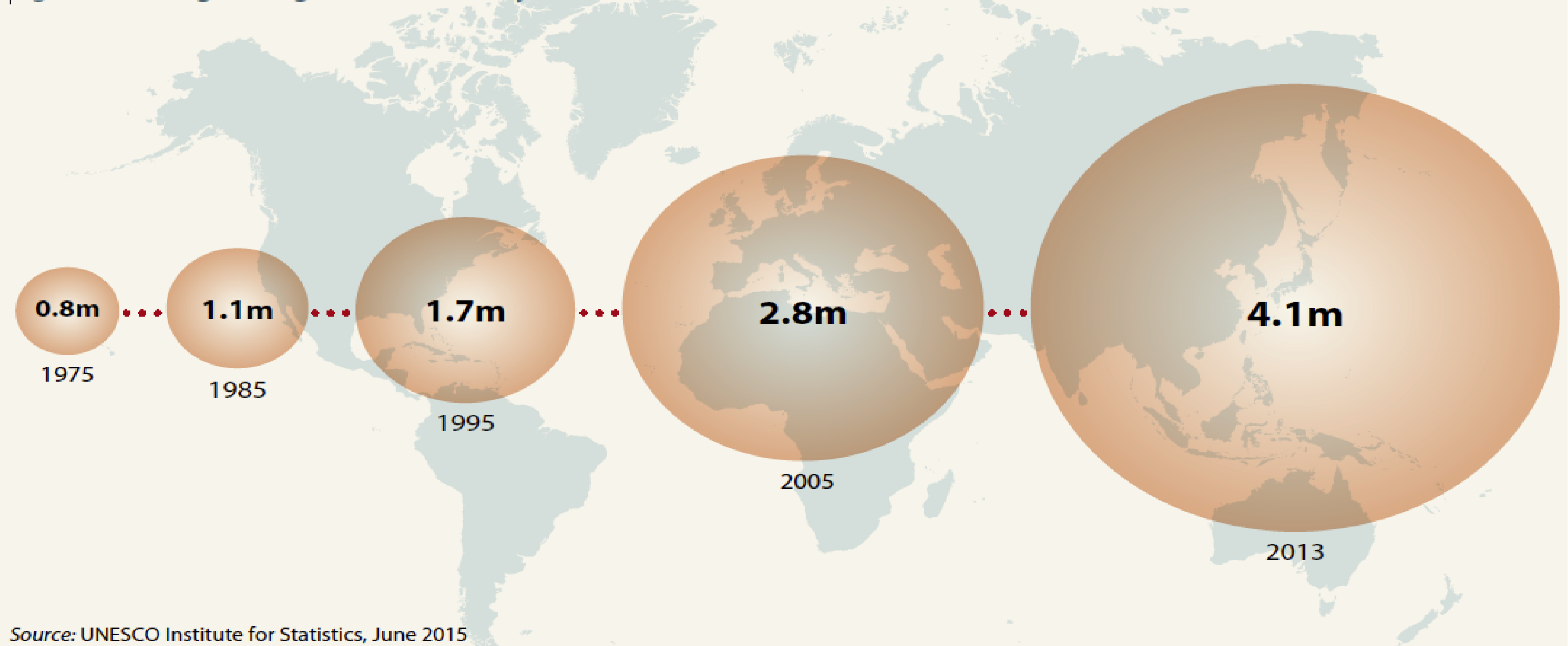
Large energy infrastructure programmes: **Kenya** (geothermal), **Gabon** (hydropower) **Tunisia** (solar), **Morocco** (solar and wind), etc.

Some oil-rent economies investing in renewable energy amid rising domestic energy consumption (e.g. for desalination, air-conditioning),
e.g. **Algeria** (wind and solar since 2011), **Saudi Arabia** (solar since 2015)

Science has become more mobile

- **More firms are relocating R&D abroad**, their physical infrastructure is more mobile than that of university campuses
- A **growing global labour market** for researchers and university students
- Greater virtual mobility: Internet has facilitated **online university courses** (MOOCs) and **international scientific collaboration**: 80-100% of articles in most LDCs have foreign partners (G20 average = 25%, OECD average = 29%)

Figure 1.4: **Long-term growth of tertiary-level international students worldwide, 1975–2013**

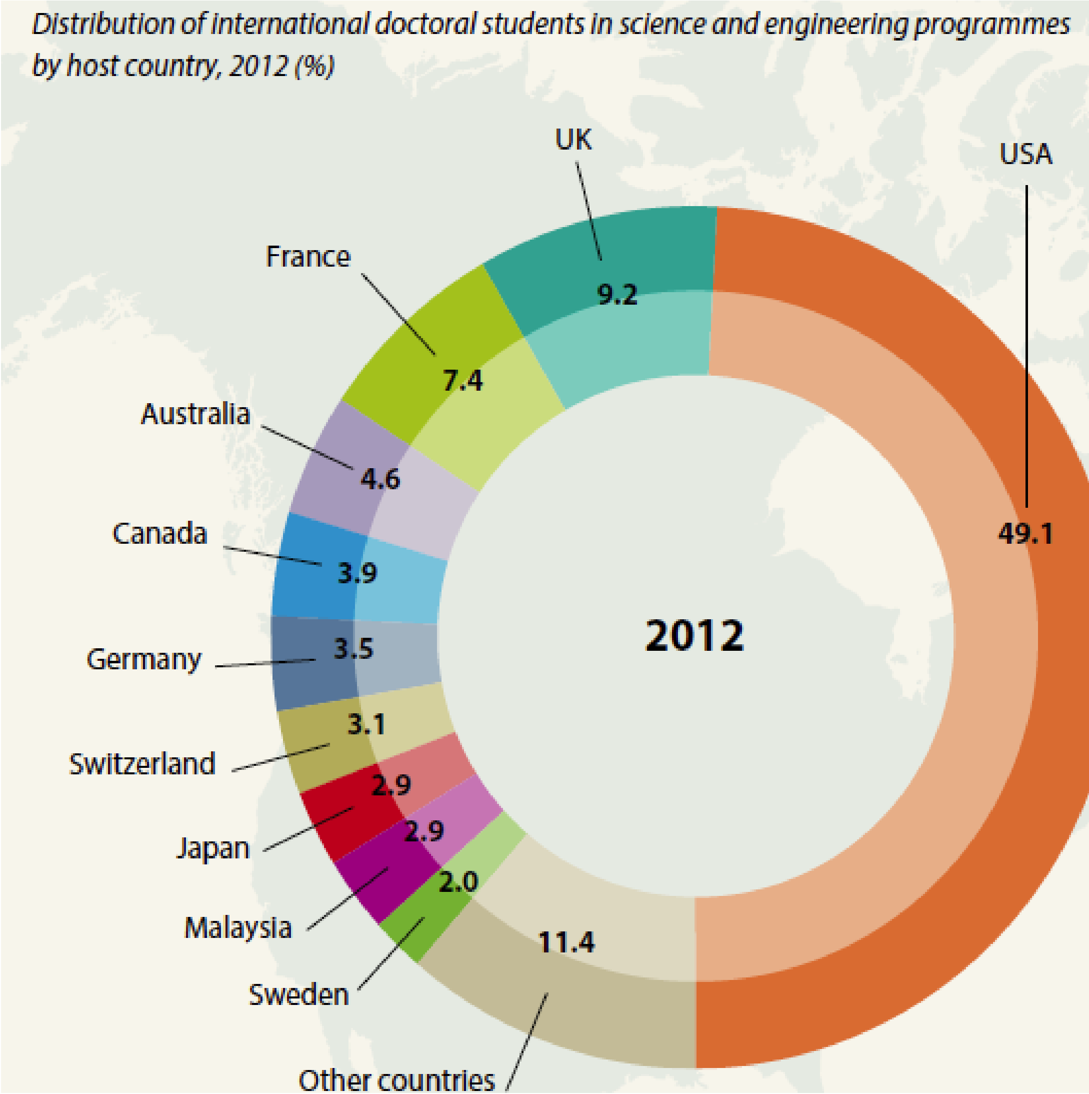


Source: UNESCO Institute for Statistics, June 2015

A PhD market still dominated by the USA

Ten countries host 89% of international PhD students in science and engineering fields.

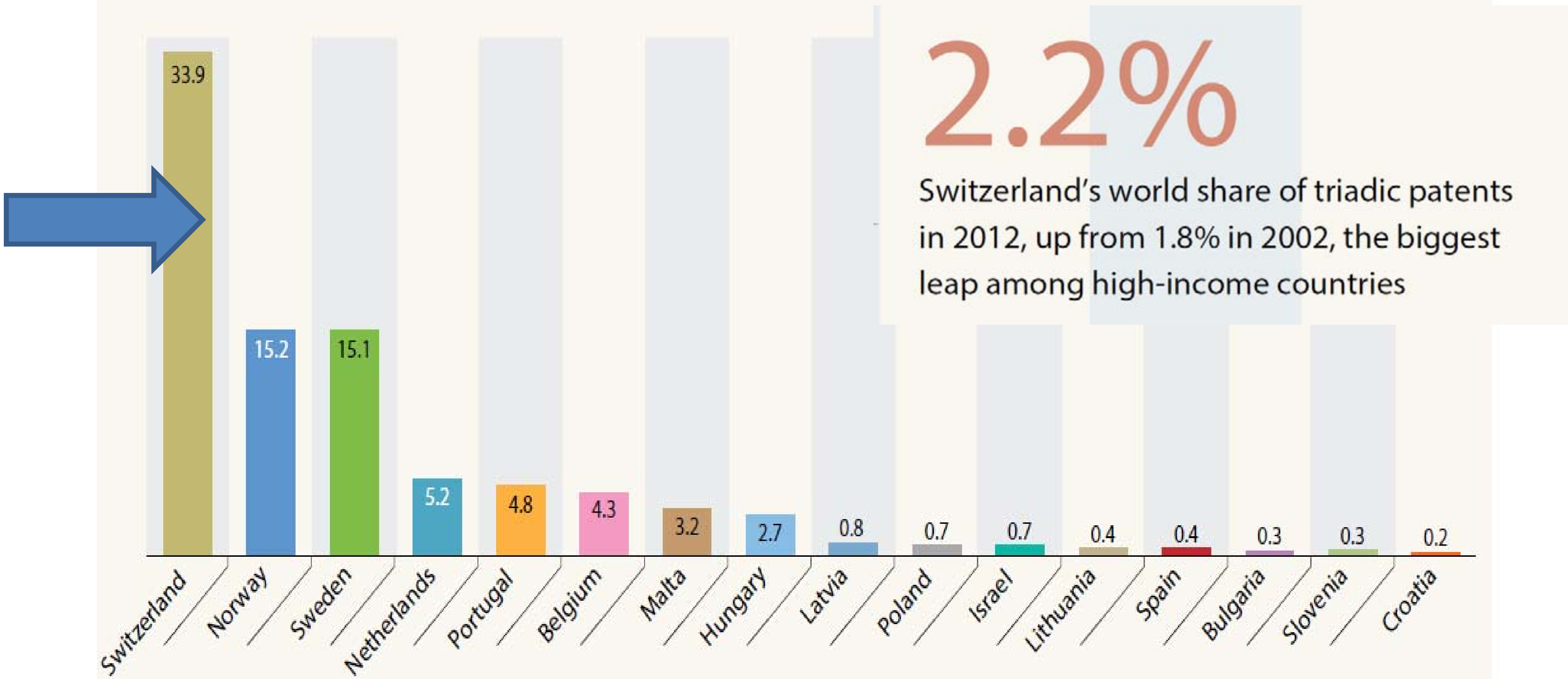
Malaysia plans to attract 200,000 students by 2020 (56,000+ in 2012), double that in 2007.



Switzerland leading innovation, its recipe for success:

- High levels of investment in R&D: 3% of GDP in 2012.
- 30% of R&D expenditure for basic research.
- 61% of R&D funded by industry, business-friendly environment
- More than half of labour force qualified for demanding jobs in S&T, thanks to excellent vocational training and ability to attract international talent to private industry and academia.

Figure 2.15: **Percentage of foreign doctorate-holders in selected countries, 2009**



Many proponents of scientific mobility to develop and attract talent

Examples

EU's scientific visa (since 2016) facilitates mobility of non-EU applicants for research jobs.

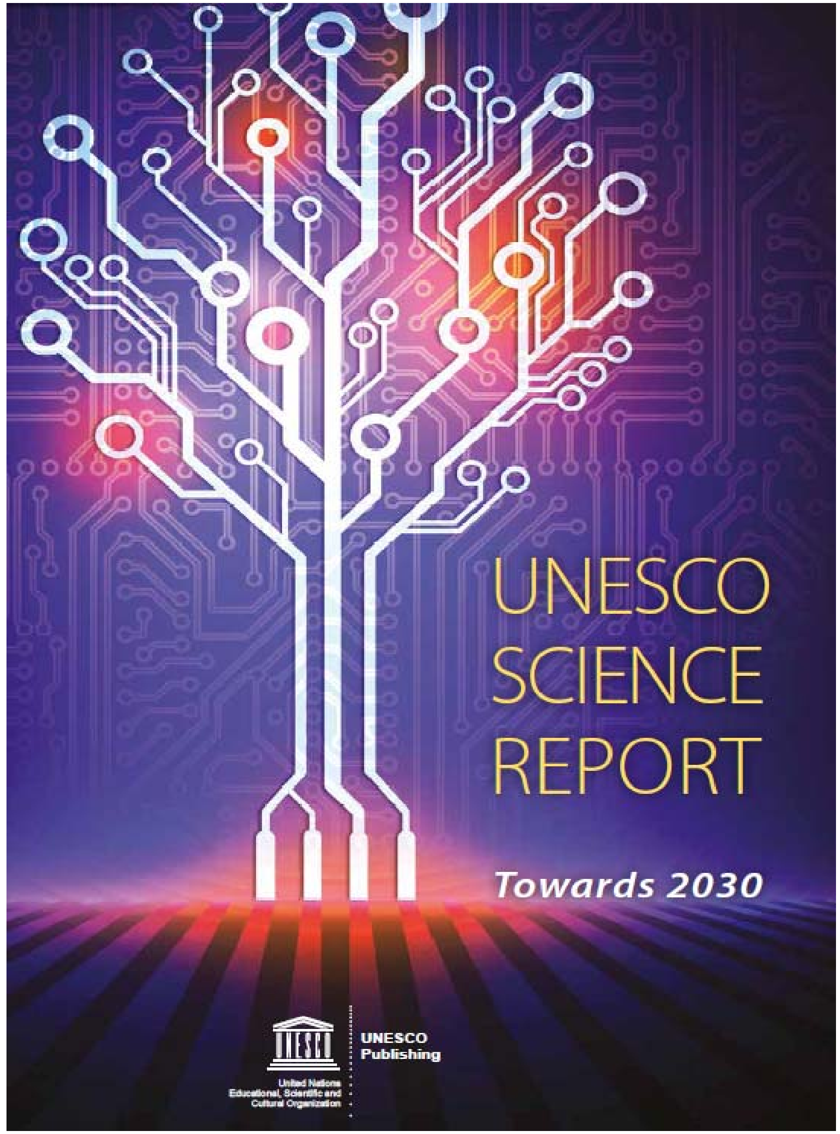
Brazil's Science without Borders (2011-2015): 100,000 scholarships for study abroad at best universities *plus* grants to bring researchers from abroad.

Iranian President Rouhani advcoated English-language university (2014) to attract foreigners: 'We have to have a relationship with the world, not only in foreign policy but also with regard to the economy, science and technology'?

A high level of mobility fosters innovation

‘Studies conducted across Europe have shown that a high level of mobility by qualified personnel between sectors (such as universities and industries) and across countries contributes to the overall professionalism of the labour force and innovative performance of the economy.’

UNESCO Science Report, based on 2014 *European Research Area Progress Report*



http://en.unesco.org/unesco_science_report