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GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY
AND INNOVATION POLICY INSTRUMENTS

Monitoring STI policies and their contexts through GO→SPIN: Ecosystems, legal frameworks and operational policy instruments

UN Regional Training Workshop on Innovation Policies for SDGs in the Arab Region
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7. *Intermezzo* for final questions and homework (exercises)

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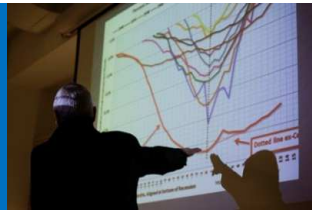
Evidence-based policy



- **Tests theory - why will the policy be effective and likely impacts if successful?**
- **Separates the uncertainties and controls for other influences outside of the policy that may have an effect on the outcome**
- **Incorporate some measurement of the impact**
- **Examines both direct and indirect effects that occur because of the policy (unintended consequences)**
- **Empirical validation**

Fundamental Sciences or Basic Sciences

Applied Sciences

Invention

Innovation

S&T (Science and Technology)

R&D (Research and Experimental Development)

STEM (Science, technology, engineering and mathematics)

STI (Science, Technology & Industry, or Science & Technology Indicators or Science, Technology & Innovation)

Research and Innovation

Incremental innovations

Radical innovations

Radical second innovations

Disruptive innovations

Creative destruction innovations

Frugal grassroots innovations

Open innovations

BOP AND PRO POOR INNOVATIONS

Inclusive innovations

Social innovations

TECHNOECONOMIC PARADIGMS

Technology paradigms

In order to understand nature and society we always divide our universe in categories (and concepts) which not necessary exist

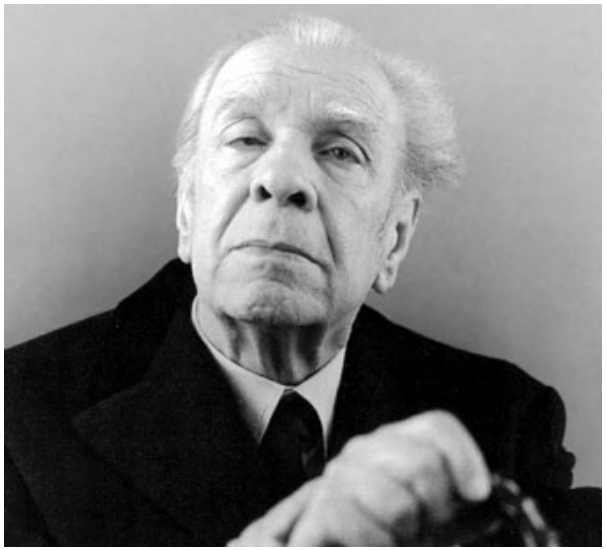
The writer Jorge Luis Borges asks why this might be so, and may be taken to suggest moderation in the multiplication of classes, differences and species.

…Esas ambigüedades, redundancias y deficiencias recuerdan las que el doctor Franz Kuhn atribuye a cierta enciclopedia china que se titula *Emporio celestial de conocimientos benévolos*. En sus remotas páginas está escrito que los animales se dividen en:

a.pertenecientes al Emperador
b.embalsamados
c.amaestrados
d.lechones
e.sirenas
f.fabulosos
g.perros sueltos
h.incluidos en esta clasificación
i.que se agitan como locos
j.innumerables
k.dibujados con un pincel finísimo de pelo de camello
l.etcétera
m.que acaban de romper el jarrón
n.que de lejos parecen moscas

…These ambiguities, redundancies and deficiencies remind us of those which doctor Franz Kuhn attributes to a certain Chinese encyclopedia entitled *The Celestial Emporium of Benevolent Knowledge*. In its remote pages it is written that the animals are divided into:

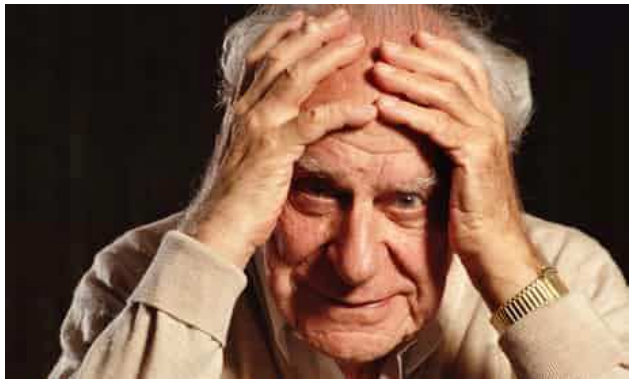
a.belonging to the Emperor
b.embalmed
c.trained
d.piglets
e.sirens
f.fabulous
g.stray dogs
h.included in this classification
i.trembling like crazy
j. innumerables
k.drawn with a very fine camelhair brush
l.etcetera
m.just broke the vase
n.from a distance look like flies



Jorge Luis Borges (1899 – 1986)

Exerpts from: “El idioma analítico del Sr. Wilkins” in *Otras Inquisiciones* 1937-1952

Science understands nature by proposing a group of conjectures which eventually are used in the formulation of a theory.
Using logic we "deduce" all the observational consequences theoretically predicted. By experiments or observations we "corroborate" or "refute" a given theory.
It is logically impossible to demonstrate that a given theory is "true" but by *Modus Tollens* if the observations and experiments contradict the predictions of the theory… we are sur that the theory is wrong.
We can only guarantee that a theory is wrong but never that is right (only corroborate it).



Karl Popper (1902-1994)
Founder of the Hyphotetico-Deductive Method

All type of measurements, observations, experiment results, or **"indicators"** are always implicitly or explicitly "theory-dependent" and paradigm-dependent (T. Kuhn)

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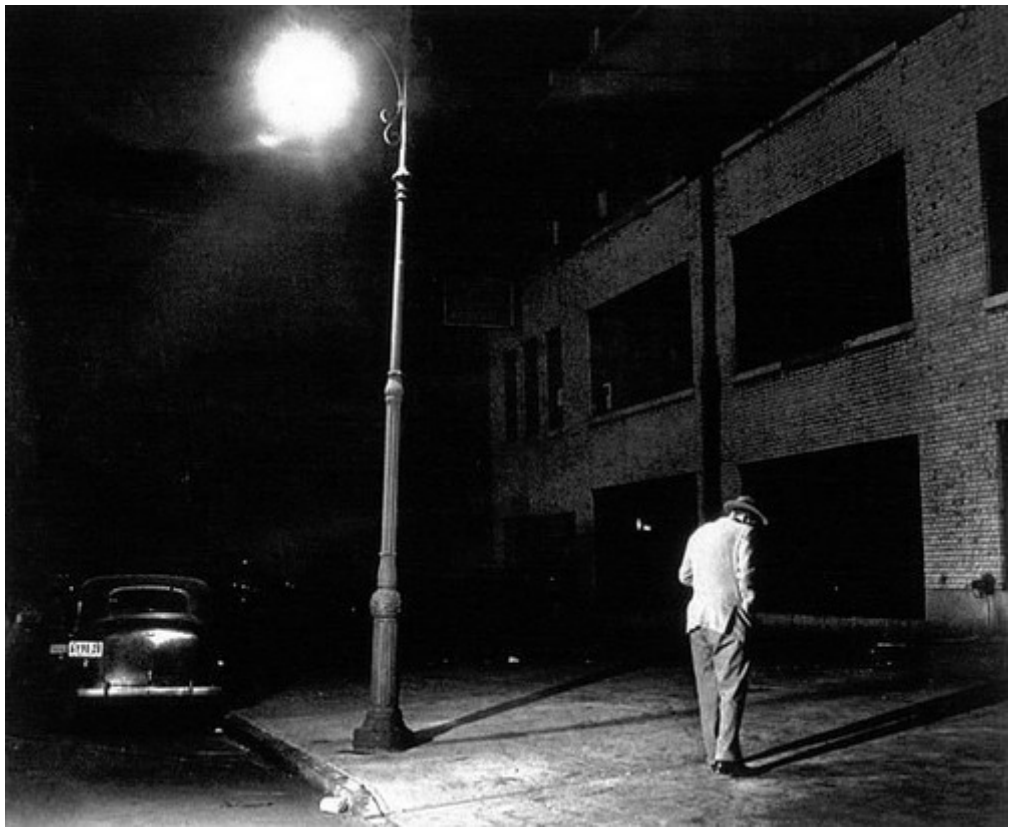
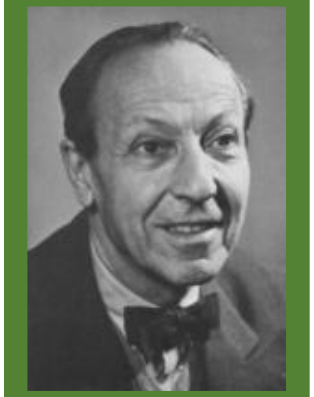


Are we using the "appropriate indicators" to understand how STI policies generate effects or how "National *Research* and Innovation Systems" (NRIS) work?

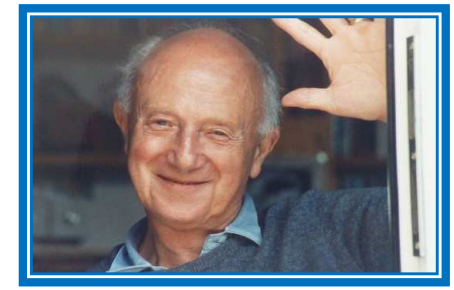


Fritz Machlup (1902 – 1983)

→ F. Machlup (1962) *The Production and Distribution of Knowledge in the US*, Princeton Univ. Press, pp. 180–181.

THE FLOW OF IDEAS THROUGH THE STAGES OF RESEARCH, INVENTION, AND DEVELOPMENT TO APPLICATION

STAGE	INPUT: Intangible	INPUT: Tangible	INPUT: Measurable	OUTPUT: Intangible	OUTPUT: Measurable
I "Basic Research" [Intended output: "Formulas"]	1. Scientific knowledge (old stock and output from I-A)	Scientists, Technical aides, Clerical aides	Men, man-hours, Payrolls, current and deflated	A. New scientific knowledge: hypotheses and theories	Research papers and memoranda; formulas
	2. Scientific problems and hunches (old stock and output from I-B, II-B, and III-B)	Laboratories, Materials, fuel, power	Outlays, current and deflated, Outlay per man	B. New scientific problems and hunches	—
				C. New practical problems and ideas	—
II "Inventive Work" (Including minor improvements but excluding further development of inventions) [Intended output: "Sketches"]	1. Scientific knowledge (old stock and output from I-A)	Scientists, Non-scientist inventors, Engineers, Technical aides, Clerical aides	Men, man-hours, Payrolls, current and deflated	A. Raw inventions: technological recipes a. Patented inventions b. Patentable inventions, not patented but published c. Patentable inventions, neither patented nor published d. Non-patentable inventions, published e. Non-patentable inventions, not published f. Minor improvements	a. Patent applications and patents b. Technological papers and memoranda c. — d. Papers and memoranda e. — f. —
	2. Technology (old stock and output from II-A and III-A)	Laboratories, Materials, fuel, power	Outlays, current and deflated, Outlay per man	B. New scientific problems and hunches	—
	3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A)			C. New practical problems and ideas	—
III "Development Work" [Intended output: "Blueprints and Specifications"]	1. Scientific knowledge (old stock and output from I-A)	Scientists, Engineers, Technical aides, Clerical aides	Men, man-hours, Payrolls, current and deflated	A. Developed inventions: blueprints, specifications, samples	Blueprints and specifications
	2. Technology (old stock and output from III-A)	Laboratories, Materials, fuel, power	Outlays, current and deflated, Outlay per man	B. New scientific problems and hunches	—
	3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A)	Pilot plants	Investment	C. New practical problems and ideas	—
	4. Raw inventions and improvements (old stock and output from II-A)				
IV "New-type Plant Construction" [Intended output: "New-type plant"]	1. Developed inventions (output from III-A)	Entrepreneurs, Managers, Financiers and bankers, Builders and contractors, Engineers	$ investment in new-type plant	A. New practical problems and ideas	New-type plant producing a. novel products b. better products c. cheaper products
	2. Business acumen and market forecasts				
	3. Financial resources				
	4. Enterprise (venturing)	Building materials, Machines and tools			



Christopher Freeman (1921 – 2010)

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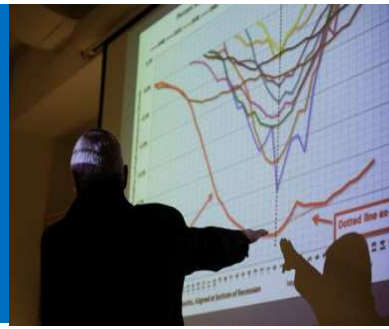
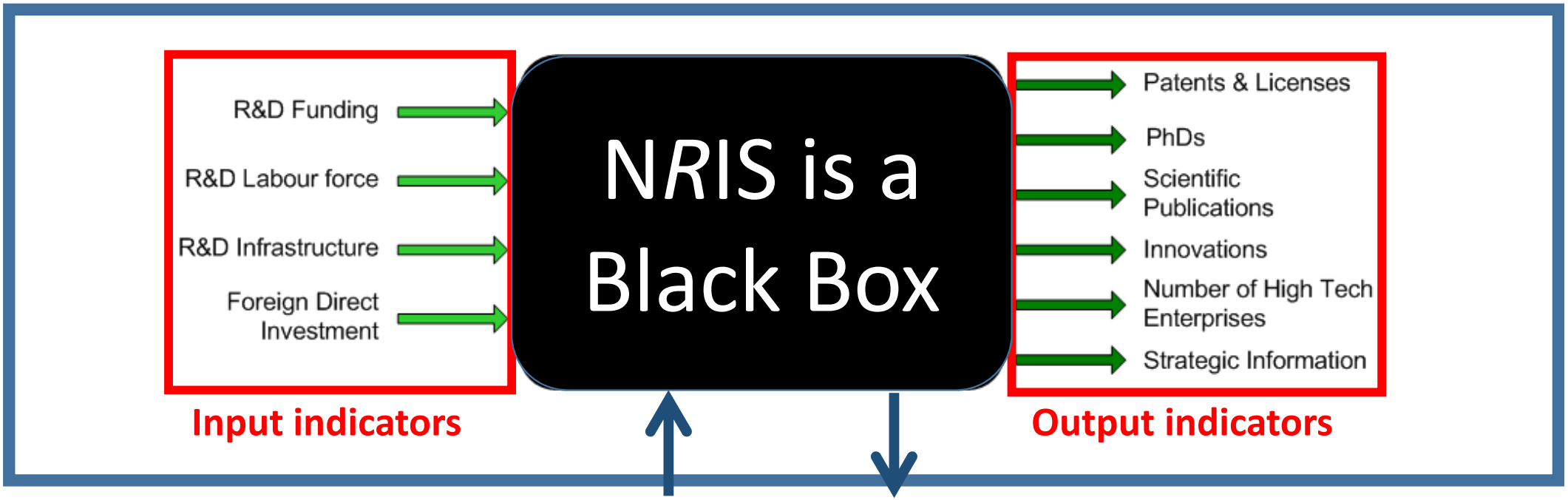
How suitable are the indicators of the Frascati–Manual family to generate "evidence-based policies"?





National and international contextual factors, geopolitics, fluxes of goods, human and financial resources, information, etc.

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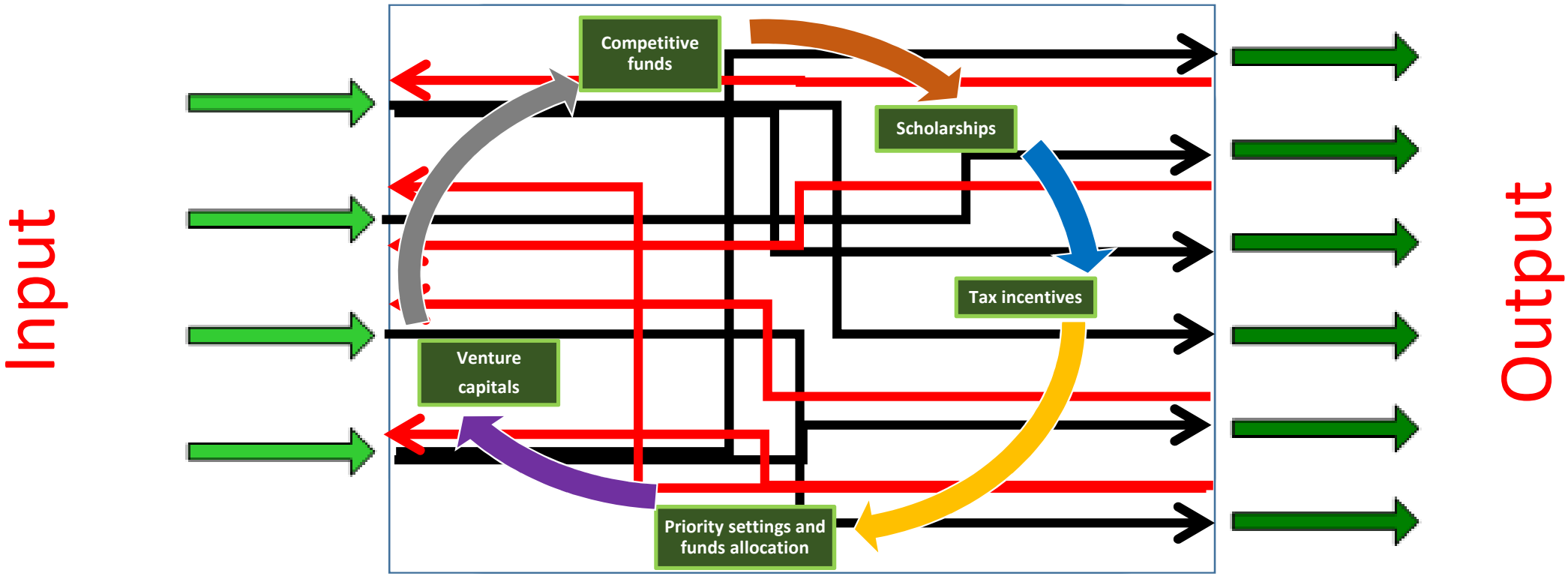
Opening the "Black Box"

by measuring the implementation and impact of STI policy instruments



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How sensitive are some temporal series of indicators to detect the influence of the national “environmental conditions” (contextual factors, governance, political stability) ?

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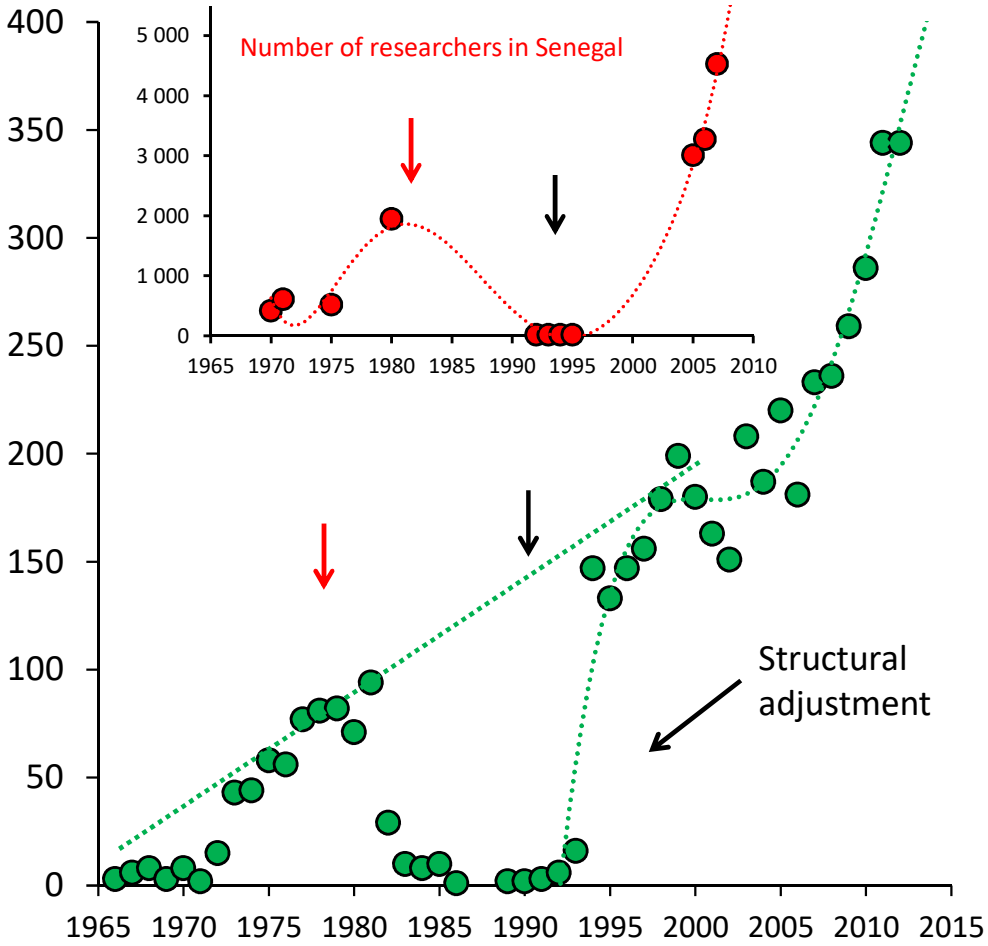
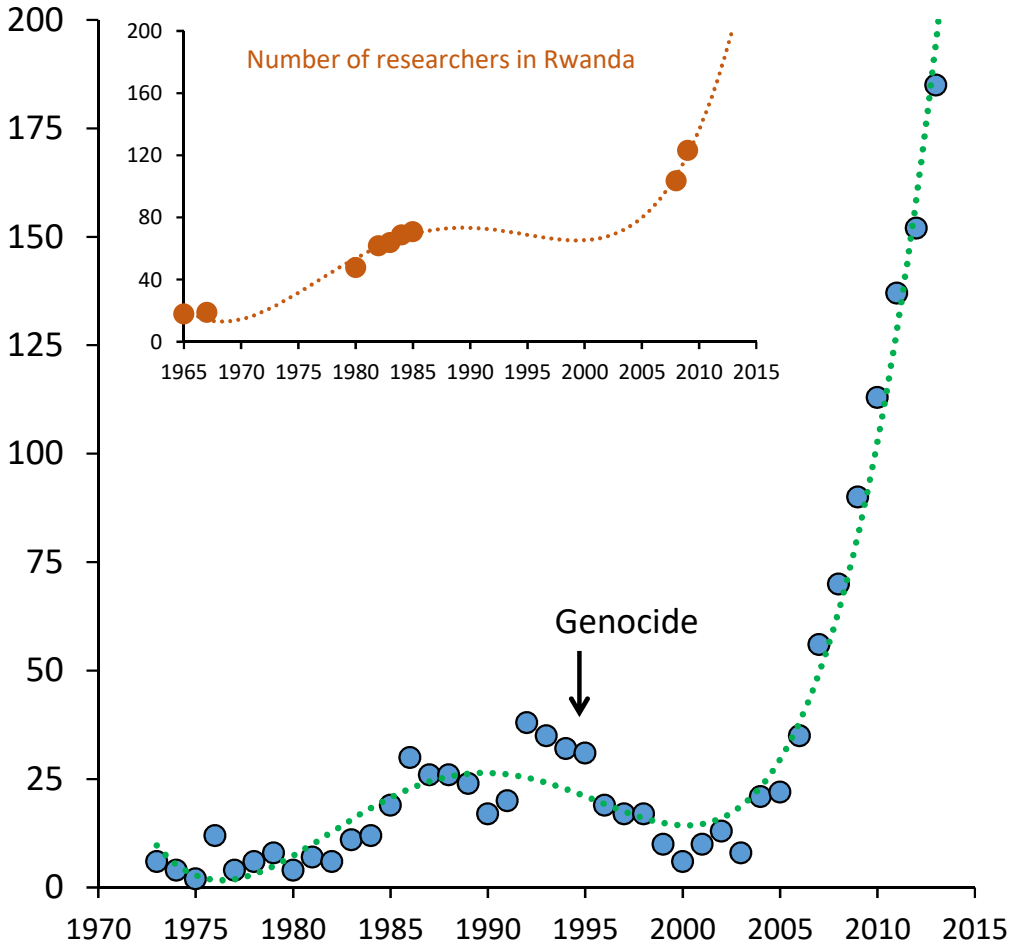
Number of scientific articles listed at WoS

Senegal



Rwanda



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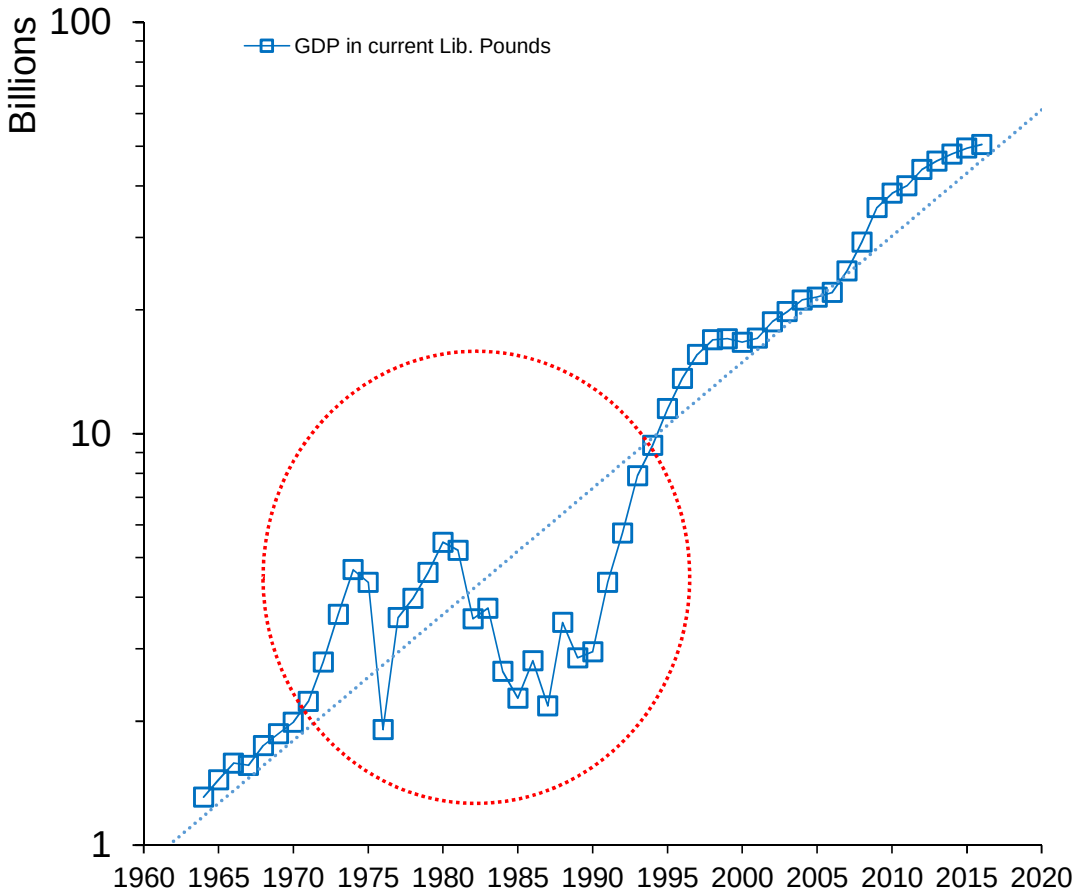
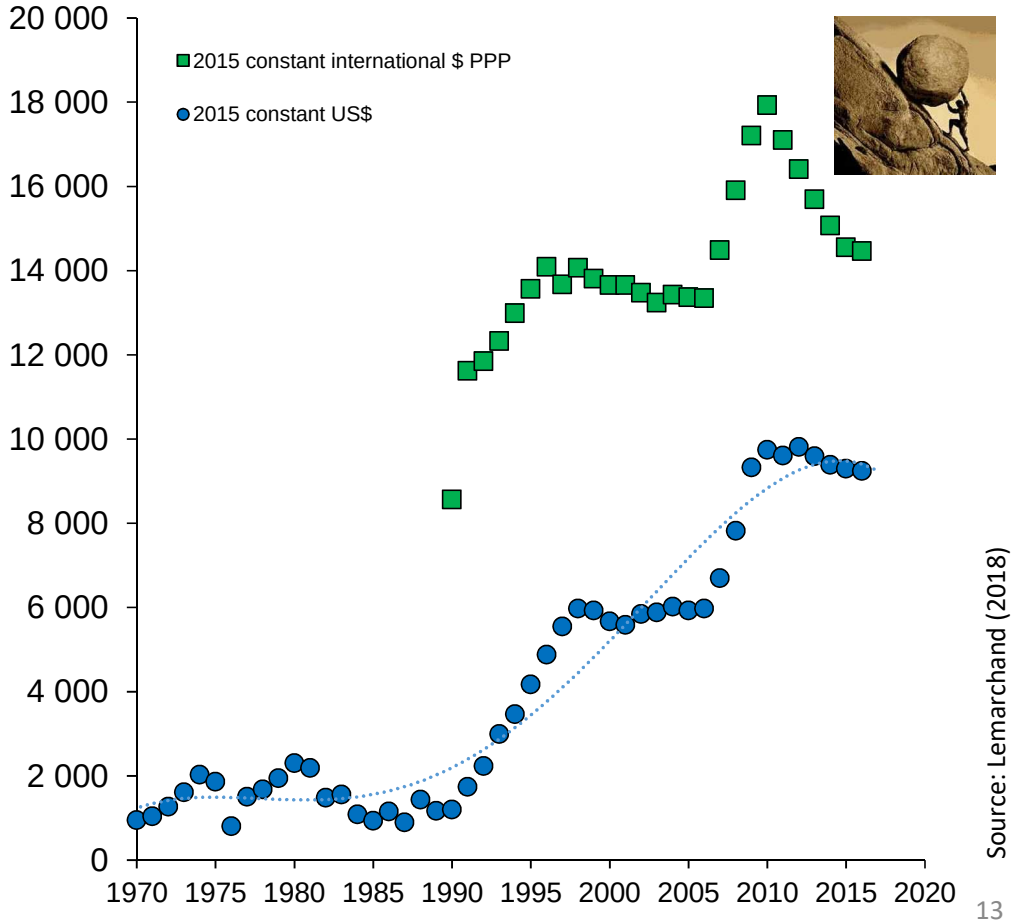
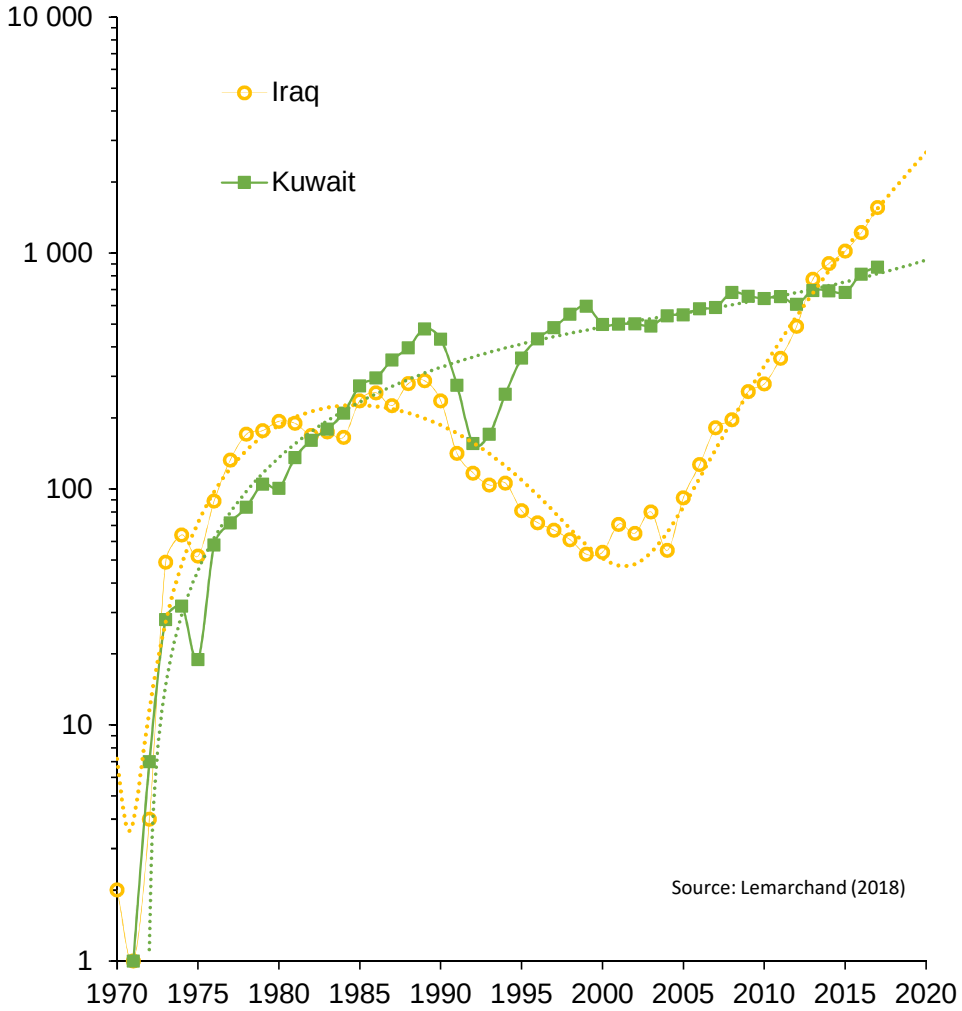
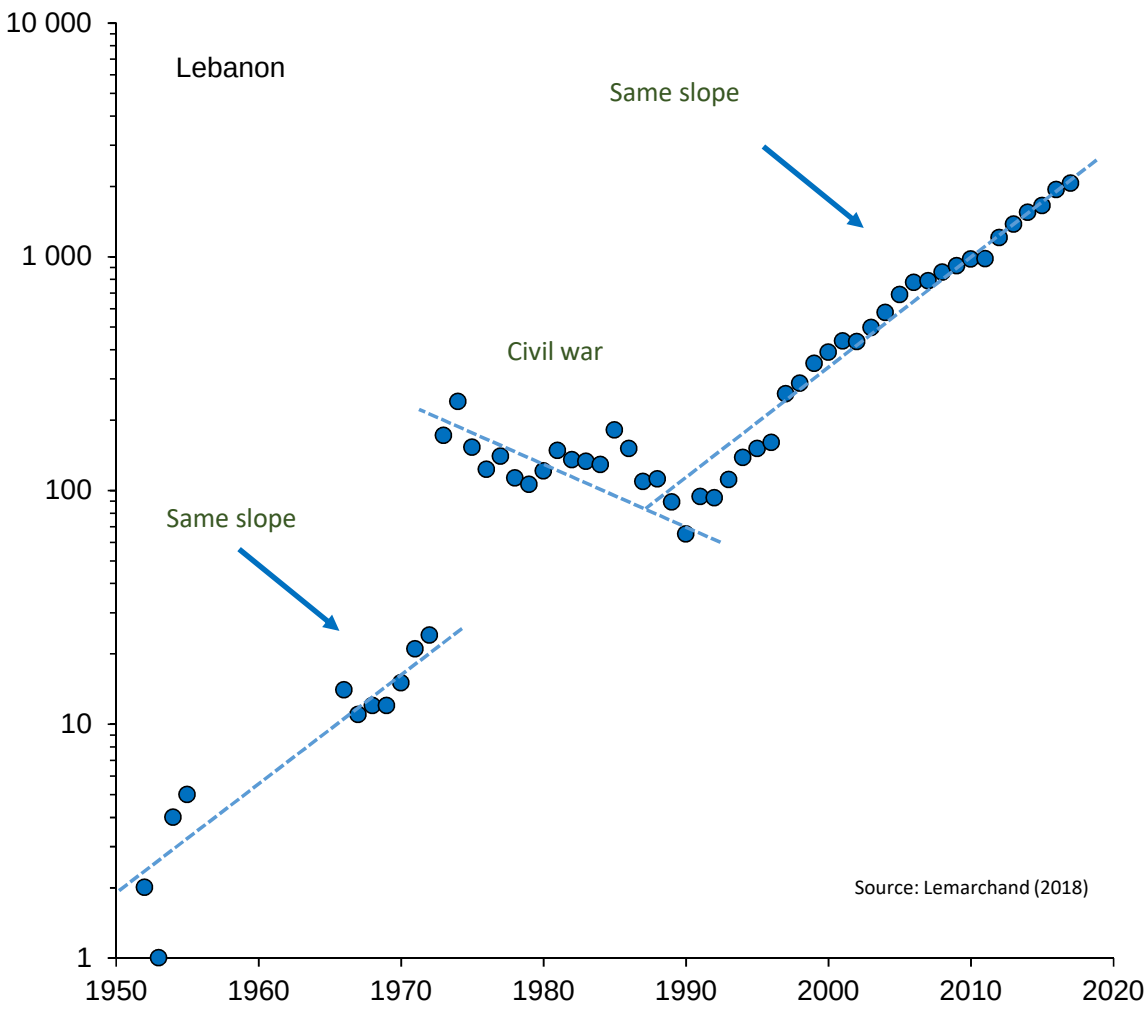
GDP in current Lib. Pounds and GDP per capita in 2015 constant US$ and $ PPP in Lebanon





Some examples of the sensitivity of scientific productivity to political stability/absence violence





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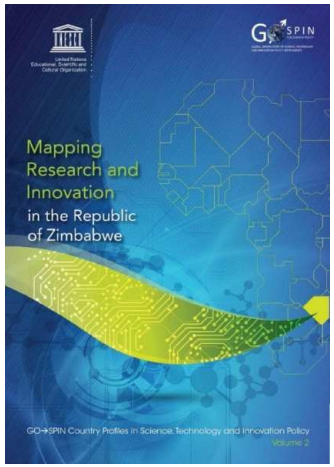

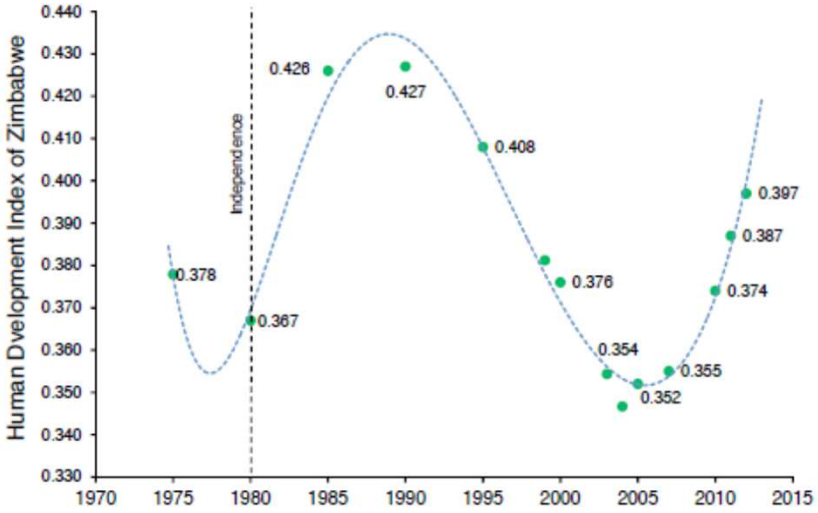

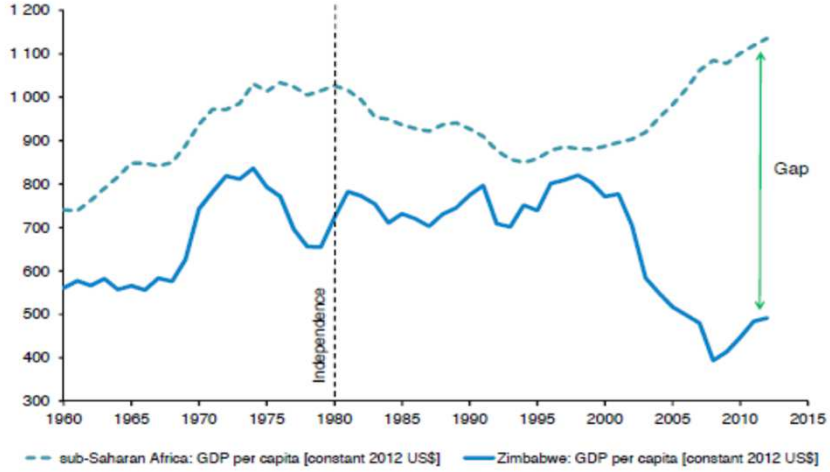

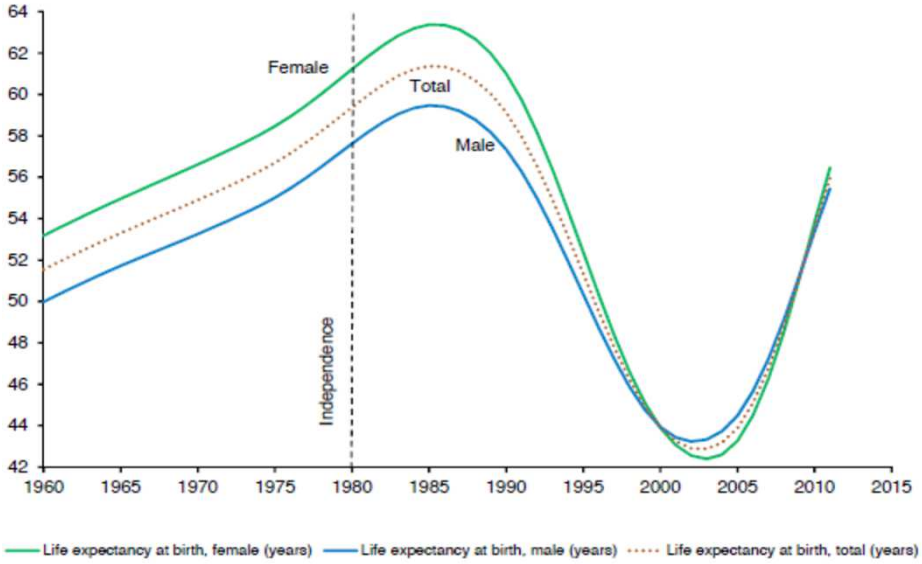

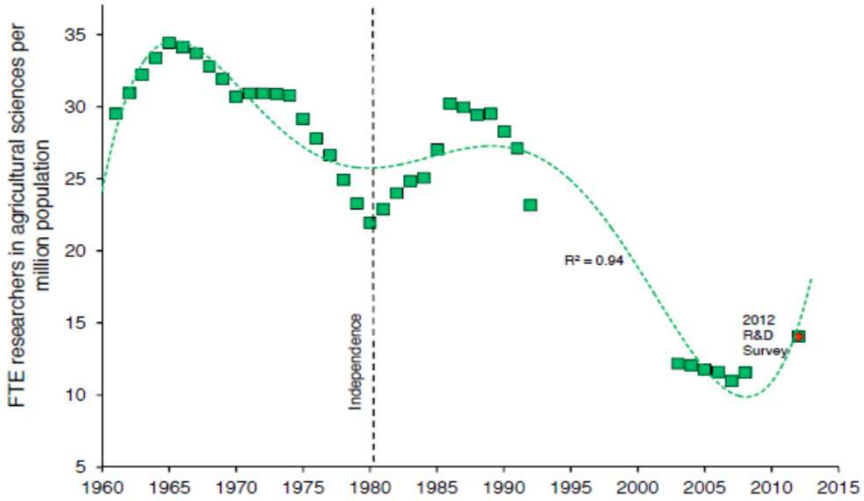

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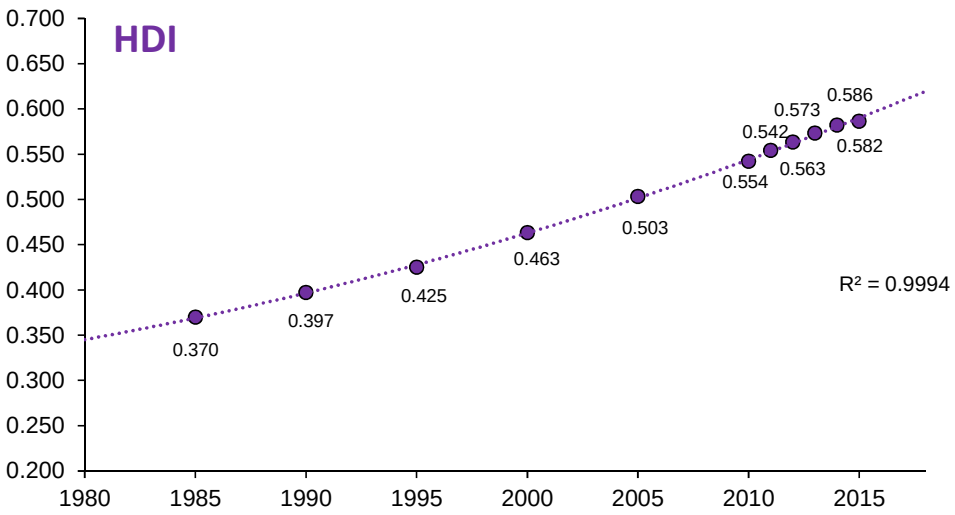

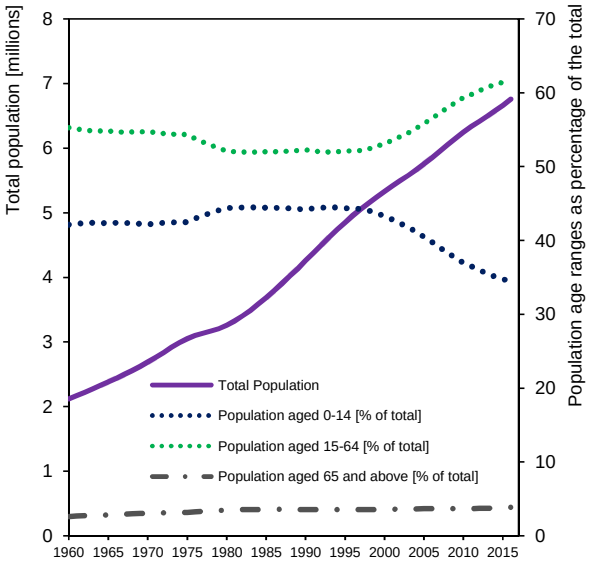

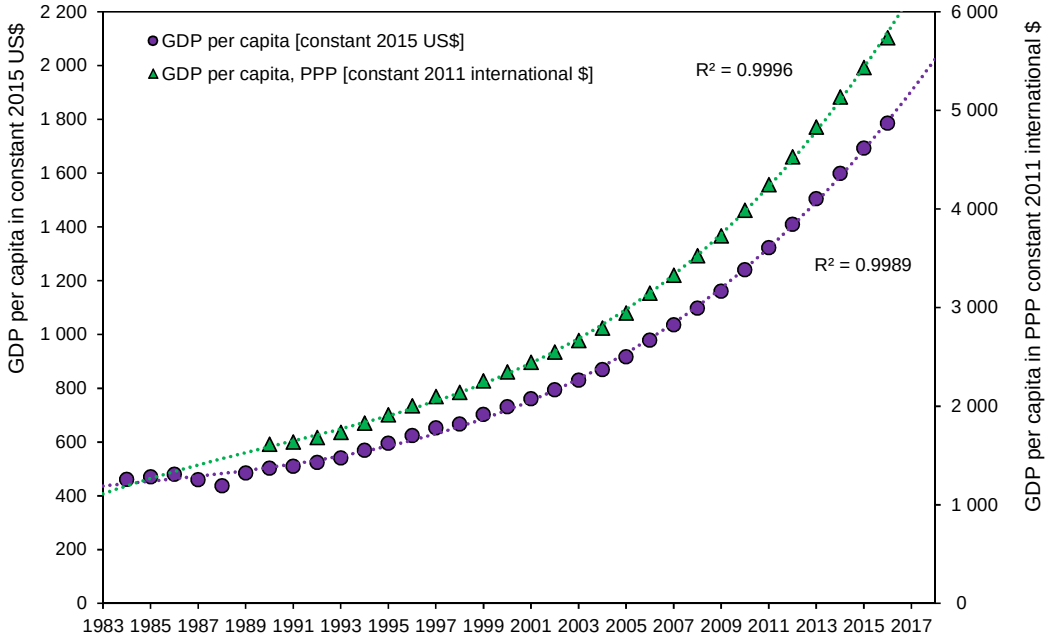

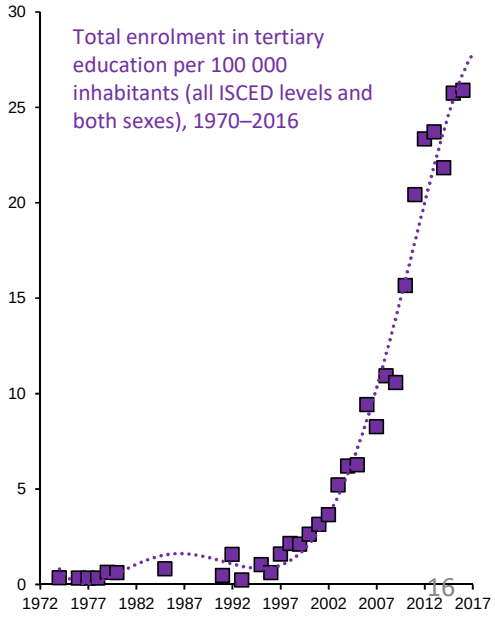

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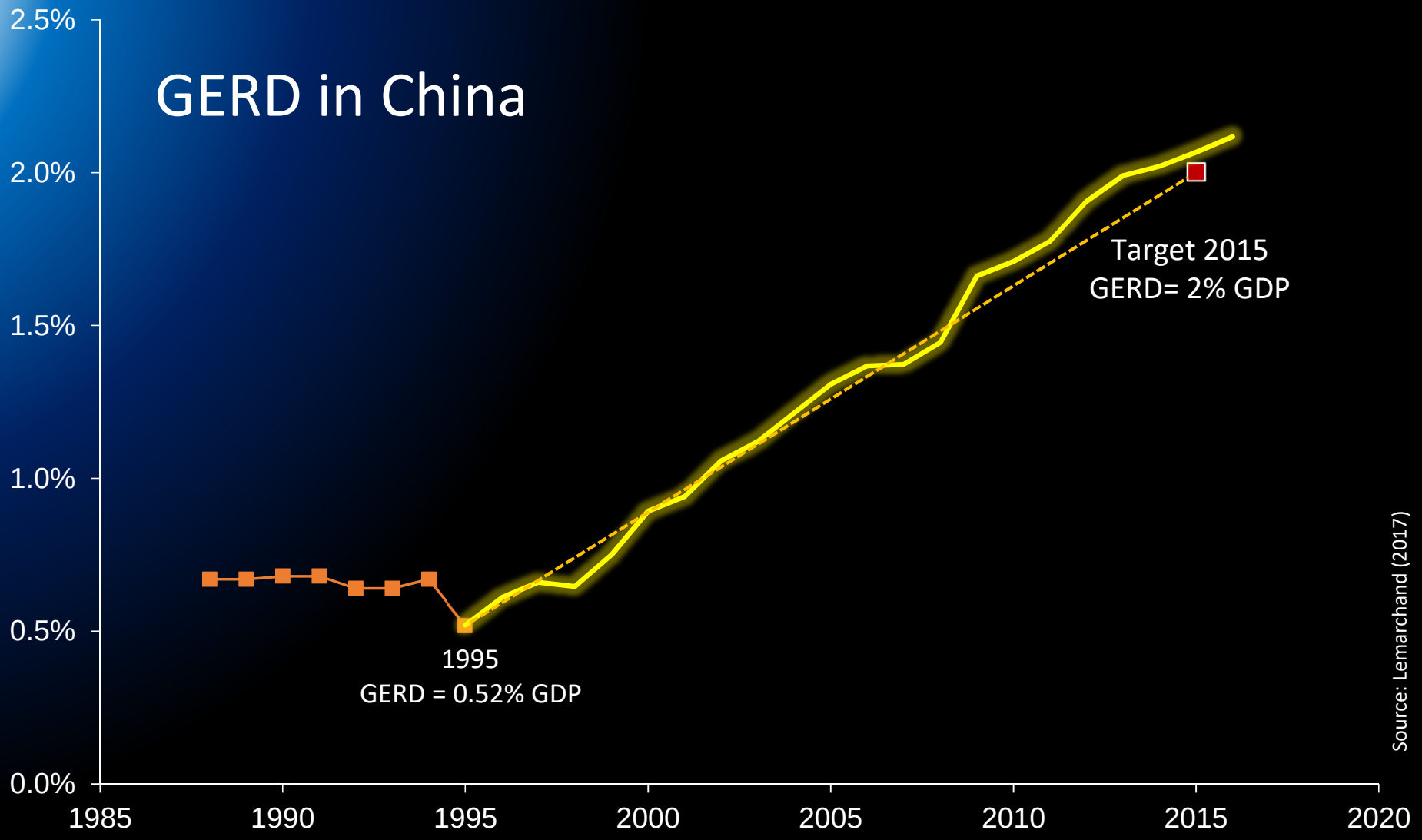
GERD in China



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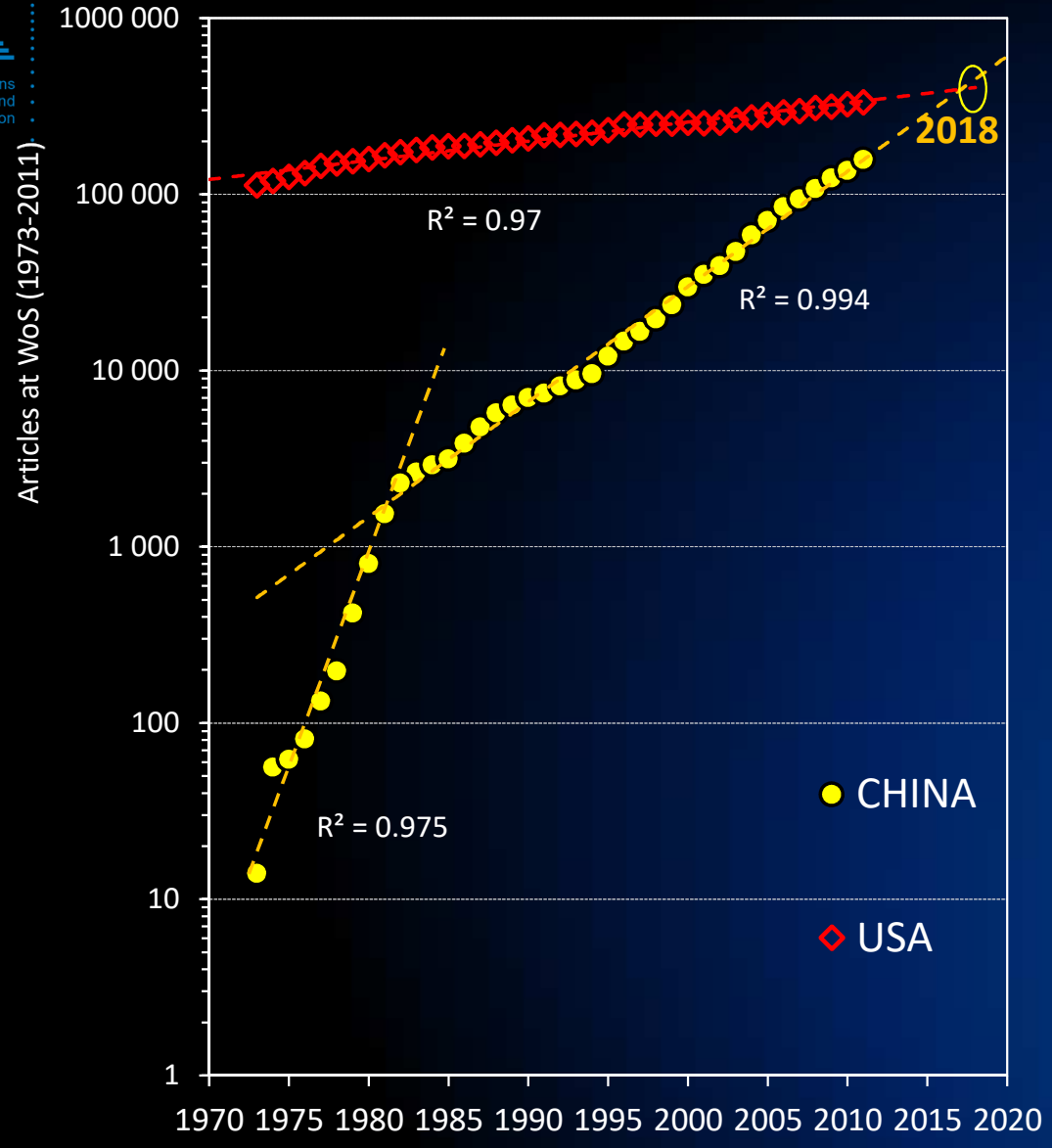
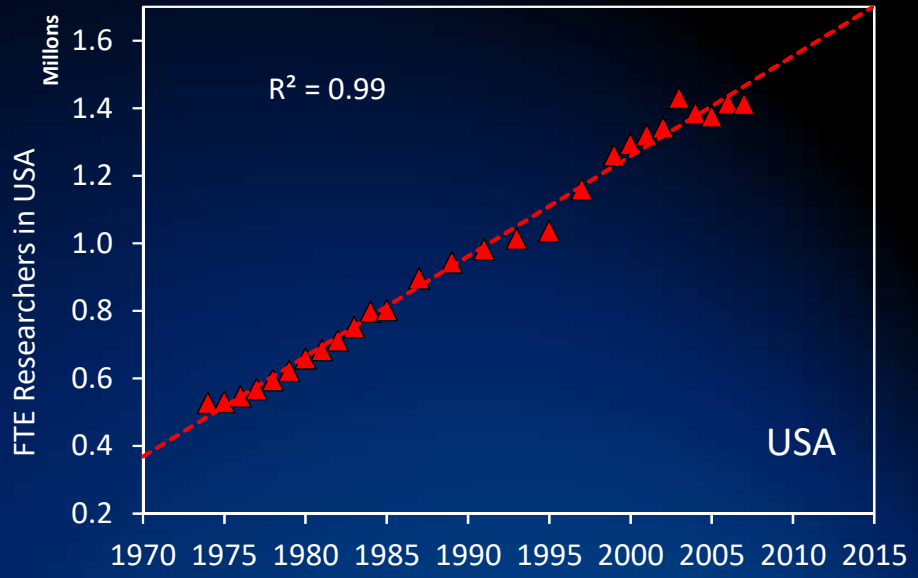
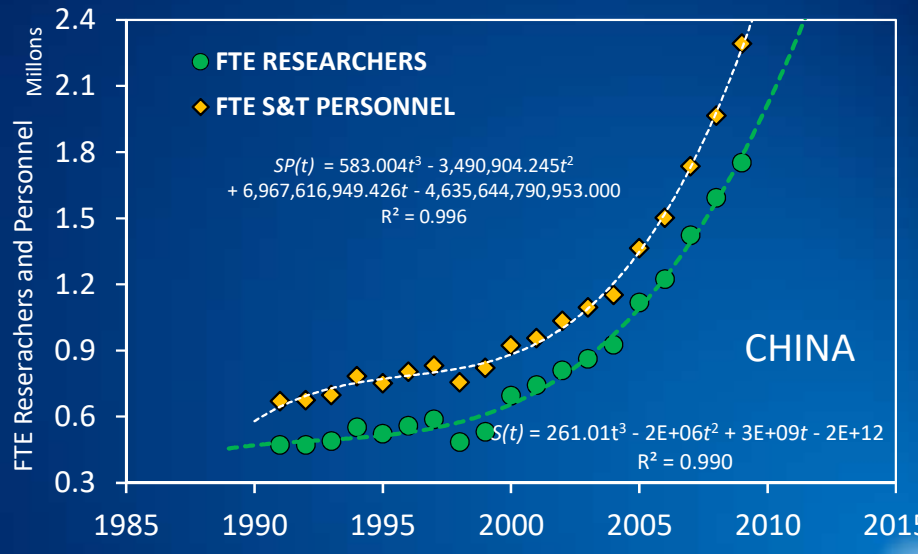
Source: Lemarchand (2012)







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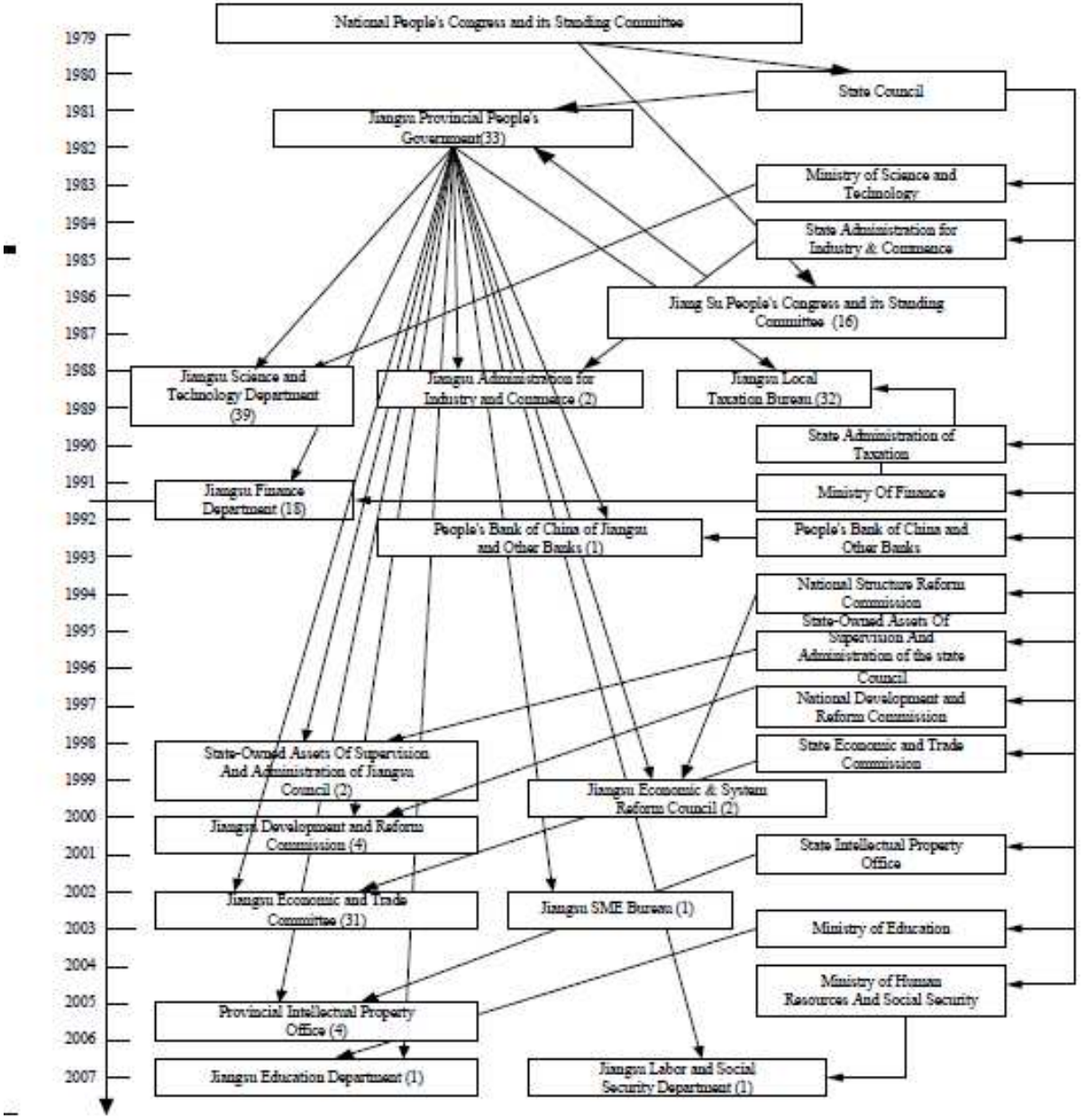
Technology Policy Framework of the Jiangsu province



Source: Wenxiang Sun et al. (2011) *Journal of Science and Technology Policy in China*, vol. 2 (3):238-254

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GO SPIN
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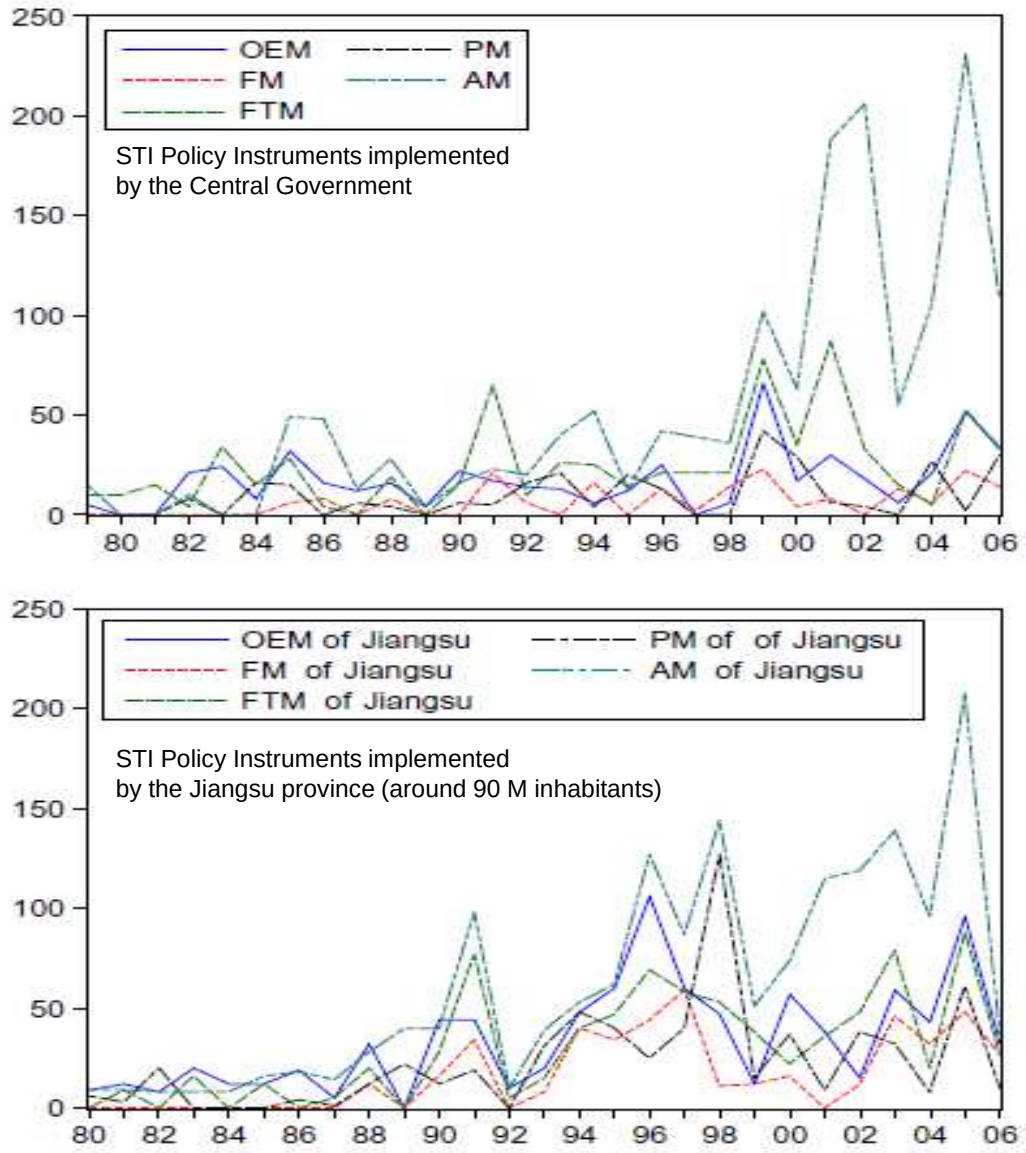
Evolution of Technological Policy Instruments in China

AM: Administrative Mechanisms
FM: Financial Mechanisms
FTM: Fiscal and Taxes Mechanisms
PM: Human Resources Mechanisms
OEM: Other Economic Mechanisms



Source: Wenxiang Sun *et al.* (2011) *Journal of Science and Technology Policy in China*, vol. 2 (3): 238-254

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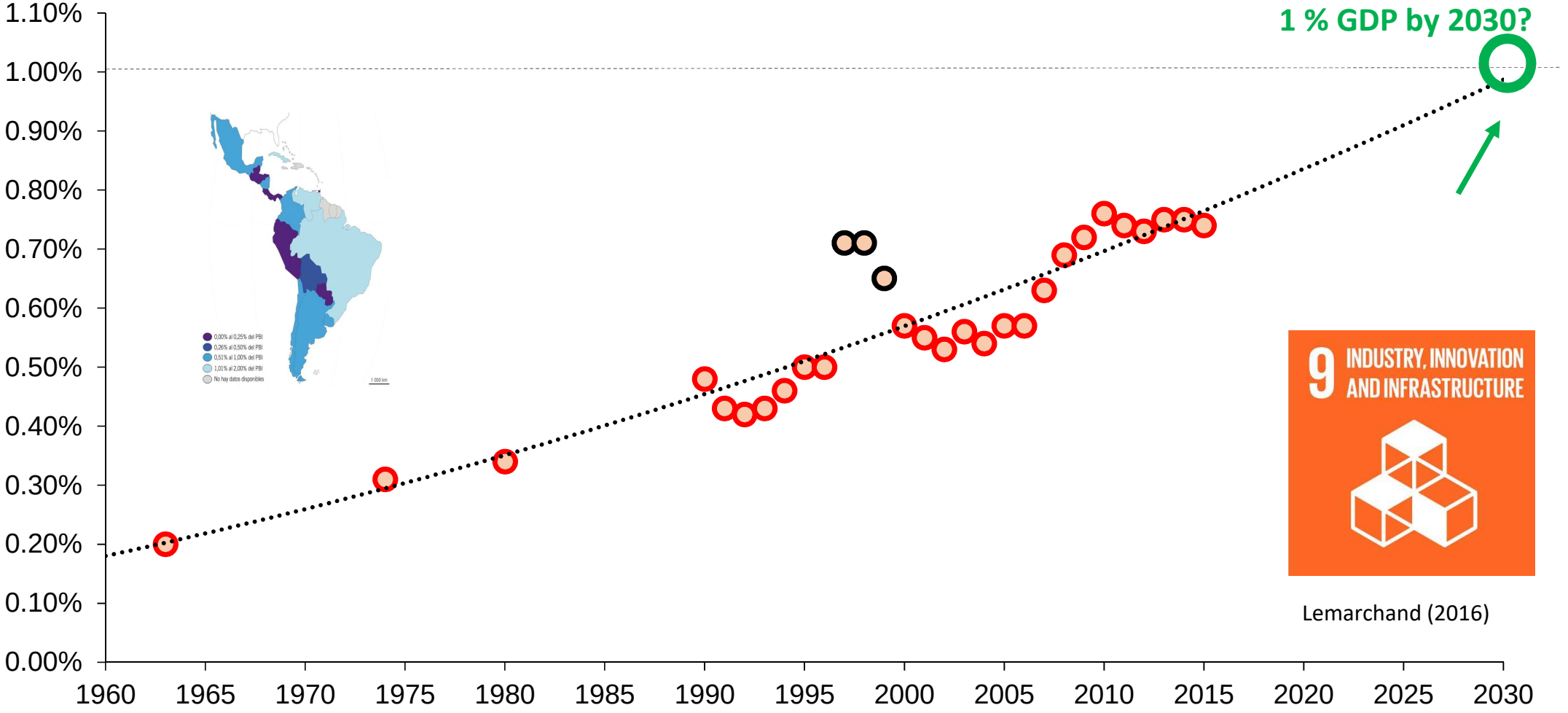
Gross domestic expenditure on R&D as percentage of GDP in LAC (long-run)



Lemarchand (2016)

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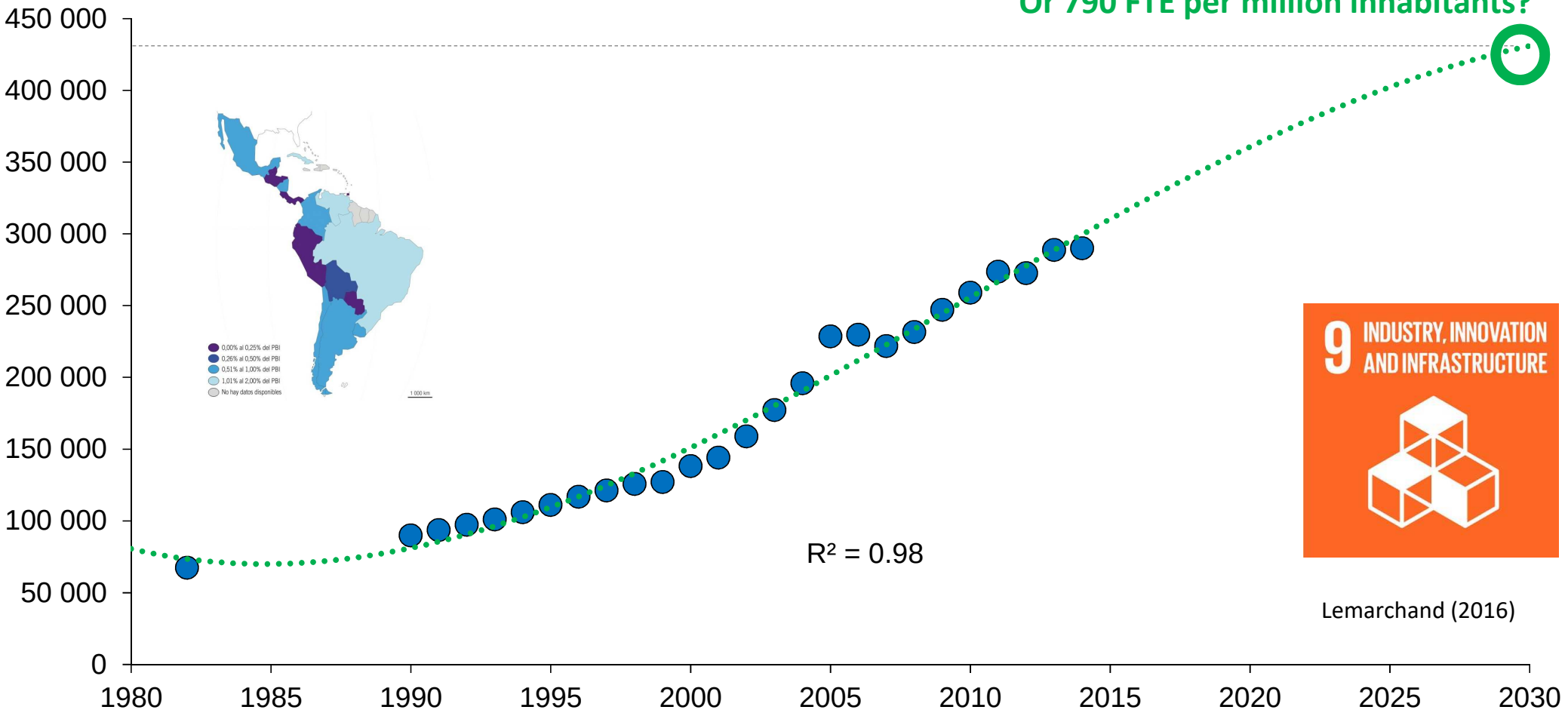
FTE researchers in Latin American and the Caribbean (long-run)

425,000 FTE Researchers by 2030?
Or 790 FTE per million inhabitants?



Lemarchand (2016)

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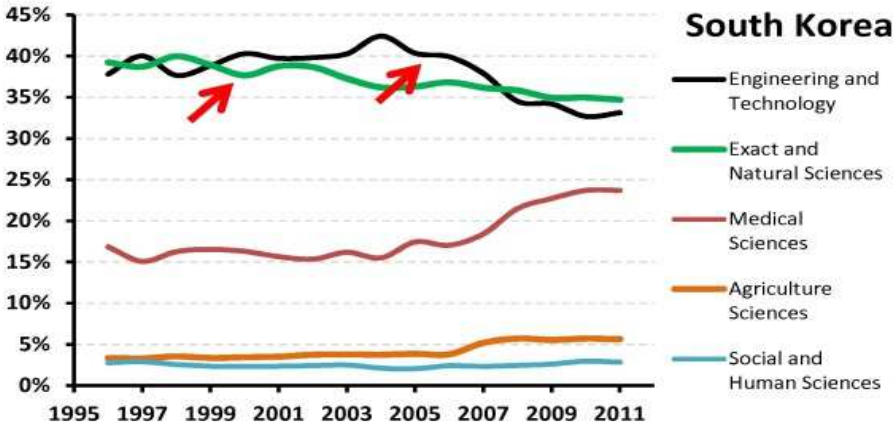
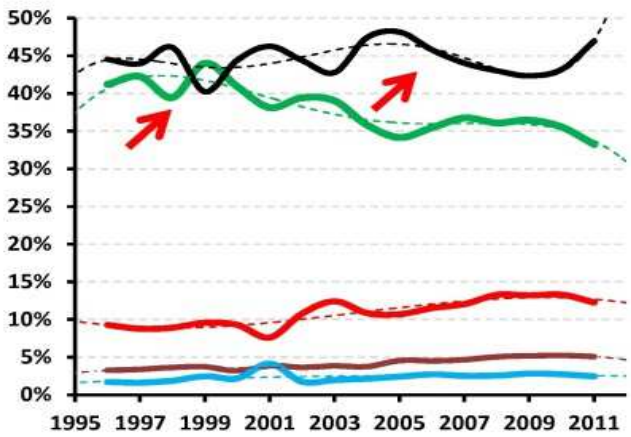
Articles by main field of science



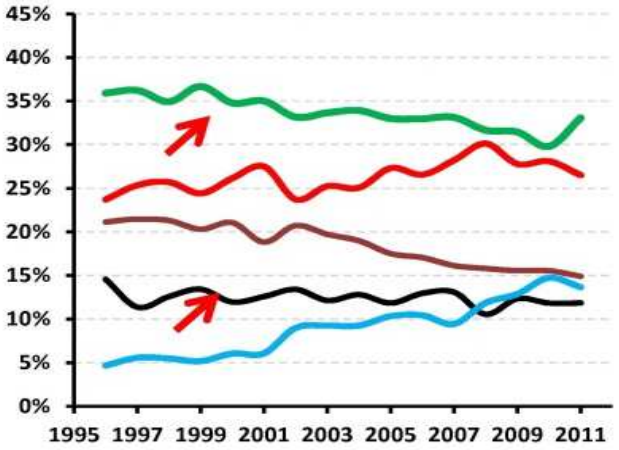
South Korea

- Engineering and Technology
- Exact and Natural Sciences
- Medical Sciences
- Agriculture Sciences
- Social and Human Sciences



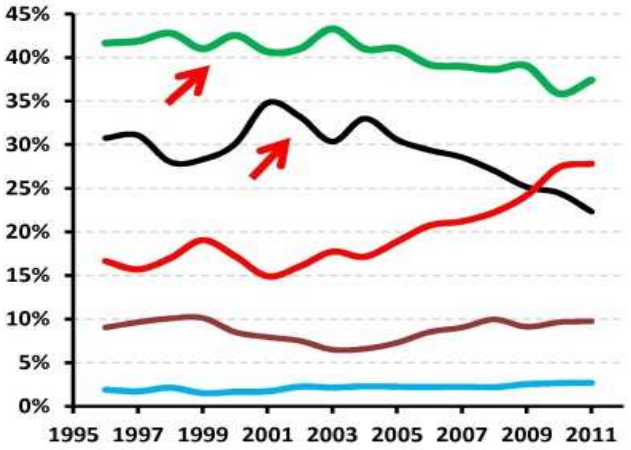
China

- Natural Sciences
- Engineering and Technology
- Medical and Health Science
- Agricultural Sciences
- Social an Human Sciences



South Africa

- Natural Sciences
- Engineering and Technology
- Medical and Health Science
- Agricultural Sciences
- Social an Human Sciences



Egypt

- Natural Sciences
- Engineering and Technology
- Medical and Health Science
- Agricultural Sciences
- Social an Human Sciences

Lemarchand (2013)

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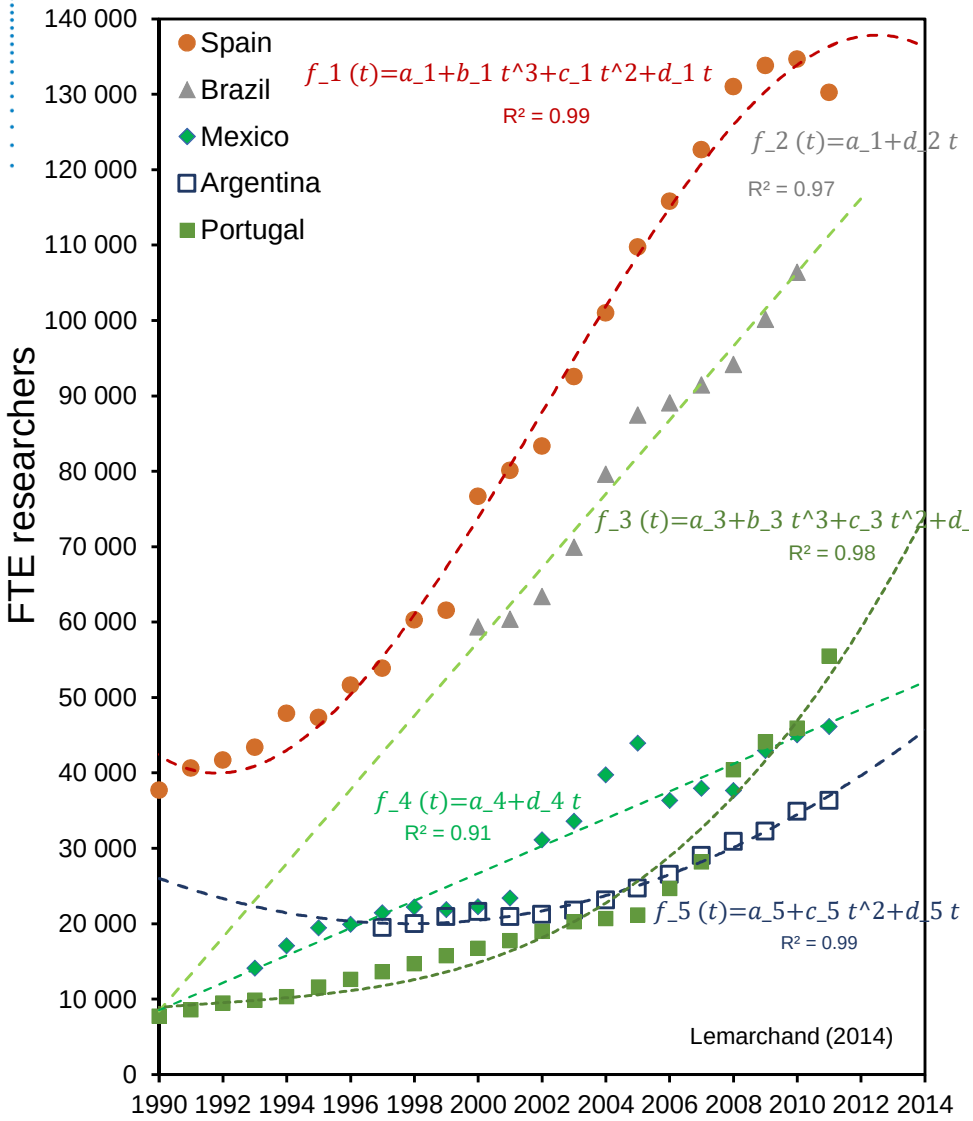
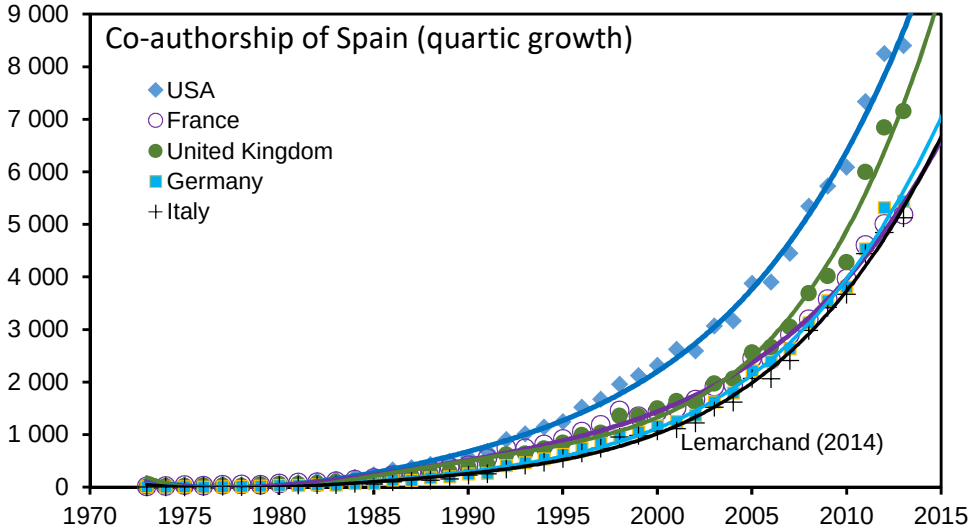
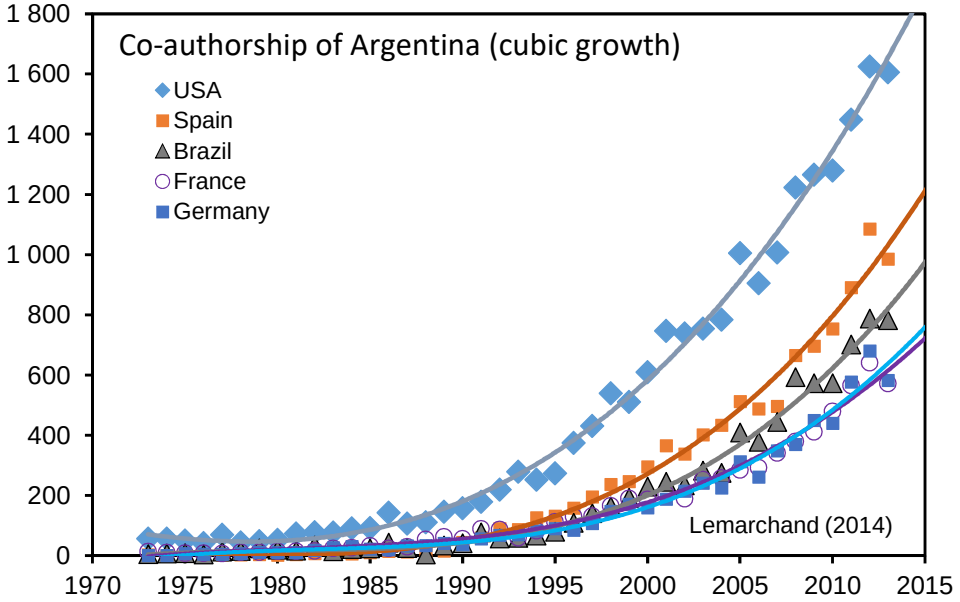
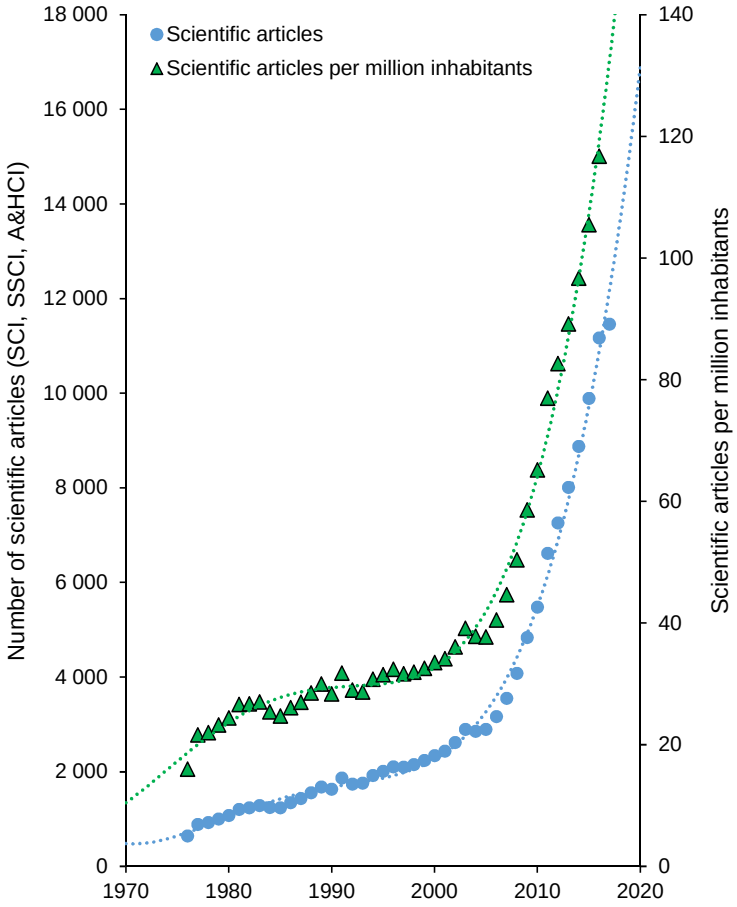


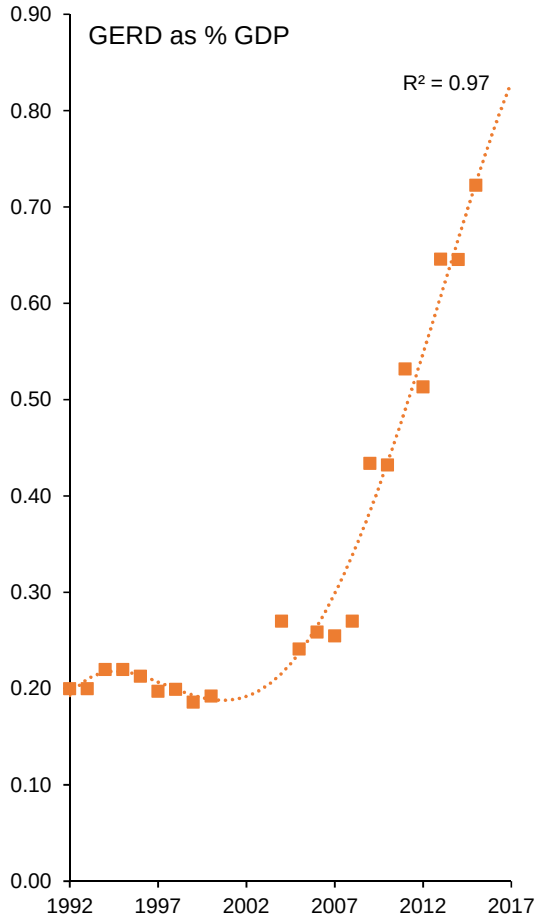


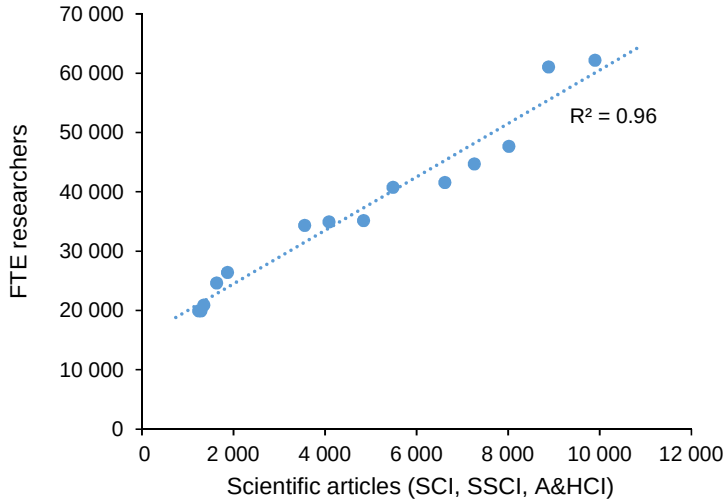


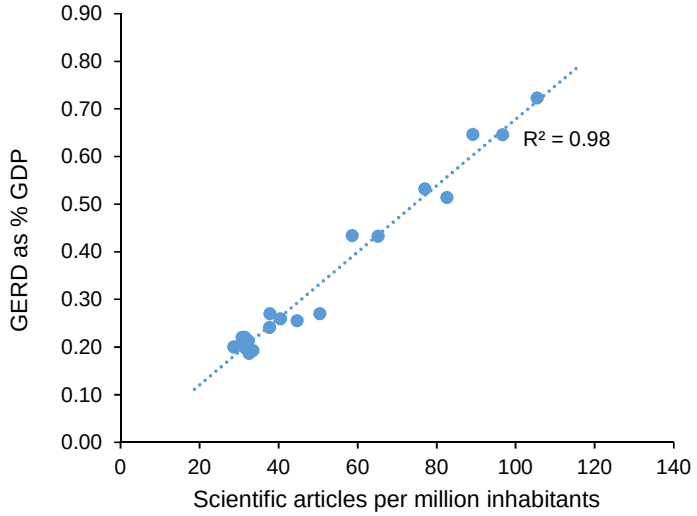
Fuente: G.A. Lemarchand en H. Horta et al. (eds.), Trends and Challenges in Science and Higher Education, Knowledge *Studies in Higher Education* 3, Springer, pp. 29 – 46, 2016

Scaling patterns of the scientific activities in Egypt









Source: Lemarchand (2018)

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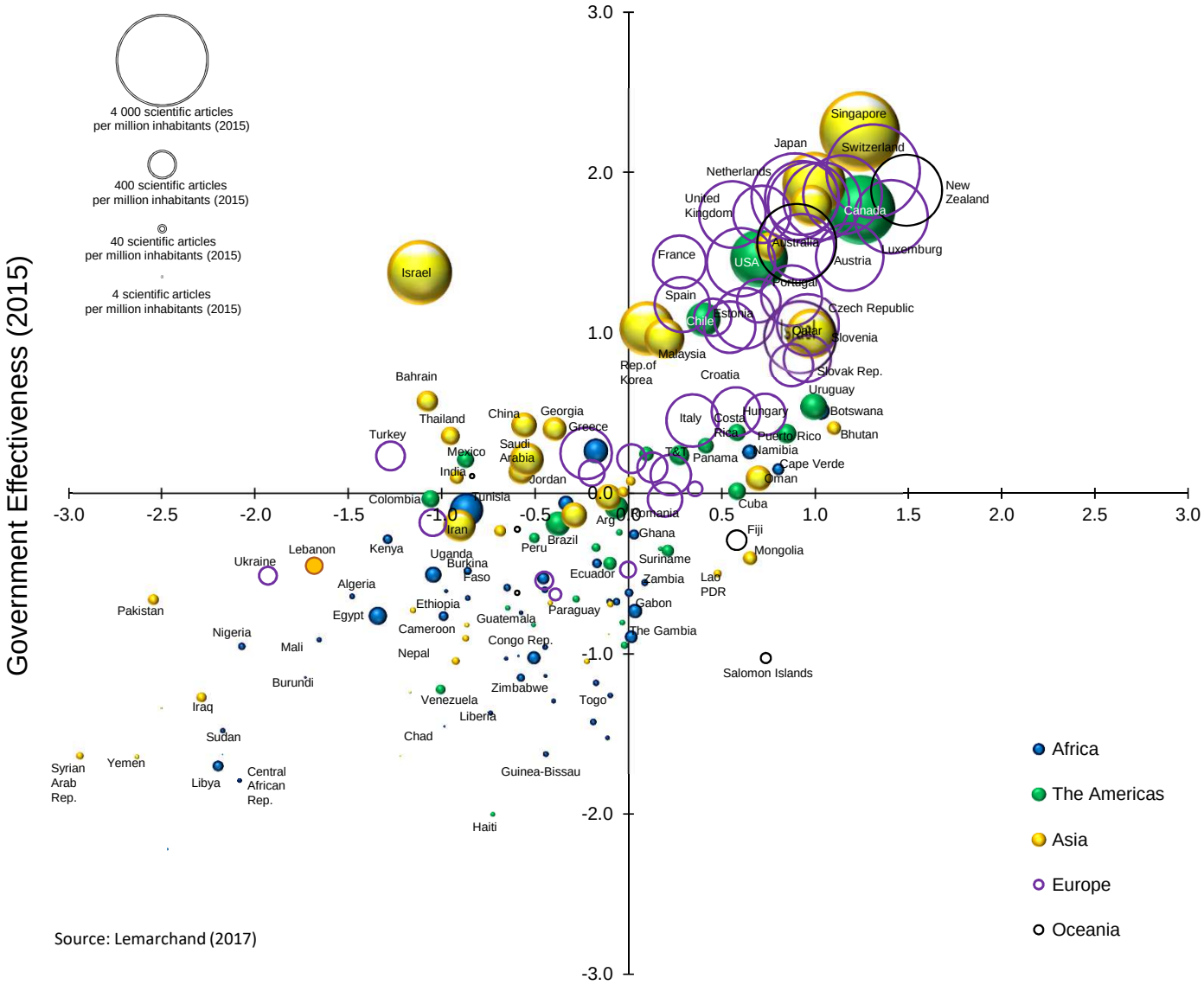
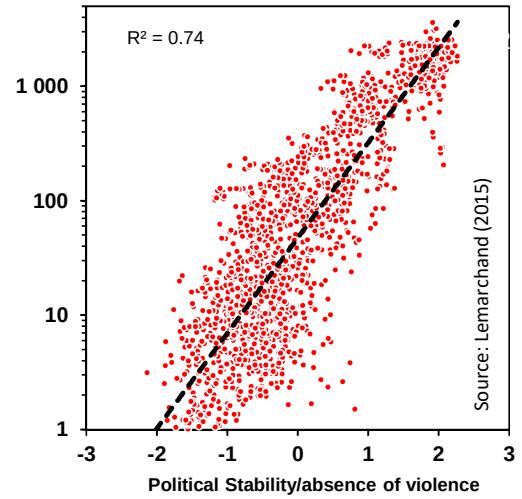
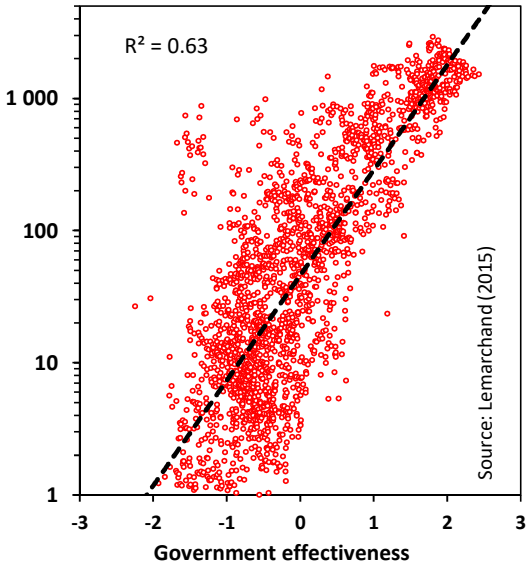
CONTEXTUAL FACTORS: Why we need political stability, government effectiveness and long-term public policies for sustainable development?

Correlation between governance indicators and scientific production in terms of publications per million inhabitants







1996-2013 around 170 countries
Approximately 2400 points

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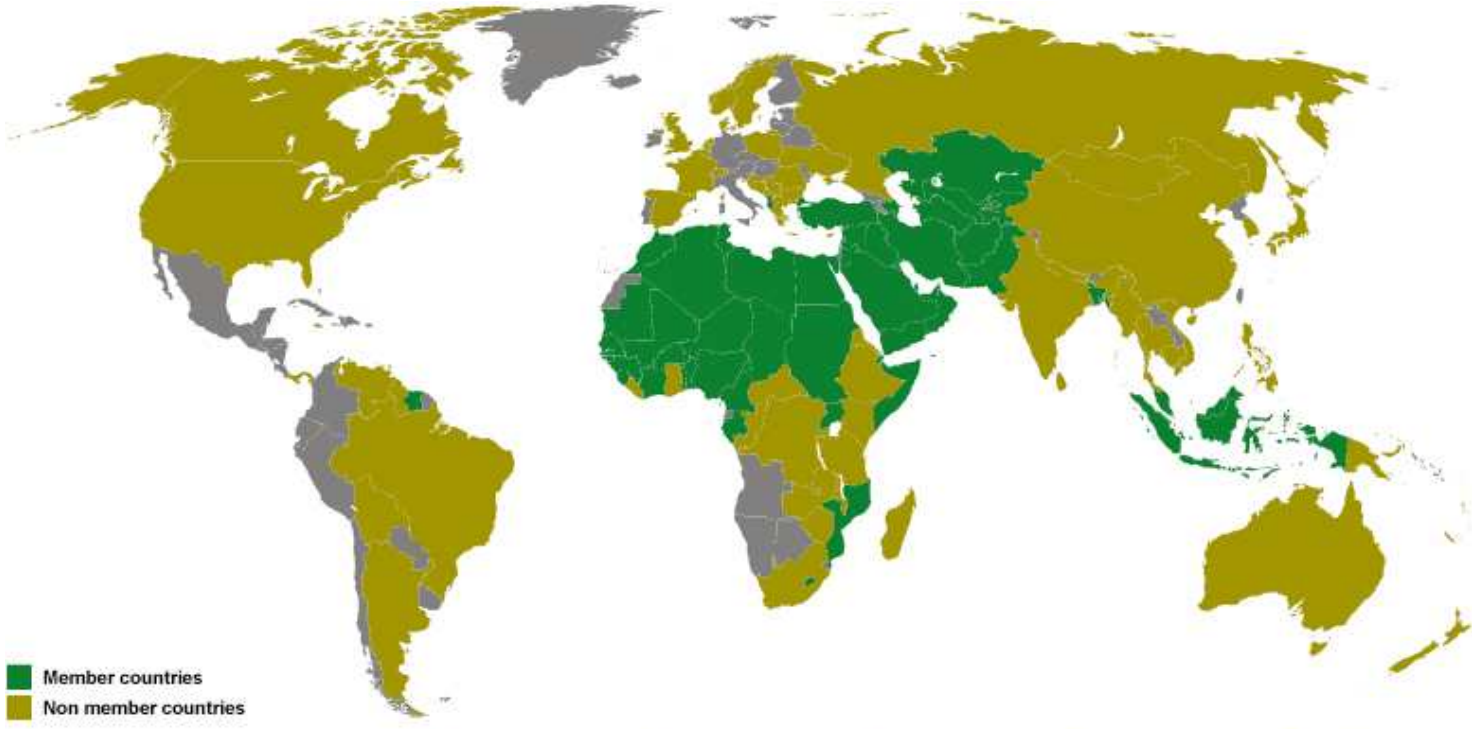
Which are the main governance characteristics of the Member countries of the Islamic Development Bank that might affect the STI performance?



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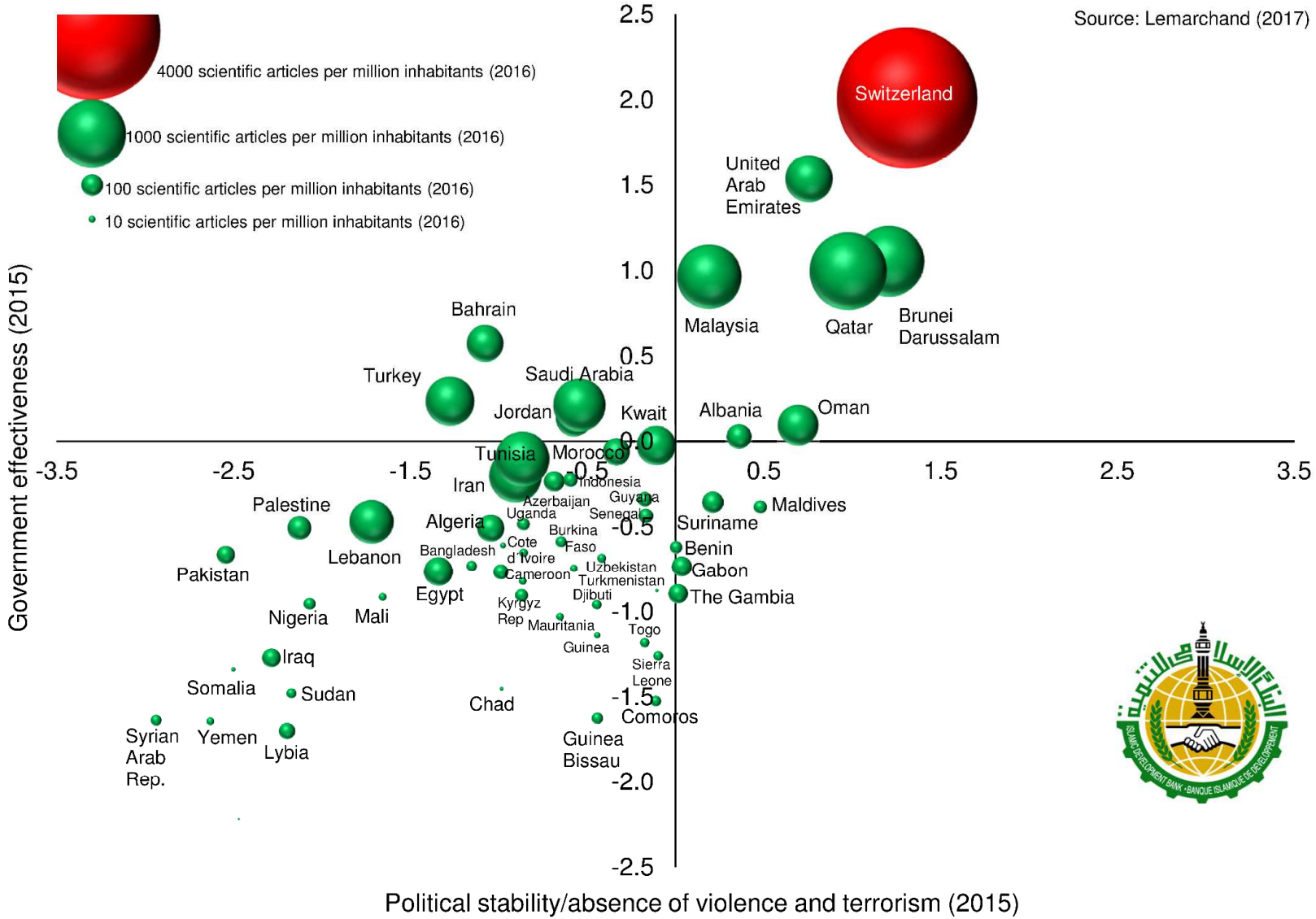

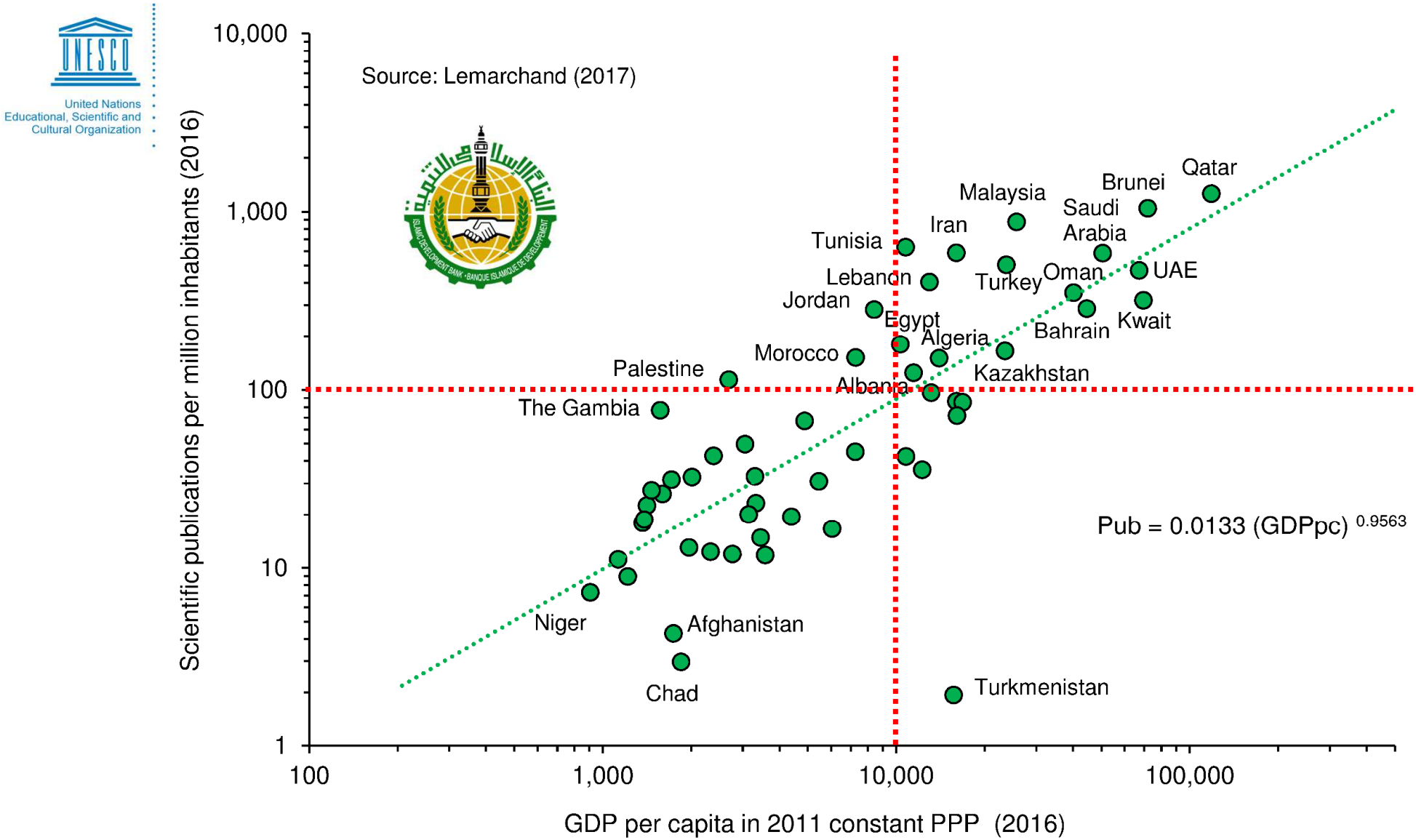
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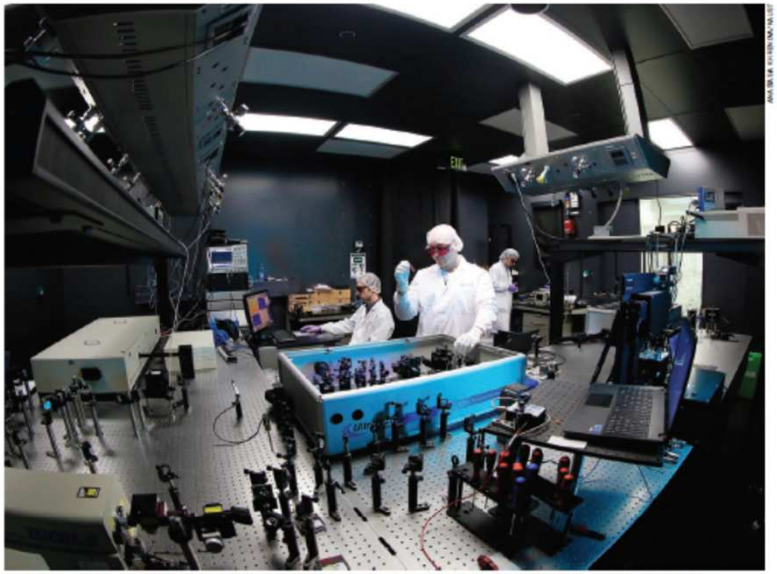
Educational, Scientific and
Cultural Organization
Source: Lemarchand (2017)
Scientific publications per million inhabitants (2016)
GDP per capita in 2011 constant PPP (2016)
10,000
1,000
100
10
1
100
1,000
10,000
100,000
Pub = 0.0133 (GDPpc) 0.9563
Qatar
Brunei
Malaysia
Saudi Arabia
Iran
Tunisia
Lebanon
Turkey
Oman
UAE
Jordan
Egypt
Kwait
Bahrain
Algeria
Morocco
Palestine
Kazakhstan
Albania
The Gambia
Niger
Afghanistan
Chad
Turkmenistan



The Solar & Photovoltaics Engineering Research Center at KAUST is among the university's many endeavours aimed at finding alternative energy sources.

MAKING THE MOST OF FINANCIAL MIGHT

In a troubled region, Saudi Arabia is capitalizing on its relative stability and resource wealth.

BY PAKINAM AMER

In a region marred by ongoing conflict, few nations in the Middle East have the financial and political capacity to prioritize expanding the frontiers of science, however, Saudi Arabia is tapping into its large stream of oil revenue to fund a research revival with the aim of becoming a regional science leader.

Over the past decade, the Saudi Arabian research environment has changed dramatically, not just in terms of greater funding, but in the way research is conducted. The Kingdom has built state-of-the-art research institutes, forged relationships with renowned foreign institutions and developed a visionary science strategy that extends into 2030.

This vision is now starting to bear fruit. Saudi Arabia had the fastest growth in weighted fractional count (WFC) output in the Middle East, surpassing all the region's other countries. Since 2012, its WFC has more than doubled, from 46 to 99 by 2015.

AN ARAB LEADER

The oil-rich Kingdom is not facing very robust competition from its Arab states neighbours. In the United Arab Emirates (UAE) and Qatar, research is indeed growing and branches of well-established Western universities are setting up, but the UAE's position is a very distant second with a WFC of 12.

Though Egypt has been the regional leader in scientific research, its recent political turmoil has hampered growth in science. The region's former stronghold has experienced a decline in WFC and slipped behind the UAE to third in the Arab world with a WFC of 9 in 2015.

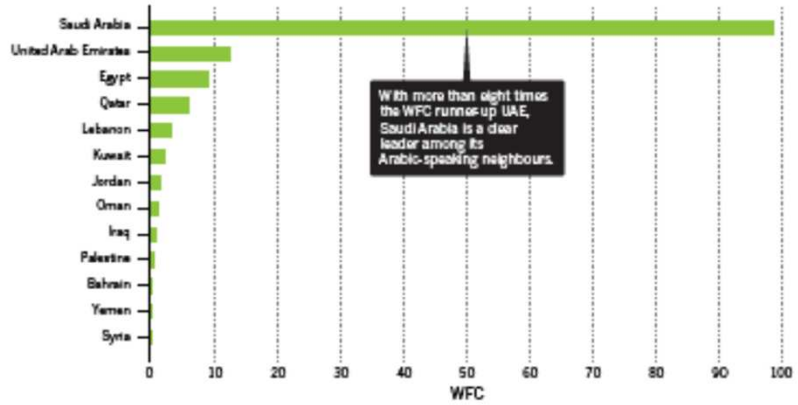
Even new high-calibre institutions like Zewail City of Science and Technology, and established powerhouses like Cairo University have not been able to keep up with the plethora of research opportunities, grants and partnerships in Saudi Arabia.

"We've set 25-year goals to create a regional and international impact in research."

Elsewhere in the Arab world, conflict thwarted opportunities for countries to sponsor scientific endeavours, with many losing the infrastructure, funding and expertise required to build research

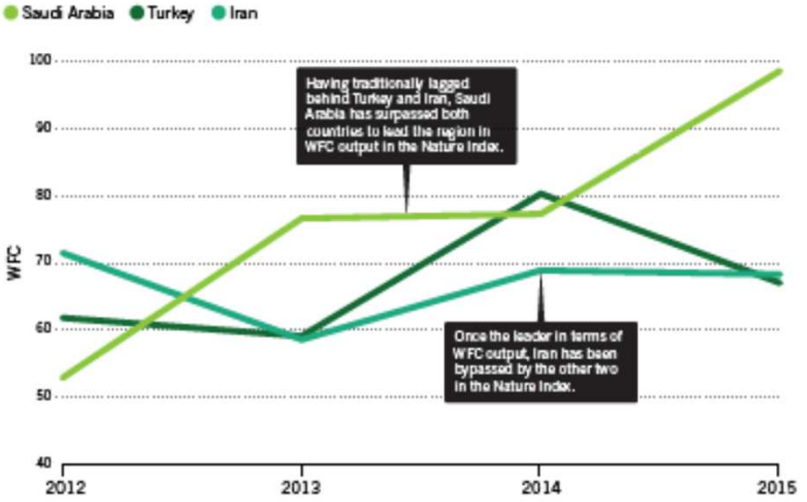
ARAB WORLD IN THE NATURE INDEX

This bar chart shows the 2015 overall output (WFC) of Saudi Arabia and its Arabic-speaking neighbours on and around the Arabian peninsula.



RISE AND FALL OF REGIONAL POWERHOUSES

The traditional regional stalwarts of science, Iran, Turkey and Saudi Arabia have seen a shift in their relative positions in the Nature Index over the years. Below is a timeline of their WFC output since 2012.



Source: Nature Index 2016

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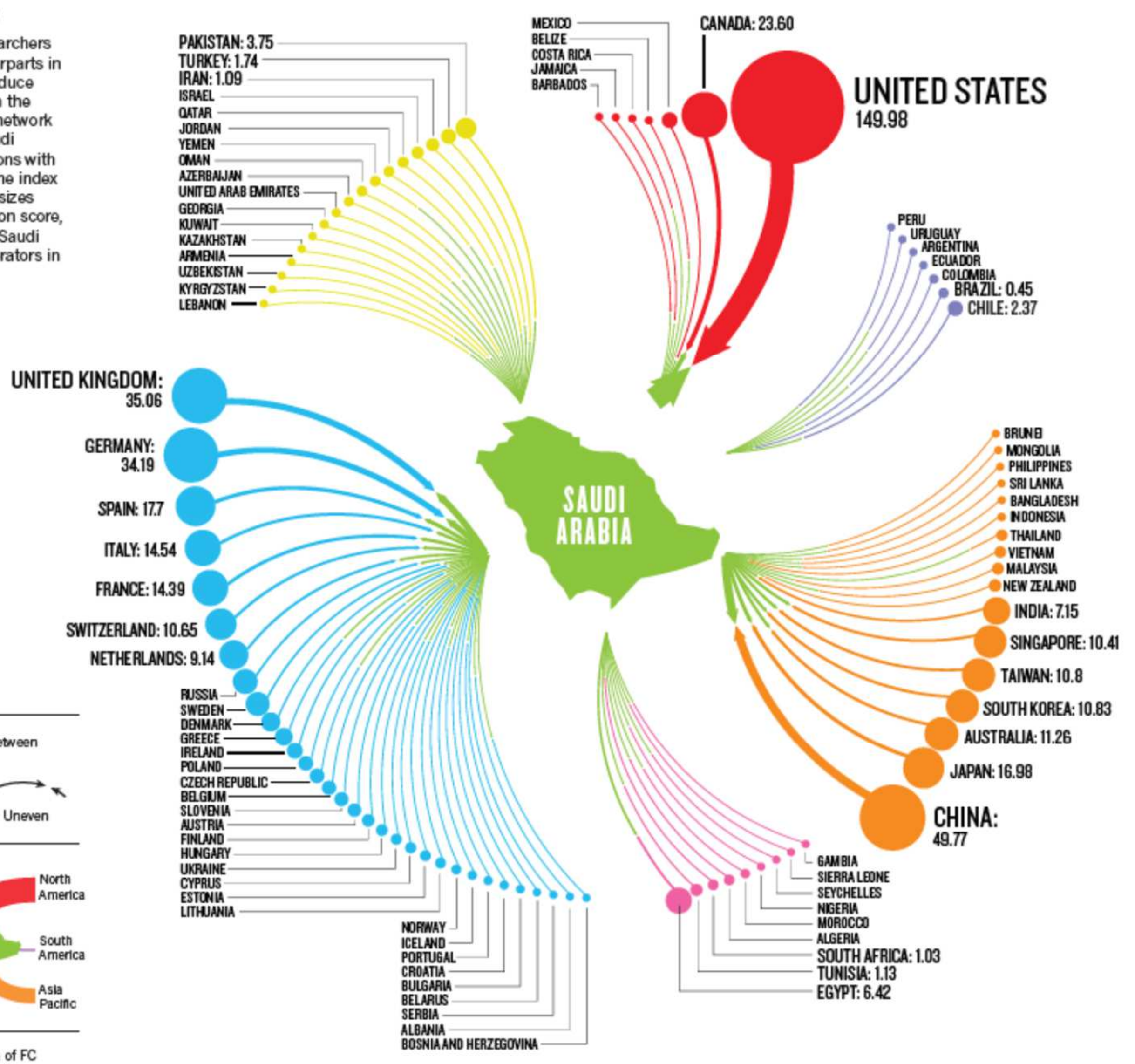
INTERNATIONAL COLLABORATIONS

In 2015 Saudi researchers worked with counterparts in 89 countries to produce research counted in the Nature Index. This network diagram shows Saudi Arabia's collaborations with other countries in the index in 2015. The circle sizes relate to collaboration score, which is shown for Saudi Arabia's top collaborators in each region.

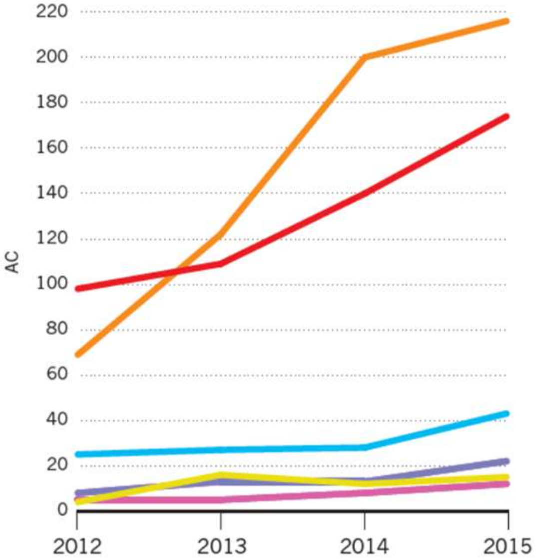


SAUDI ARABIA
UNITED STATES 149.98
CANADA: 23.60
MEXICO
BELIZE
COSTA RICA
JAMAICA
BARBADOS
PERU
URUGUAY
ARGENTINA
ECUADOR
COLOMBIA
BRAZIL: 0.45
CHILE: 2.37
PAKISTAN: 3.75
TURKEY: 1.74
IRAN: 1.09
ISRAEL
QATAR
JORDAN
YEMEN
OMAN
AZERBAIJAN
UNITED ARAB EMIRATES
GEORGIA
KUWAIT
KAZAKHSTAN
ARMENIA
UZBEKISTAN
KYRGYZSTAN
LEBANON
UNITED KINGDOM: 35.06
GERMANY: 34.19
SPAIN: 17.7
ITALY: 14.54
FRANCE: 14.39
SWITZERLAND: 10.65
NETHERLANDS: 9.14
RUSSIA
SWEDEN
DENMARK
GREECE
IRELAND
POLAND
CZECH REPUBLIC
BELGIUM
SLOVENIA
AUSTRIA
FINLAND
HUNGARY
UKRAINE
CYPRUS
ESTONIA
LITHUANIA
NORWAY
ICELAND
PORTUGAL
CROATIA
BULGARIA
BELARUS
SERBIA
ALBANIA
BOSNIA AND HERZEGOVINA
BRUNEI
MONGOLIA
PHILIPPINES
SRI LANKA
BANGLADESH
INDONESIA
THAILAND
VIETNAM
MALAYSIA
NEW ZEALAND
INDIA: 7.15
SINGAPORE: 10.41
TAIWAN: 10.8
SOUTH KOREA: 10.83
AUSTRALIA: 11.26
JAPAN: 16.98
CHINA: 49.77
GAMBIA
SIERRA LEONE
SEYCHELLES
NIGERIA
MOROCCO
ALGERIA
SOUTH AFRICA: 1.03
TUNISIA: 1.13
EGYPT: 6.42

OUTPUT

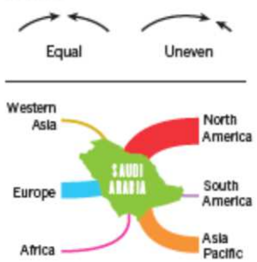
The AC of Saudi Arabia has risen quickly over the past four years, driven by strong international collaborations.

A country or institution's AC is the number of articles in the index that have at least one author from that country or institution.



LEGEND

Contribution balance between countries



CS is based on the sum of FC resulting from collaborative papers between Saudi Arabia and its partner country.

Source: Nature Index 2016

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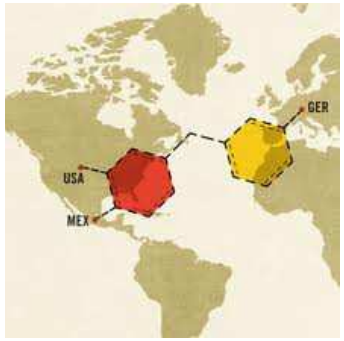
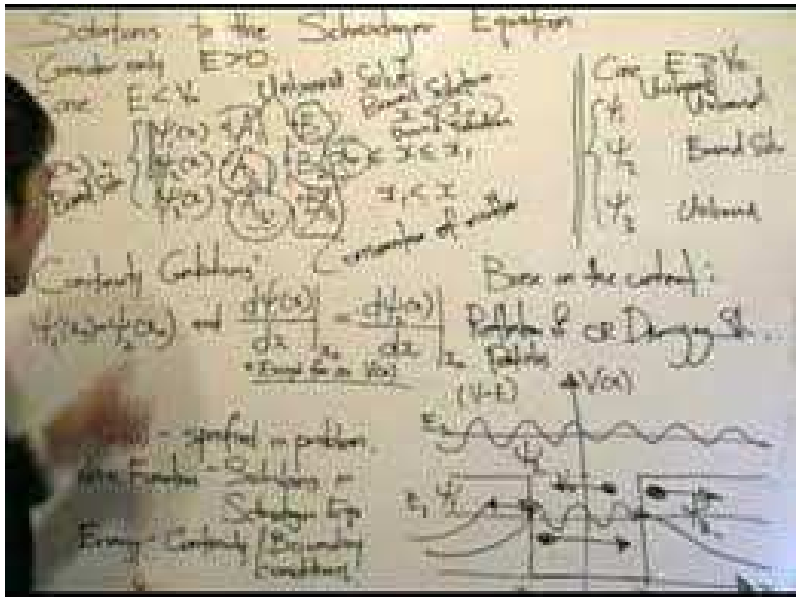


More on context:



What are *implicit* policies? … and How we measure them?

National contextual policies that *implicitly* affect the performance of STI policies

Institutional Factors	United States	Japan	Germany
Founding conditions	➢Diversity ➢Abundant resources ➢Huge domestic market ➢Puritanism ➢Market competition	➢Homogeneity ➢Tokugawa Era (1603-1868) ➢ ---------- ➢Confucianism ➢Strong government	➢ ---------- ➢Early industrialization ➢Financing through banks ➢Cartelization ➢Worker participation
Role of the government	➢Encourage market competition ➢Low industrial policy	➢Encourage agreement ➢High industrial policy	➢Encourage stability ➢Direct industrial policy
Legal system	➢Common law ➢Transparent ➢Flexible ➢Adversarial litigation	➢Civil law ➢Guiding ➢Flexible ➢Conciliatory litigation	➢Civil law ➢Transparent ➢Inflexible ➢----------
Capital Market	➢Market for control of ownership ➢Highly developed	➢Market for stability of ownership ➢Moderately developed	➢Market for stability of ownership ➢Moderately developed
Education System	➢Decentralized ➢Diverse	➢Centralized ➢Homogeneous	➢Centralized ➢Vocational system
Culture	➢Individualism ➢Heterogeneous	➢Collectivism ➢Homogeneous	➢Moderate collectivism ➢Homogeneous
Governance system	➢Strong institutional holdings ➢Shareholder oriented ➢One-board system	➢Cross holdings among firms ➢Stakeholder oriented ➢One-board system	➢Bank holdings ➢Stakeholder oriented ➢Dual-board system
Strategic paradigm	➢Short-term oriented ➢External growth ➢High managerial autonomy	➢Long-term oriented ➢Incremental growth ➢Low managerial autonomy	➢Long-term oriented ➢Internal growth ➢Moderate managerial autonomy
Employment relationship	➢Employment-at-will ➢Non-participative ➢Performance and market-based ➢Largest gap between top and bottom	➢Lifetime employment ➢Participative ➢Seniority-based ➢Smallest gap between top and bottom	➢Long-term employment ➢Participative ➢Performance and seniority-based ➢Moderate gap between top and bottom

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- An analysis of the STI implicit policies in general laws (on industrialization, mining, foreign investment, education, etc.) should uncover the main implications or side effects for science, technology and innovation functions and activities.
- The first step would be to identify those policies oriented to areas *other* than STI that could have an important impact on them. For this there is a need for a certain understanding of the way the STI system functions in the country, through an examination of its place in relation to the economic, social, and educational systems.

STI implicit policies

(a) Economy (primarily directed to the functioning of the economic system): finance (credit, interest rates), fiscal (taxation, exchange rates, exchange control); internal trade (tariff and nontariff barriers); domestic trade (prices, marketing, government-procurement); wages and labour compensation policies; foreign investment, compensation and nationalization; economic development policies; specific industrial policies; legal and general instruments; policies designed to foster regional development.

(b) Manufacture sector: description of the industrial policies and incentives to promote big, medium, small and micro enterprises. Provide UNESCO all the information related with industrial surveys and the policies to relate the productive sector with research.

(c) Human Resources: education system (literacy, primary, secondary, vocational, etc.); higher education policies (universities, training institutes, management training, post-doctoral training); fellowship policies; industrial training and retraining, technician training; policies for the use of foreign personnel; policies toward emigration of professionals, policies or repatriation and networking with skilled manpower (brain-drain vs. brain-gain policies); policies for the promotion of human resources; salary structures and awards; mobility.

(d) Cultural: mechanisms which modify general value structures, attitudes, norms, etc., including the position of women (gender equality policies); policies fostering a knowledge society; social appropriation of science (popularization of STI activities; science museums; science contests or Science Olympiads among the youth, etc.); policies modifying the structure of mechanisms and procedures conferring status and prestige, etc.

(e) Sustainability policies: policies for the exploitation and preservation of natural resources; policies on environmental control, pollution; policies to promote green societies; policies to promote green production of goods and services; policies to promote green consumption patterns.

(f) Demographic and social: health care; mortality rates; population control; income policies, distribution of income; policies increasing social mobility.

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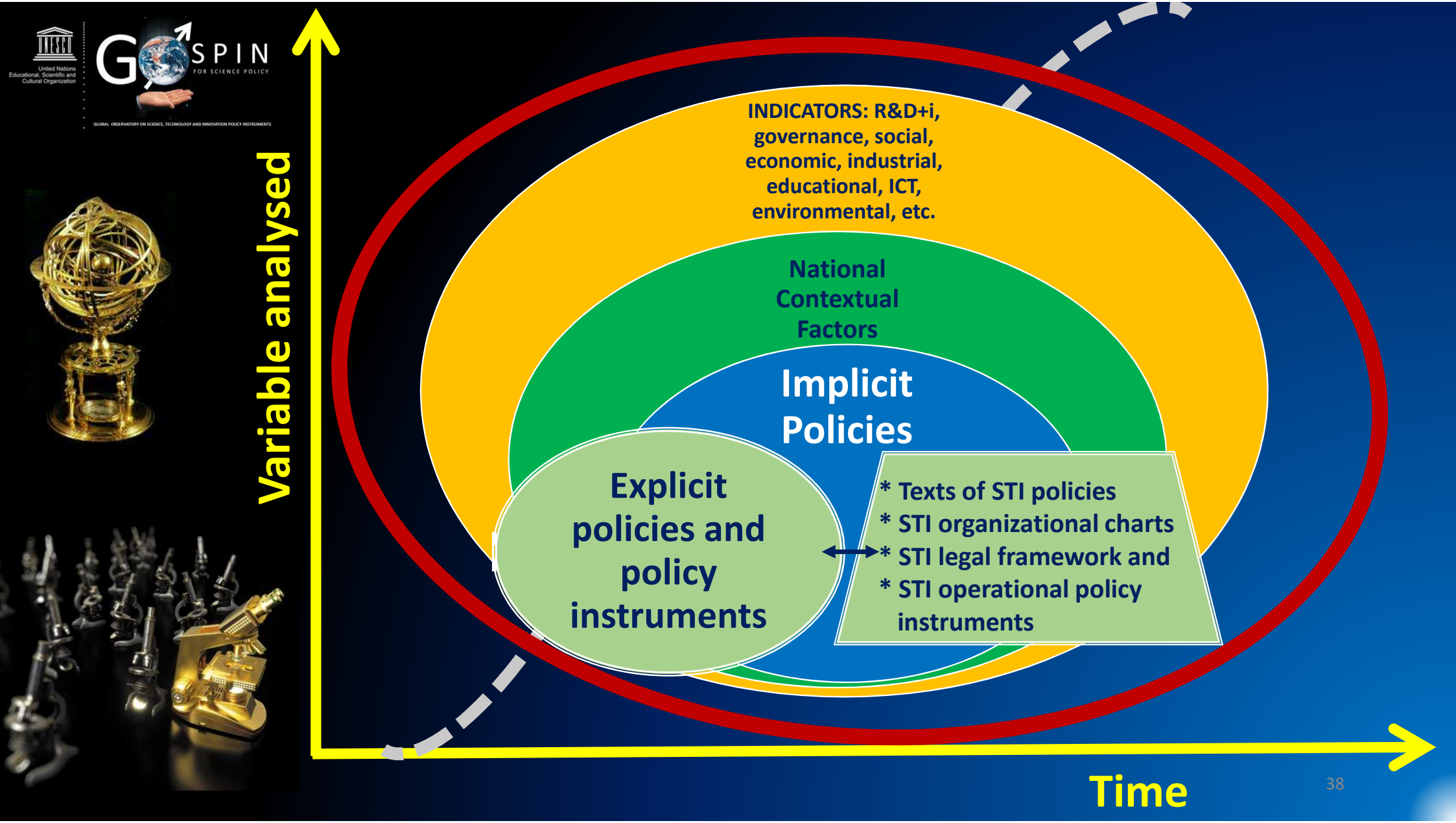
Characteristics of Government economic policies	Implicit impact within STI activities
Credit policies biased toward capital equipment, particularly when foreign aid and credit are involved	Capital-intensive technologies are preferred over capital saving or labour-using technologies.
Fiscal incentives geared toward promoting additional capital investments (tax credits, tax exemptions, etc.)	Investment in equipment becomes more attractive that investment in working capital to enlarge labour force
Social policies that make labour expensive (social security, unemployment funds, medical benefits, etc.)	Demand for capital equipment, machinery and even intermediate products is oriented outward, particularly to developed countries
Overvaluation of exchange rates (making imports cheaper)	Importing foreign machinery and equipment becomes attractive
Gross inequalities in the distribution of income	Industrial activities are oriented toward producing goods for a small segment of the population with high income. Technologies are geared to producing a large variety of goods for this population segment and import for this purpose.
Conservationism of local entrepreneurs	Distrust for local STI capabilities, preference for well known and proved technologies (generally foreign). Risk capital for new and advanced technologies are not available.
Protectionism, oligopolies, myopic price controls	Entrepreneurs have no real incentives to reduce costs and operate more efficiently, hence there is little demand for local research and innovation activities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GO SPIN
FOR SCIENCE POLICY
GLOBAL OBSERVATORY ON SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS
Variable analysed
INDICATORS: R&D+i, governance, social, economic, industrial, educational, ICT, environmental, etc.
National Contextual Factors
Implicit Policies
Explicit policies and policy instruments
* Texts of STI policies
* STI organizational charts
* STI legal framework and
* STI operational policy instruments
Time

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Time for questions

First run

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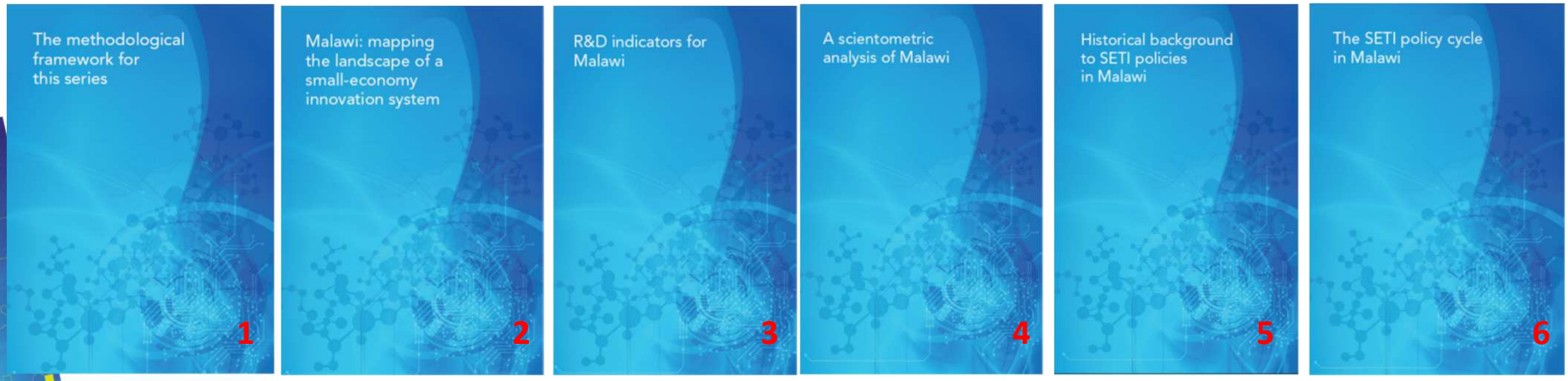
GO→SPIN
FOR SCIENCE POLICY
GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS

Contents of UNESCO's GO→SPIN Country Profile series



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GO SPIN FOR SCIENCE POLICY
GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS

Contents of UNESCO's GO→SPIN Country Profile series

1. A long-term description of the political, economic, social, cultural and educational contextual factors;
2. Analysis of gender in science and engineering national behaviour
3. A study of R&D and innovation indicators;
4. A long-term scientometric analysis of scientific publications, patents, trademarks and utility models;
5. Historical analysis of STI policies and institutions;
6. A standard content analysis of the explicit STI policies, including those research and innovation policies implemented in other sectors, such as the agricultural, energy, health, industrial and mining sectors;
7. A description of the STI policy cycle;
8. A complete analysis of the STI organizational chart at five different levels (policy-making level; promotion level; research and innovation execution level; scientific and technological services level and evaluation level);
9. An inventory of all the STI government bodies and organizations related both to research and innovation and to science and technology services;
10. An inventory of the STI legal framework, including acts, bills, regulations and international agreements on STI issues;
11. A standard inventory with 18 different analytic dimensions of all the SETI operational policy instruments in place;
12. A SWOT analysis of the country's research and innovation landscape.

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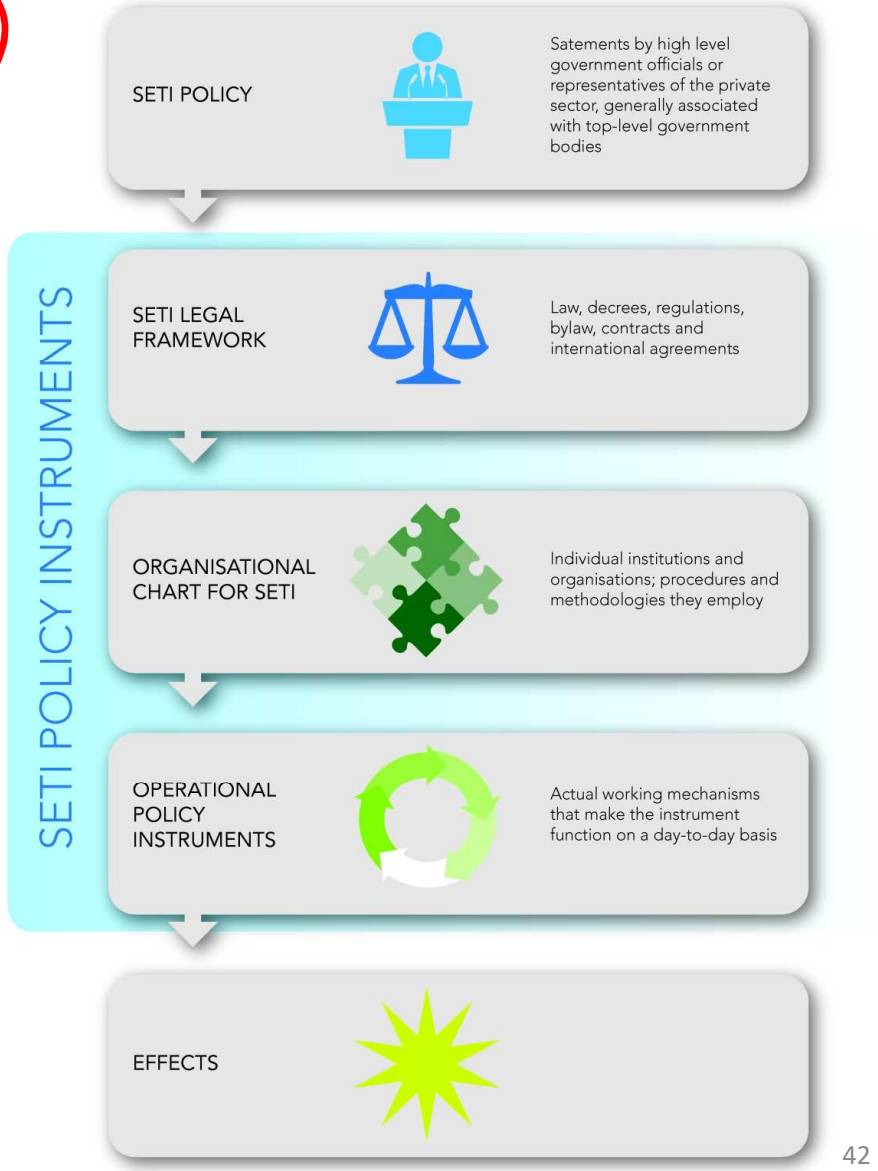
GO SPIN
FOR SCIENCE POLICY

GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY
AND INNOVATION POLICY INSTRUMENTS

Explicit policies

The structure of GO→SPIN analytic units



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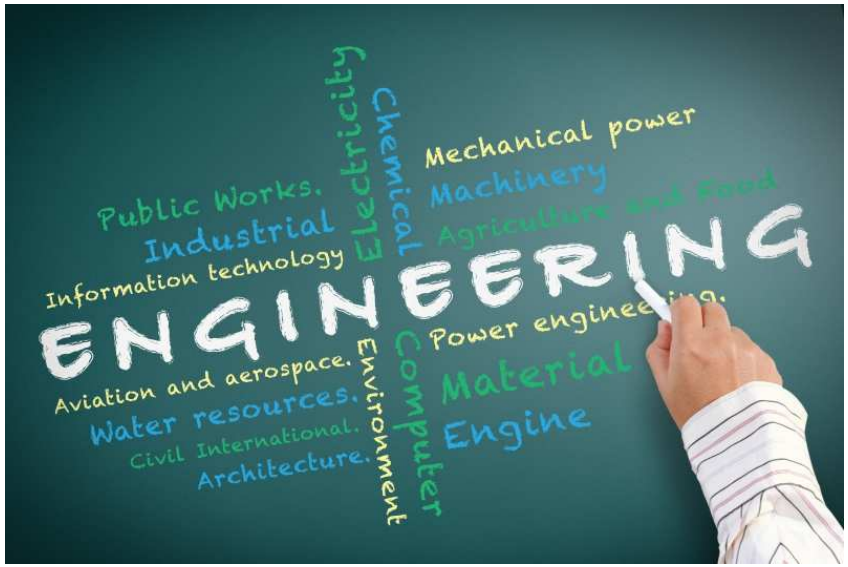
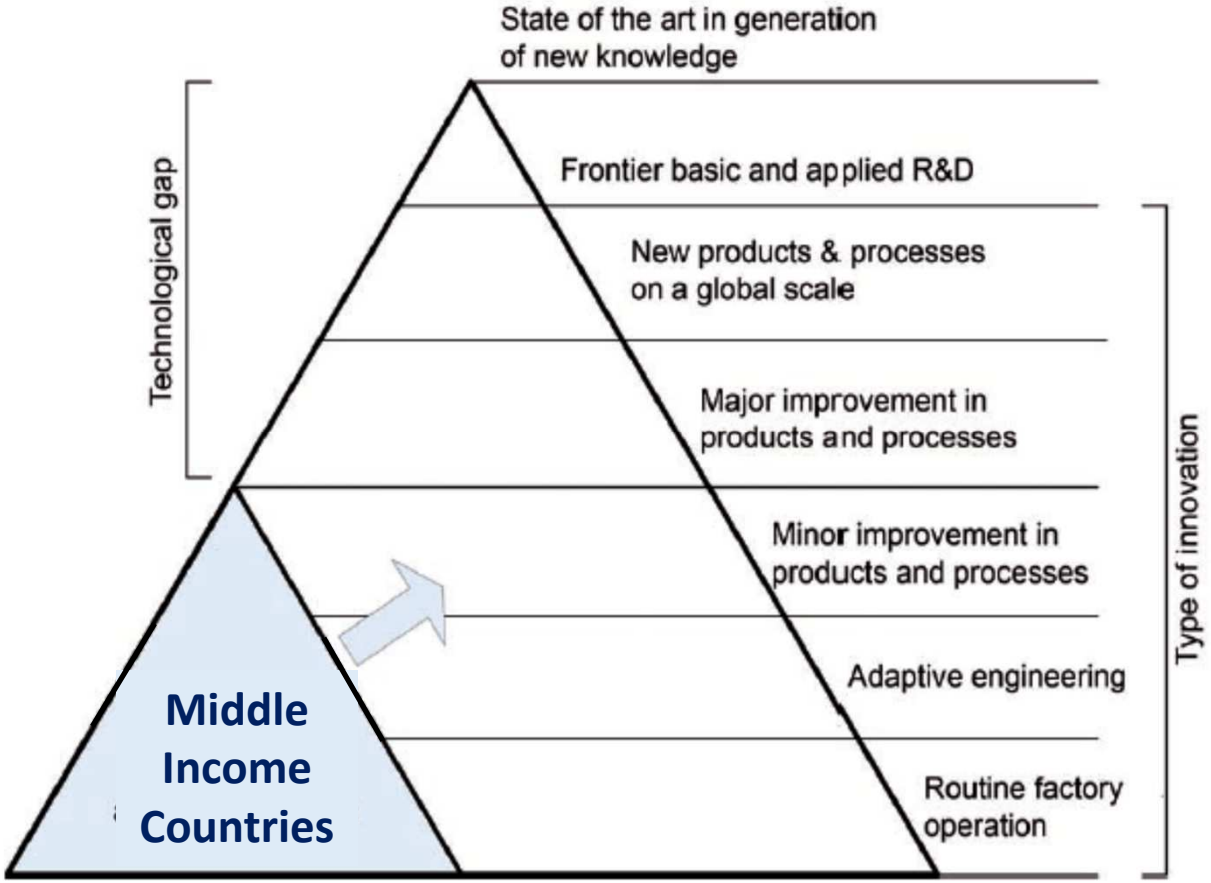
Technological gap according to the type of innovation and technological capacity: A need for specific engineering policies





Source: Lemarchand (2010)

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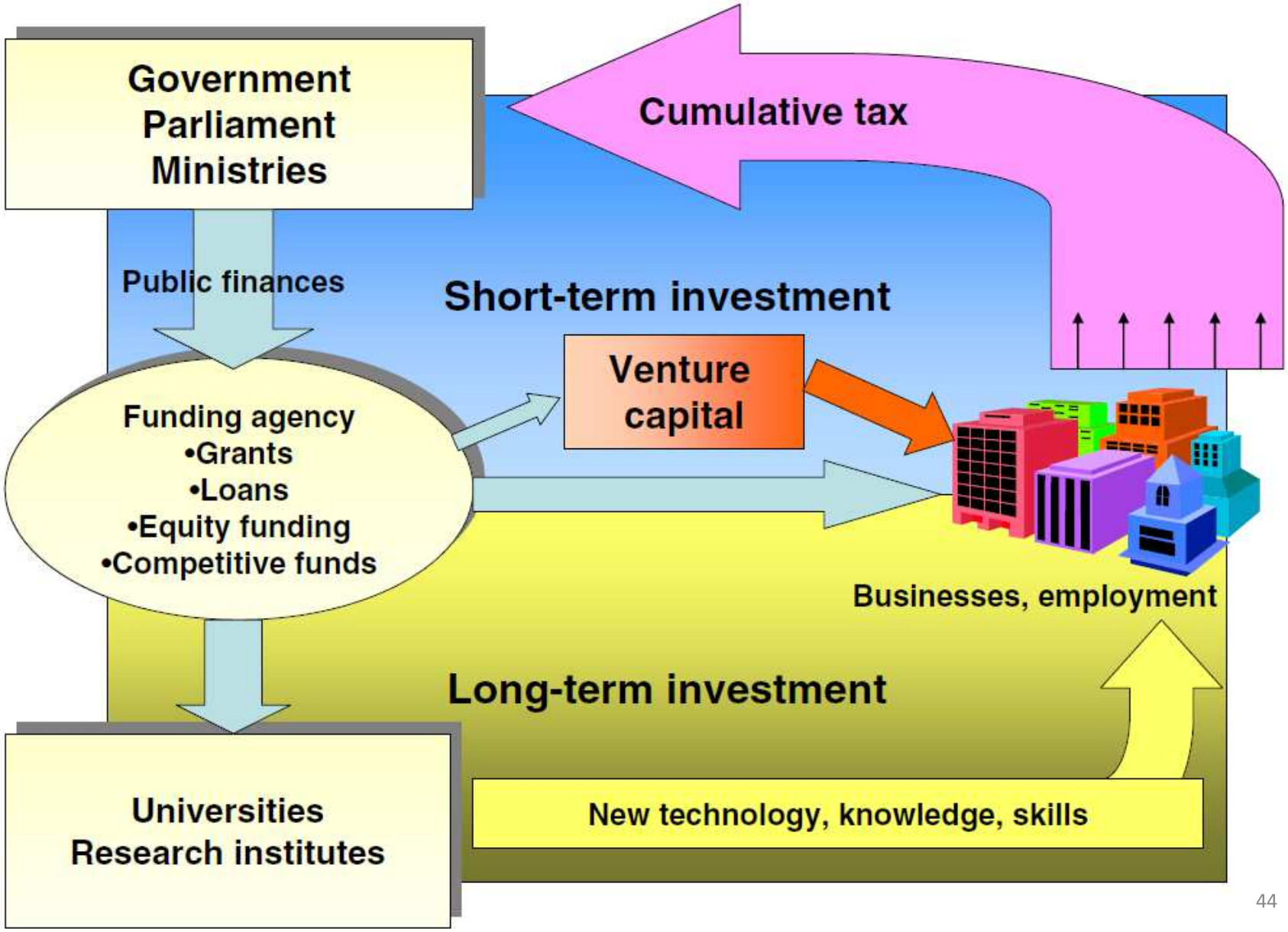

Source: UN ECLAC (2008)

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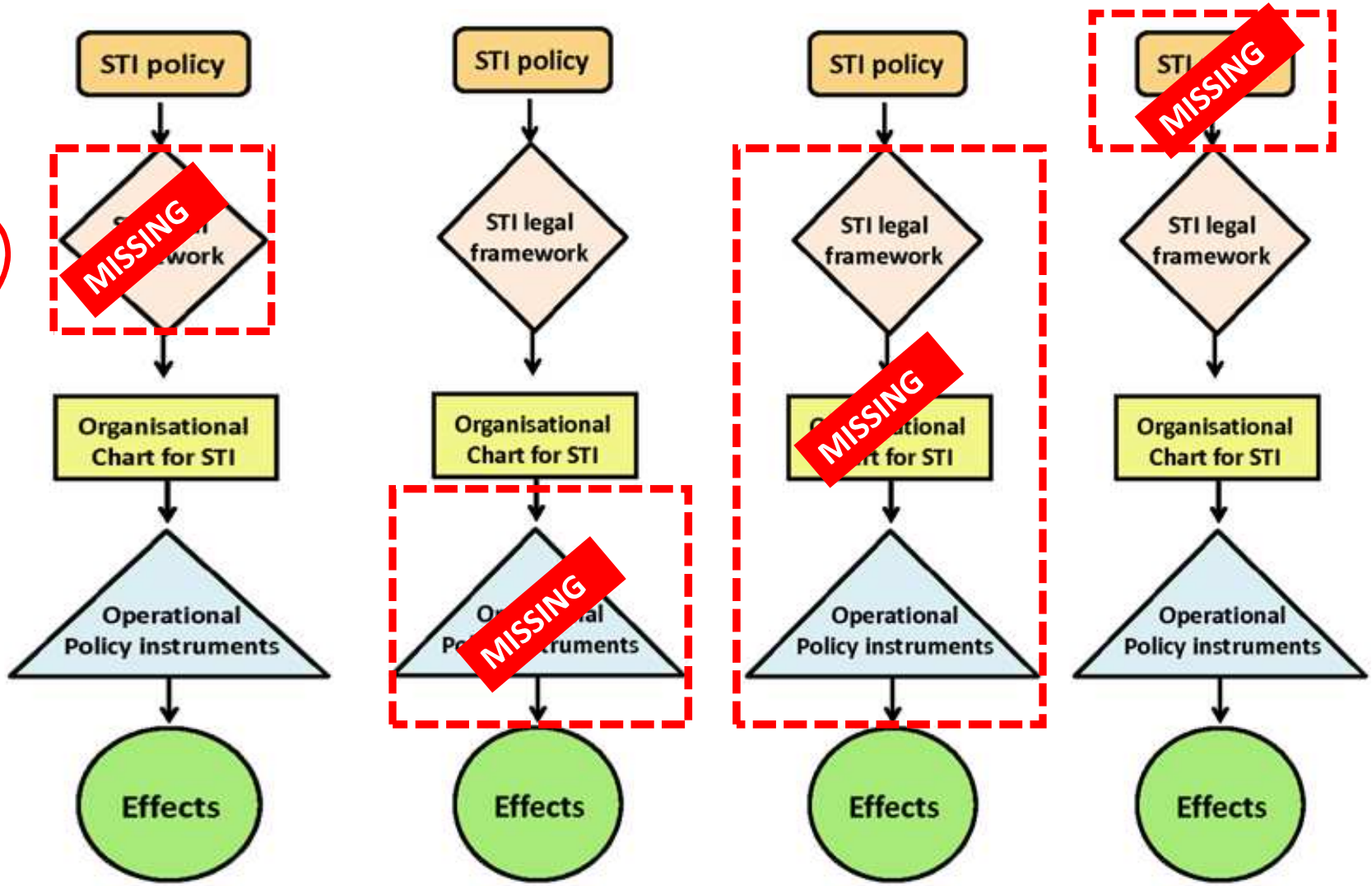
Pathologies of instruments: policy implementation failures

Explicit policies



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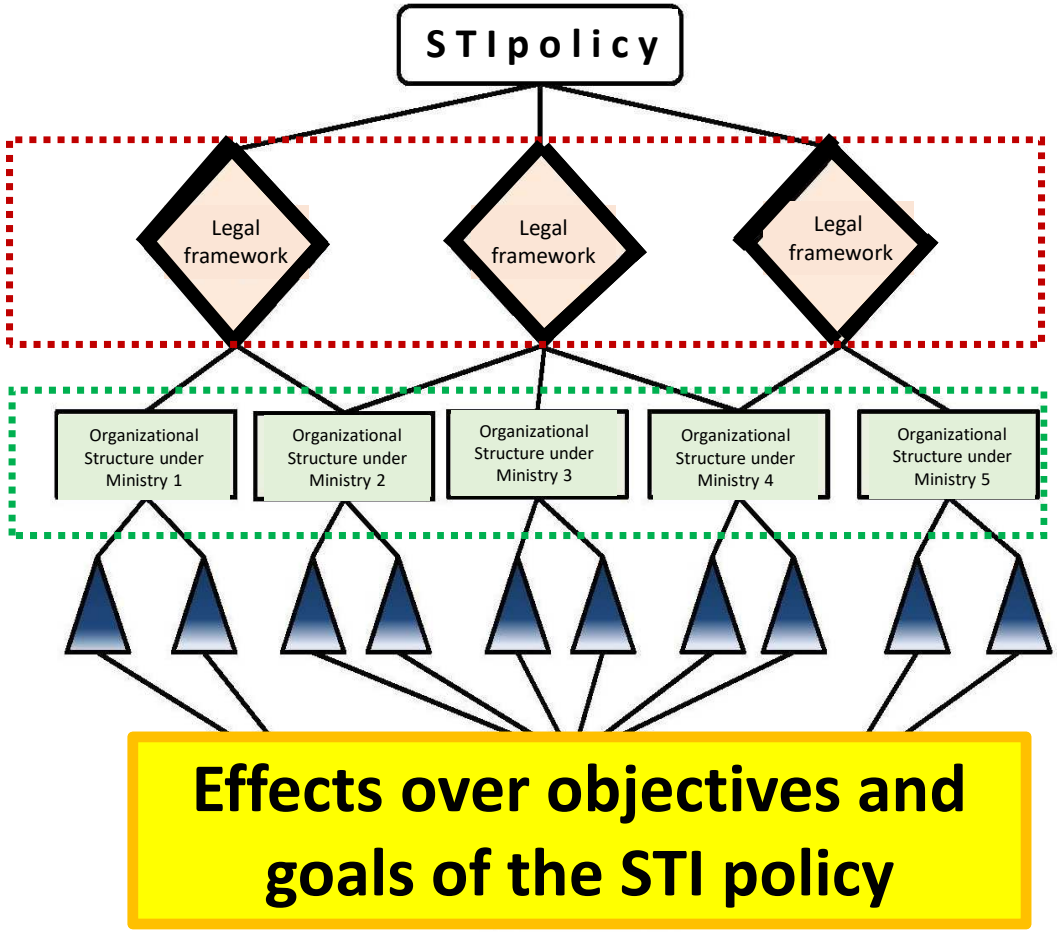
Golden Rule for the implementation of STI policies

Parliamentarian committee on science, technology and innovation

Inter ministerial cabinet for science, technology and innovation



Policy or National Multiannual Plan

Legal devices (for different sectors)

Organizational structures
(@ different national ministries)

Operational policy instruments
(organized in a coherent way to generate synergies in order to obtain a particular long-term effect)

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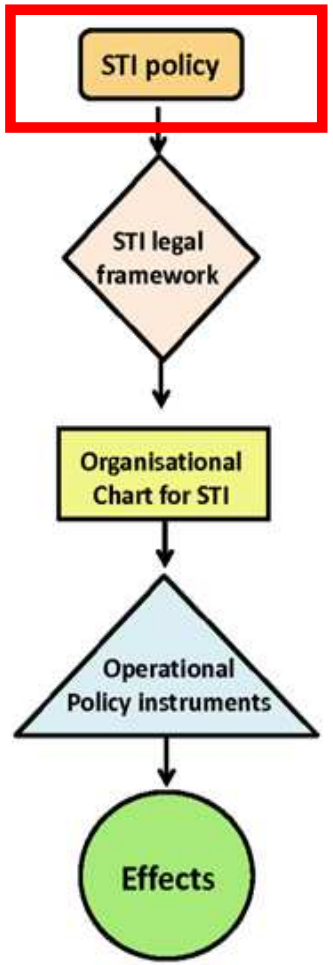
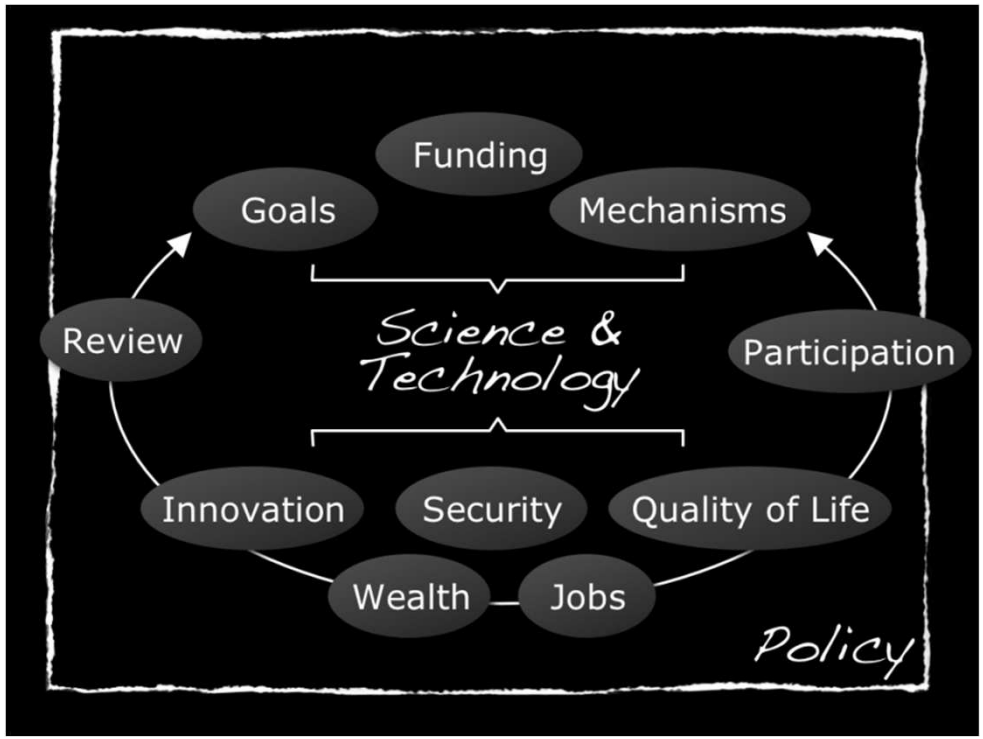
Analising the content of the STI "explicit" policies

DESIGNING STI POLICIES AND STI MULTIANNUAL NATIONAL PLANS





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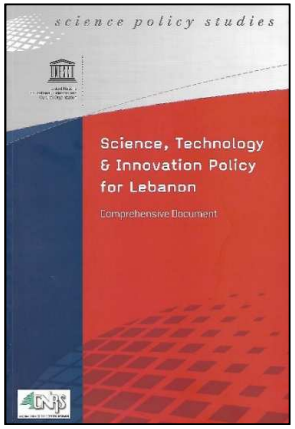
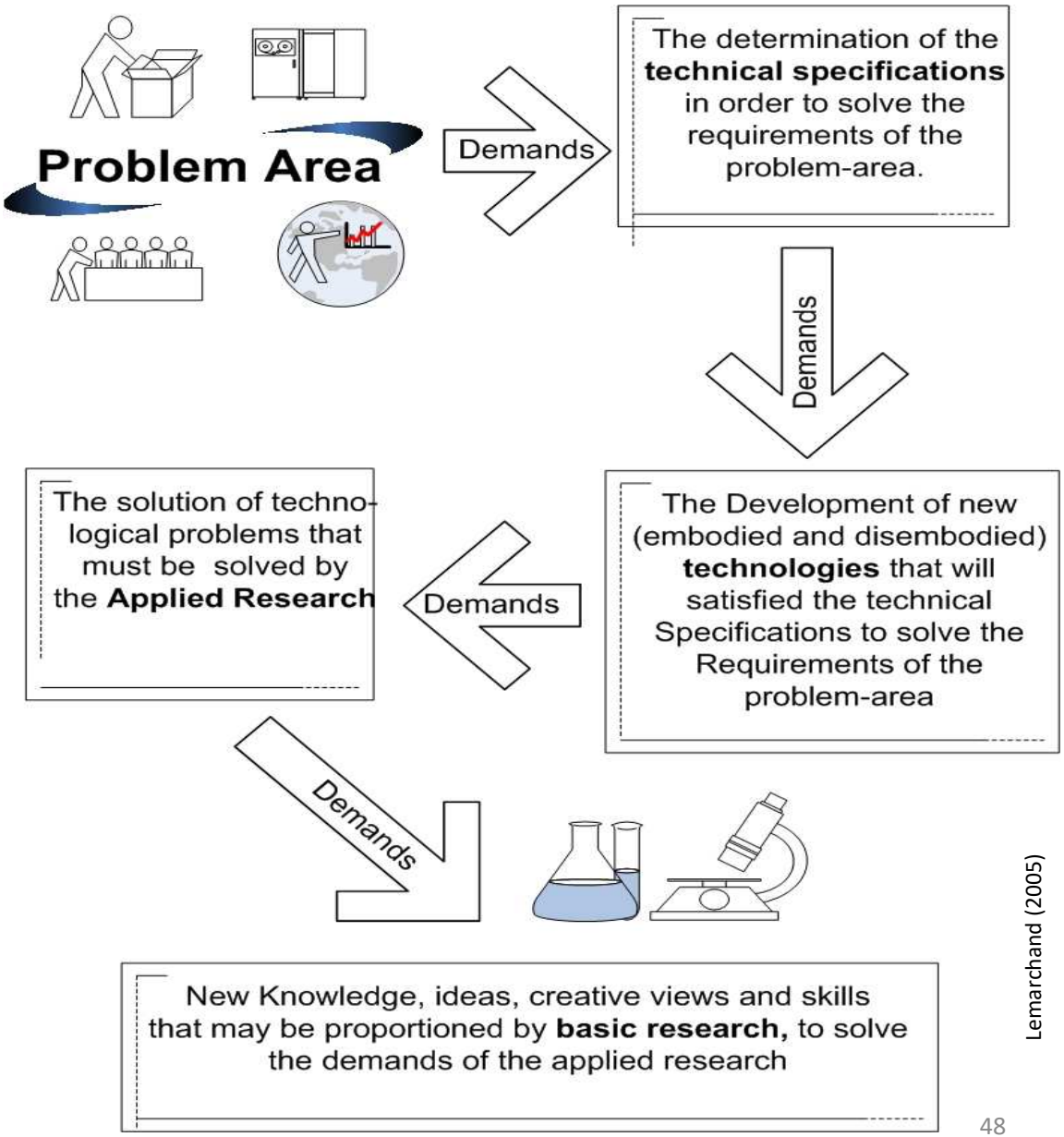
GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS



Priority setting mechanisms for STI policies

Focusing on societal demands



Lemarchand (2005)

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Content analysis of the “explicit” STI national policy (official docs)

1. Policy vision
2. Policy mission
3. Policy goals
4. Policy objectives
5. Priorities at the strategic level of the STI policy
6. Normative planning strategies of the policy
7. Policies related to the supply of STI
8. Policies related to demand for STI
9. Policies to foster networking between the STI supply and demand sides
10. Regional and international dimensions of STI policies
11. Monitoring, assessment, technological forecasting and prospective scenarios
12. STI policy start date
13. Timespan for STI policy planning
14. Link to the official document

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Ministry of Science and Technology goals to reach by Brazil's 2022 bicentennial

- Increase investments in R&D to 2% of gross domestic product, with more than half from private enterprise
- Double to 340 000 the number of scholarships awarded annually by the ministries of Science and Technology and Education
- Grow the research community to 450 000, or 2 researchers per 1000 inhabitants, up from the current 8 per 10 000
- Generate 5% of the world's production of scientific papers
- Triple the percentage of higher-education graduates in engineering to 15%
- Master the technologies of microelectronics, pharmaceutical production, nanotechnology, biotechnology, and a host of green technologies
- Increase by 10-fold the number of innovative companies, from 3% of industrial companies to 30%
- Increase by a factor of 10 or more the number of patents a year, to at least 4000
- Ensure independence in the production of nuclear fuel and reactor technologies
- Master the manufacturing technologies of satellites and launch vehicles

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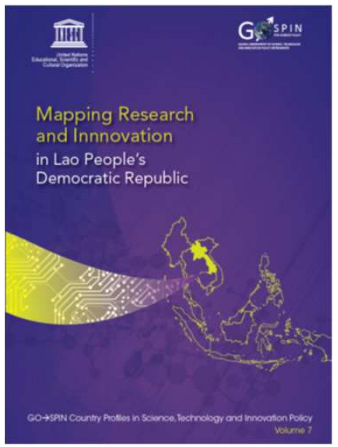

Priorities at the strategic level of the STI policy: (1) Establish and begin construction of a science and technology zone by 2018; (2) allocate budget for research projects related to promoting sustainable development that covers 25% of the annual research budget; (3) adopt and apply international technology that is suitable within the Lao context, to increase national productivity and competitiveness; (4) develop and expand basic infrastructure in the media industries and IT to become a hub for providing social media services and products.

Normative planning strategies of the policy: (1) Increase investment in research and development from 1% to 2% of public investment by 2020; (2) promote private investment in research and development to cover at least 30% of public investment by 2020; (3) train 11 researchers per 10 000 of the population by 2020.

Policies related to the supply of STI: (1) Improve and upgrade research institutes under the Ministry of Science and Technology so at least one institute is comparable with international standards by 2020; (2) support the development of researchers at universities across the country by allocating a budget to promote research work on at least 50 projects by 2020; (3) create a science magazine, promote research work and publish findings in science magazines and international magazines, in at least 250 articles by 2020.

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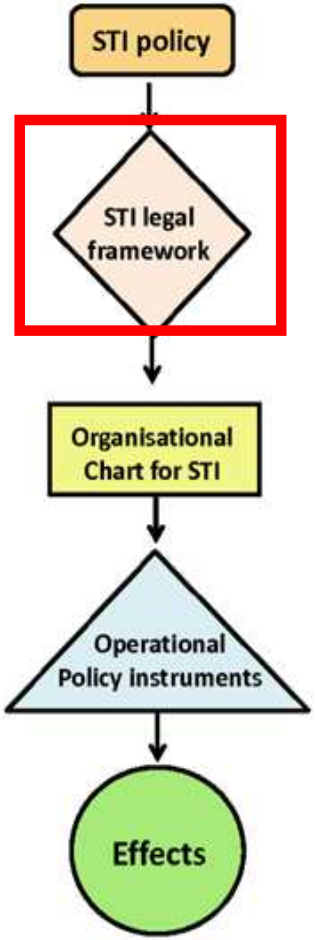
STI Legal Framework



The so-called “legal framework” might also be considered as a set of “legal instruments” or “legal devices.” This embodies the policy, or parts of it, in the form of a law, decree or regulation. Formal agreements, contracts and international STI cooperation treaties may also be included in this category. A legal device goes one step beyond a “policy” by stipulating obligations, rights, rewards and penalties connected with its being obeyed.

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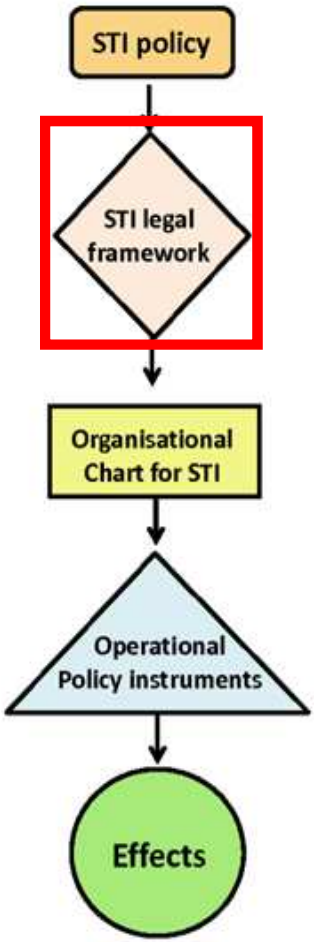

GO→SPIN Inventory of STI legal Framework

Complete inventory of:

1. **National laws and acts**
2. **National Decrees**
2. **National Regulations**
4. **International agreements**

All related to scientific research, technological development and productive innovation activities, including institutional organization, regulation of activities, capacity building, tax exemptions, etc. Each item should include a:

a. Title
b. Enactment date
c. Short description of the content
d. Access to full-text (electronic links if available)

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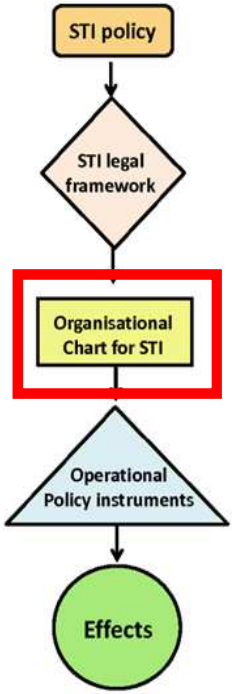
Mapping the stages of the STI policy cycle



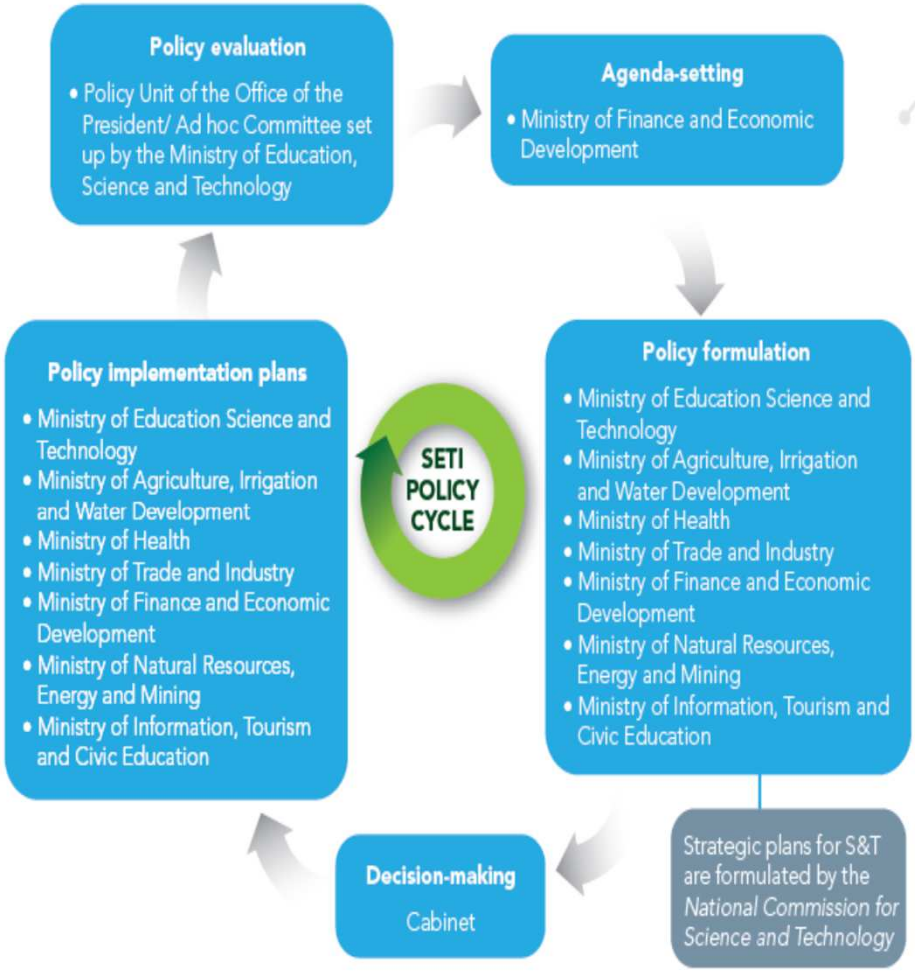


Figure 31: SETI policy cycle in Malawi, 2014. Source: UNESCO

(1) Agenda-Setting: refers to the process by which problems on STI and its relation to society and the economy come to the attention of the government.

(2) Policy Formulation: refers to the process by which STI policy options are formulated by the government.

(3) Decision-Making: refers to the process by which governments adopt a particular STI course of action or non-action.

(4) Policy Implementation: refers to the process by which governments put STI policies into effect.

(5) Policy Evaluation: refers to the process by which the impact of STI policies, are monitored by both State and societal actors, the result of which may be a re-conceptualization of policy problems and solutions.

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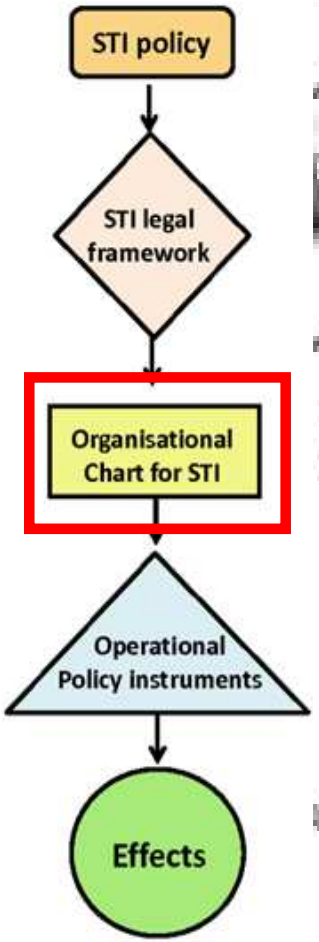

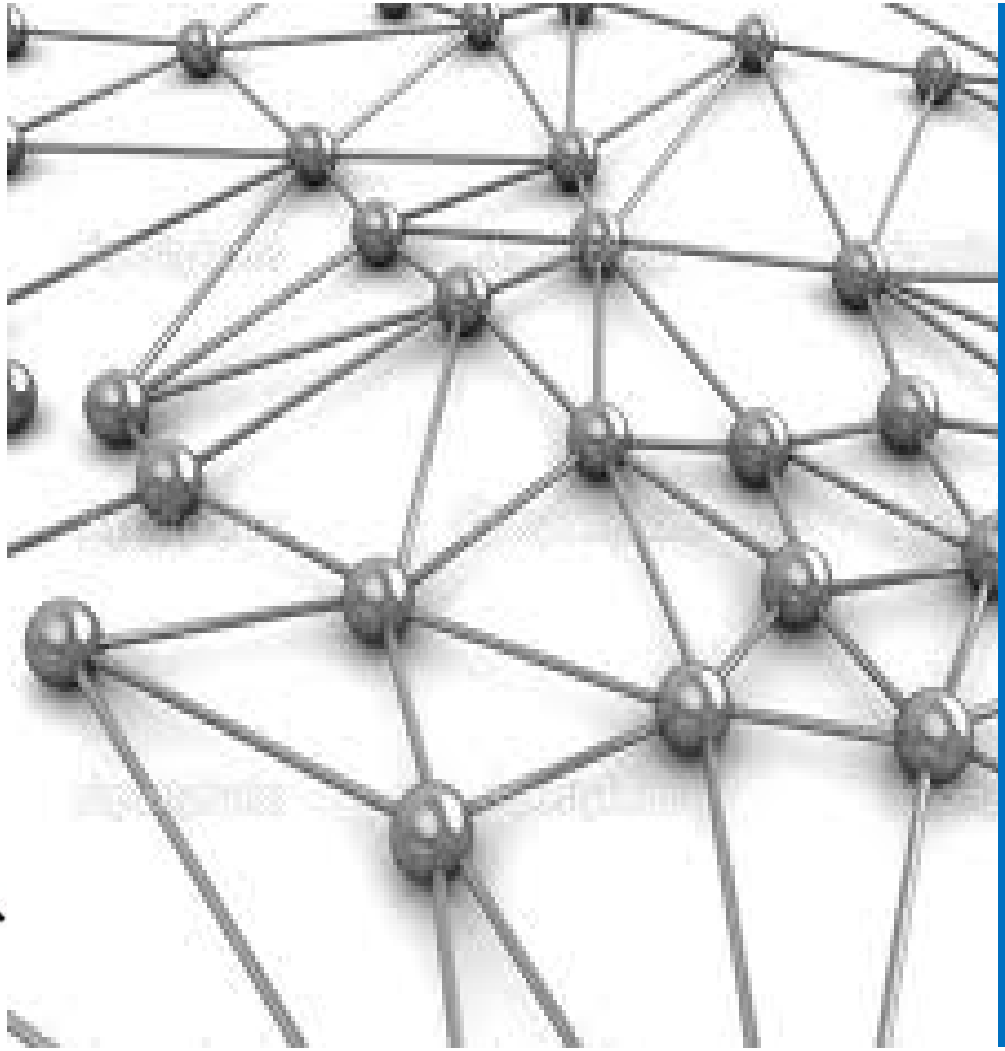

How robust is the STI organizational structure to effectively promote research and innovation for sustainable development in the long-run?

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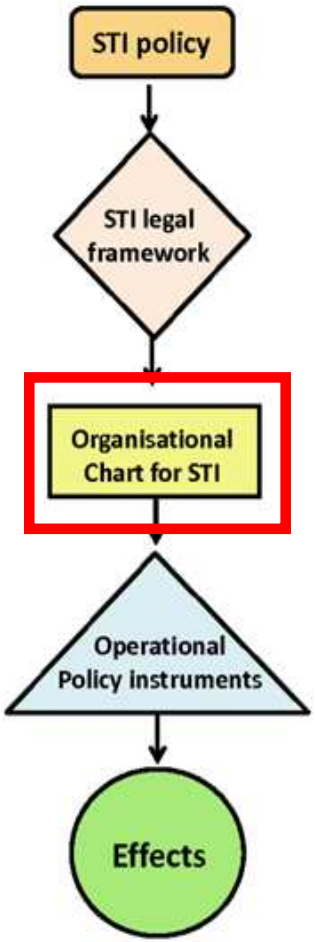
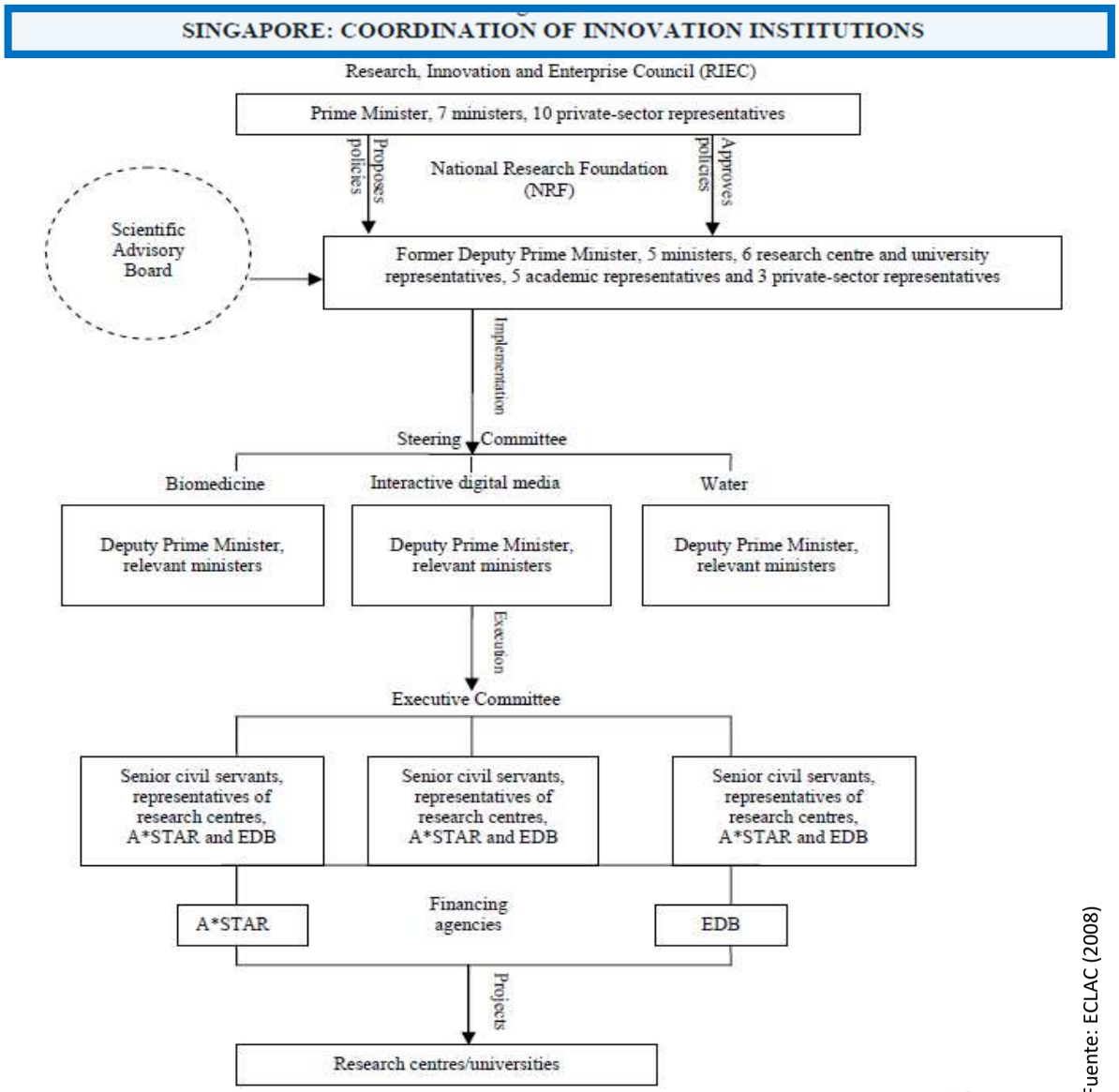


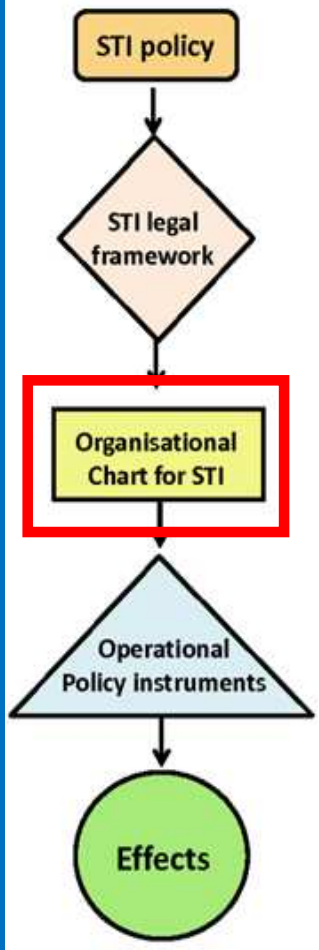
The importane of having a robust organiztion chart for the implementation of STI policies



Fuente: ECLAC (2008)

STI organizational structure

GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS



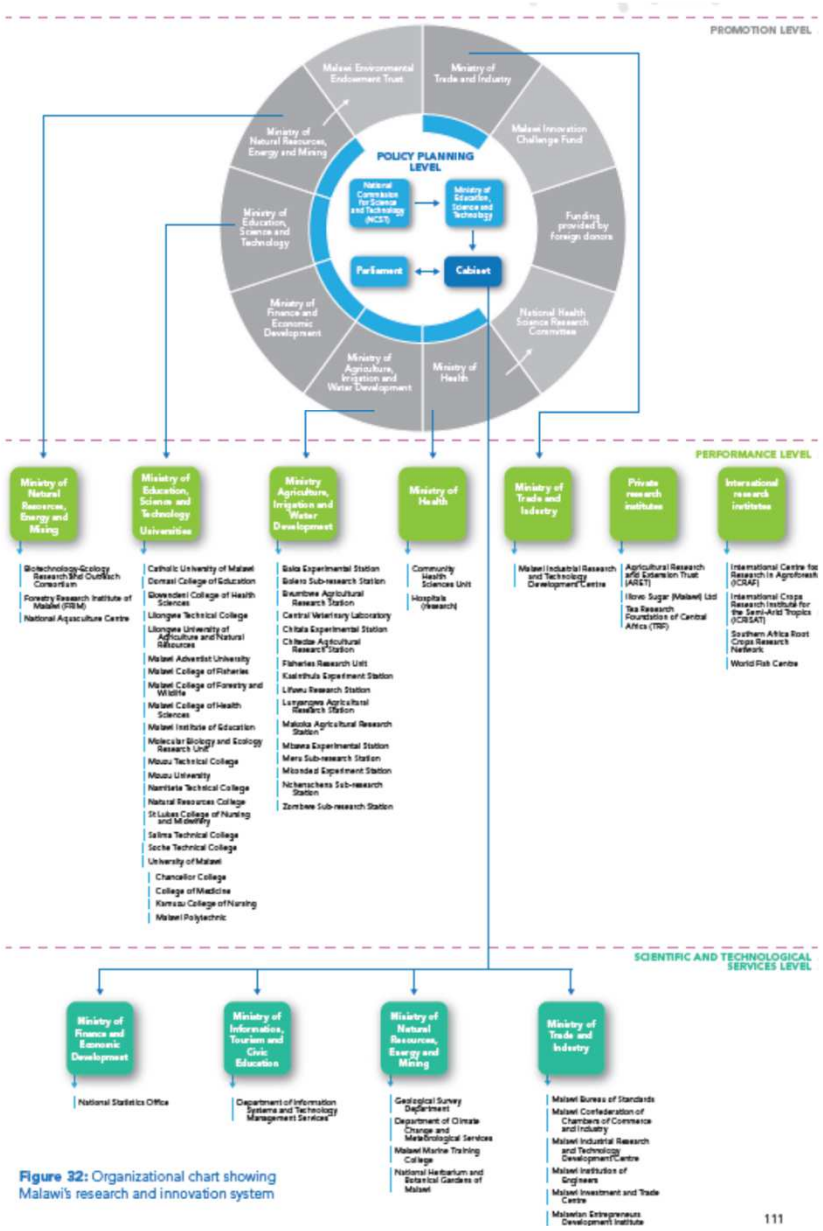


Figure 32: Organizational chart showing Malawi's research and innovation system

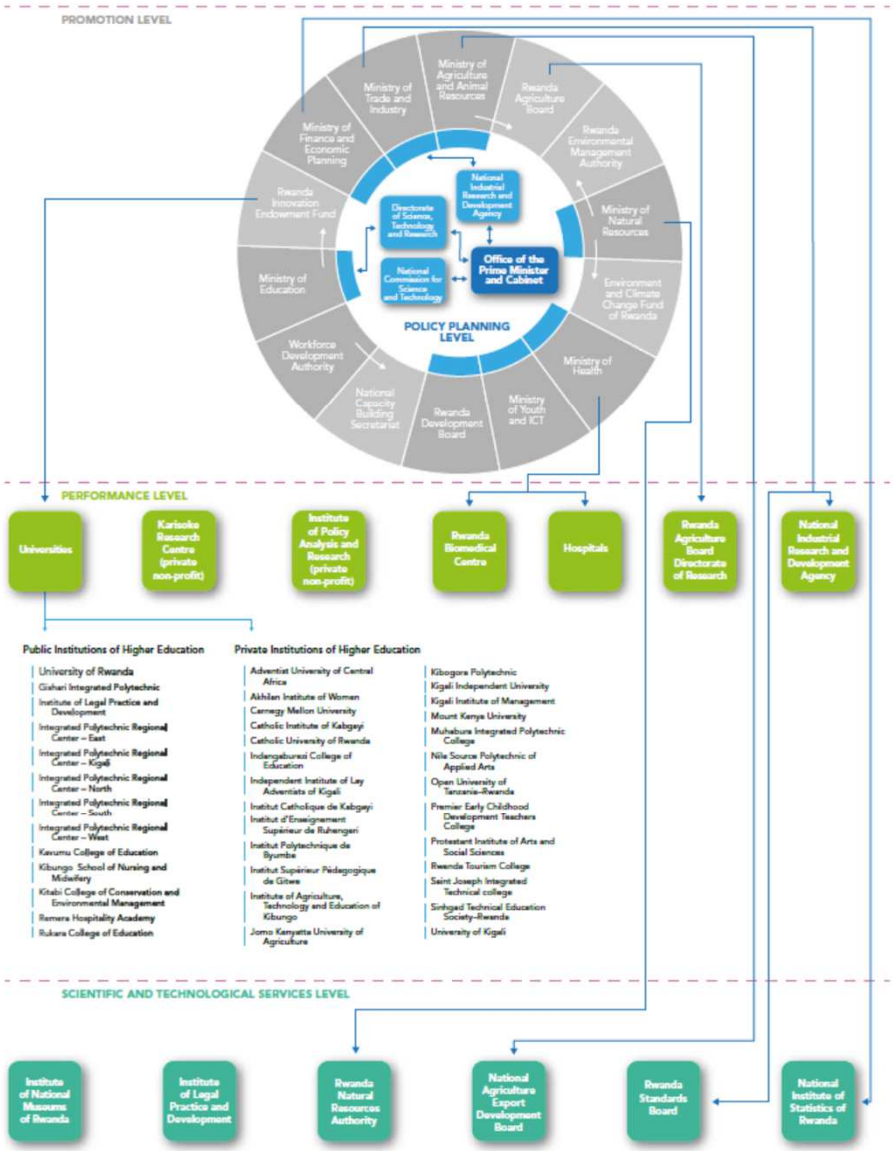
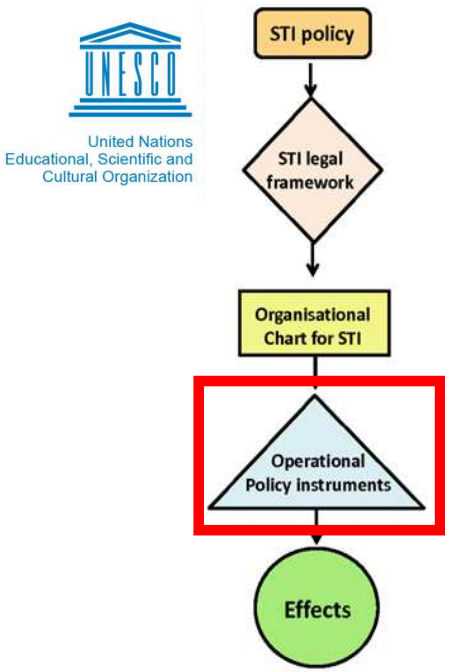
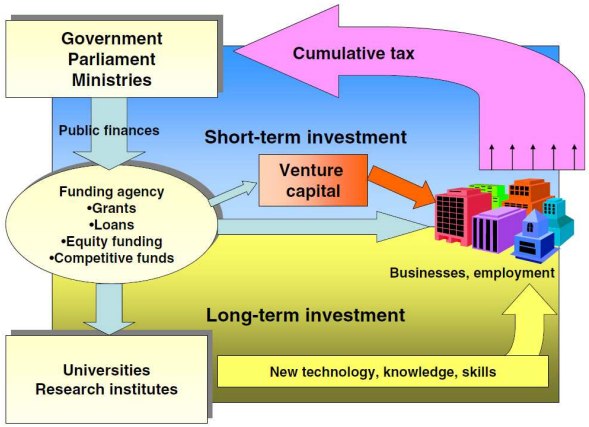


Figure 42: Organizational chart showing Rwanda's research and innovation system (c. 2015). Source: UNESCO





- Policy instruments are the means employed by those who exercise power and authority to influence the decisions made by other agents.
- They induce and motivate individuals, groups, firms, organizations and institutions to behave in accordance with the guidelines and criteria established by the policies.
- They are the connecting link between the purpose expressed in a policy statement and its implementation in practice.

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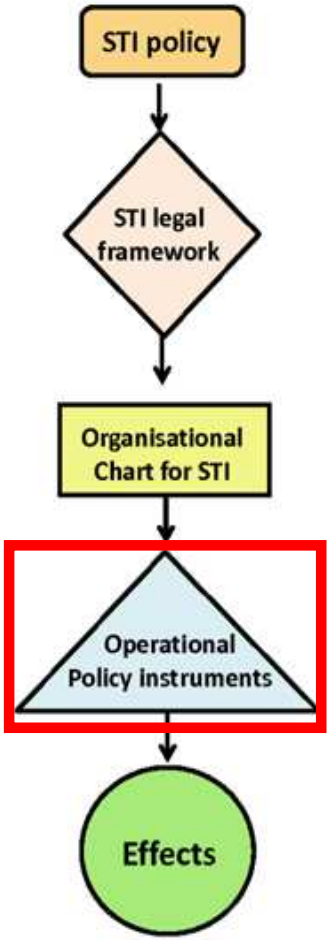
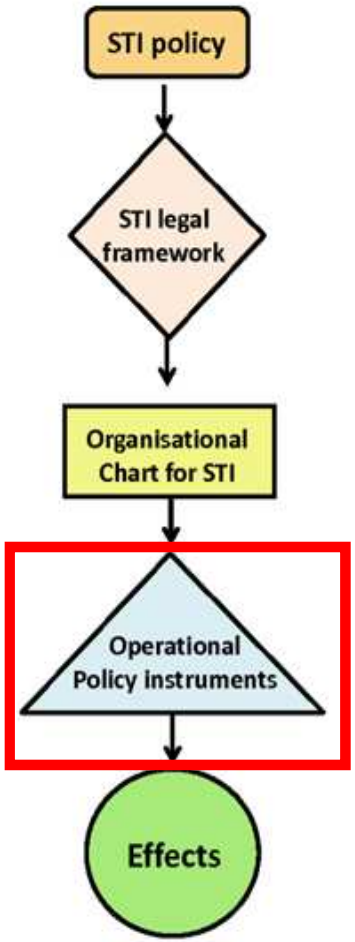


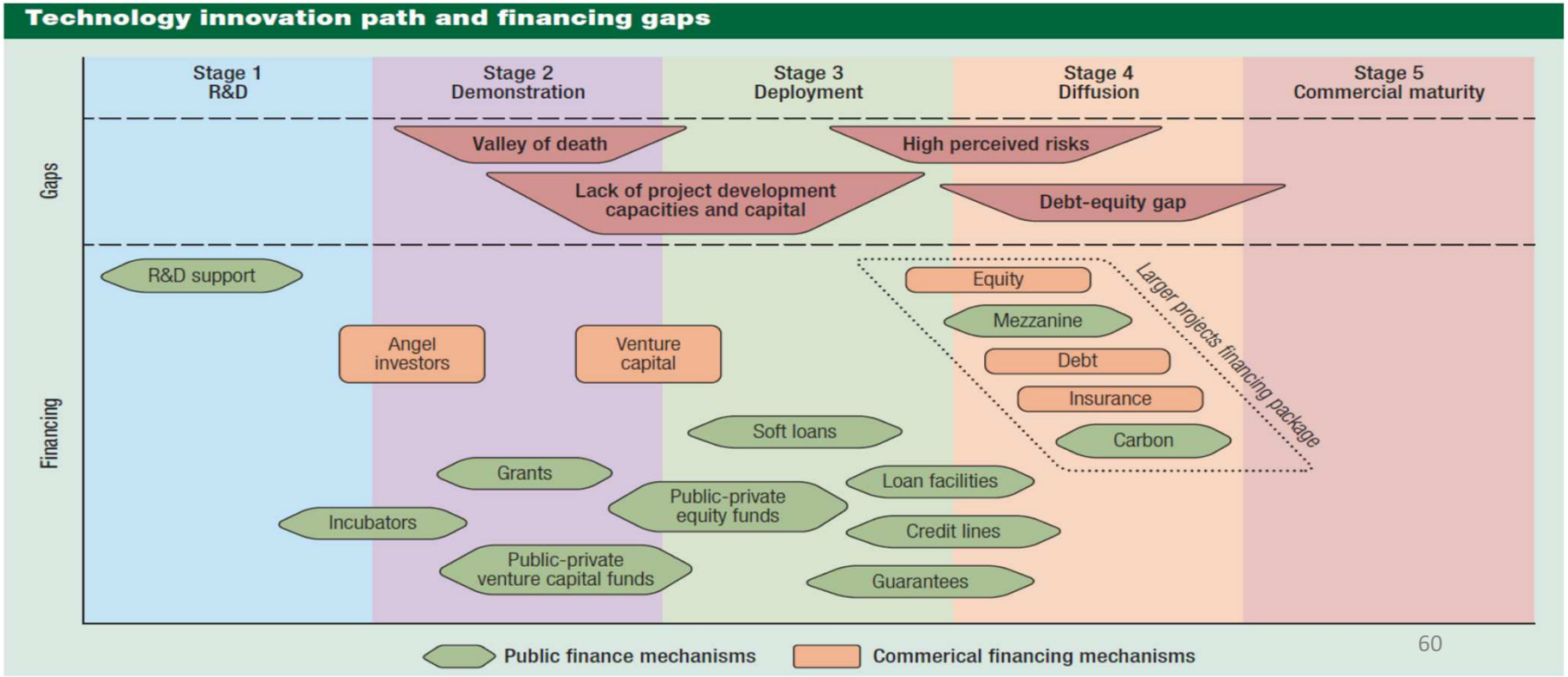
Industrial deepening	Technological capability	Skill demand	Education and training	In-firm training	Links to other players
Low-level, simple assembly and processing mainly for domestic market	Ability to master simple assembly technologies, copy simple designs and repair machines, but no capacity to adapt processes	Literacy, numeracy and simple technical and managerial training	Formal primary education	No formal in-firm training. Informal learning through repetition and trial and error	None likely
Intermediate level, including export-oriented activities in light industry	Capability to undertake minor adaptations to processes and products, but little or no design and development capabilities	Low base of engineering and scientific skills. Small and medium-size enterprises have low skill levels	Good secondary and technical schooling and management and financial training	Some in-house training mainly by export-oriented firms	To buyers and suppliers, but very unlikely to technology institutions
Advanced and deep industrial structure mainly in technology-intensive industries	Ability to monitor, import, adapt and operate state-of-the-art advanced technologies	Highly specialized manufacturing skills with a focus on technical subjects such as engineering and mathematics	Excellent tertiary technical education and specialized industrial training by institutions of technical and vocational education and training. High numbers of university-trained managers	Large investments in formal and informal in-firm training	Strong to suppliers, buyers, consultants, universities and technology institutions

Source: Adapted from Lall (2001).

GO→SPIN – Operational STI policy instruments



Different stages of the innovation process require different types of STI policy instruments and supporting mechanisms



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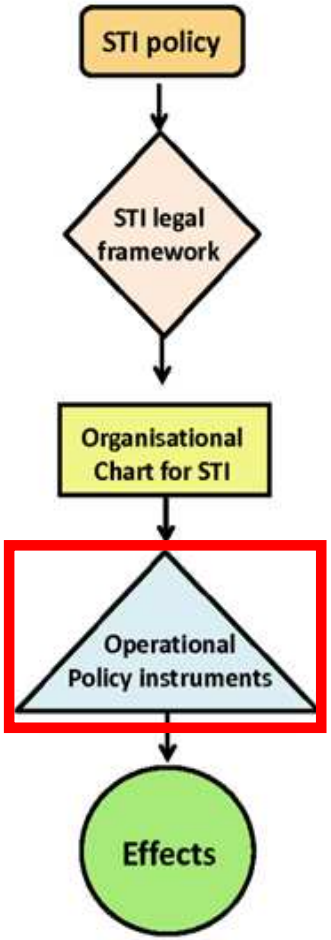
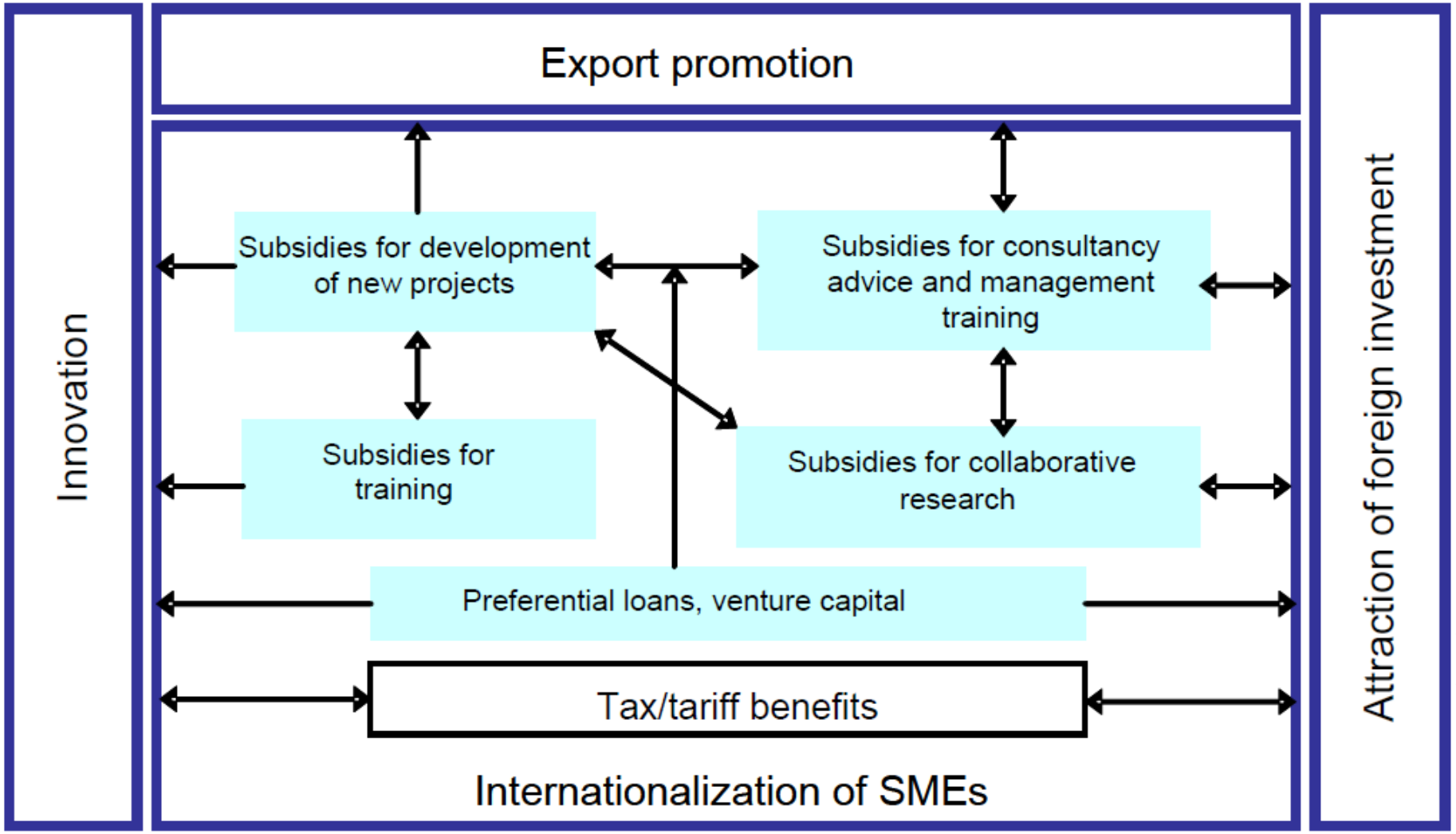
Functional links between support programmes: SMEs





Source: CEPAL (2008)

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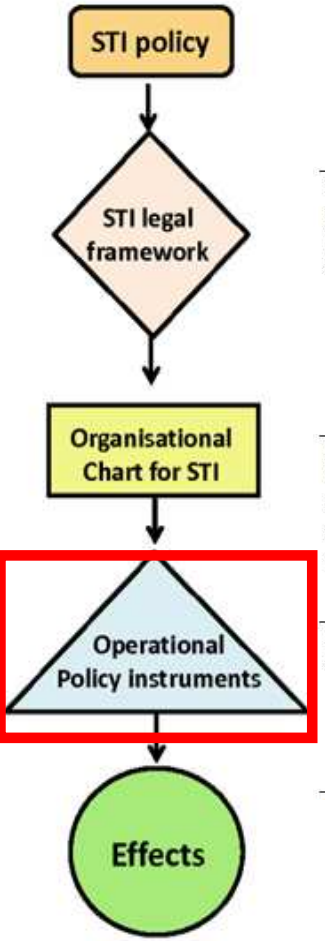

Examples: The Argentine Technological Fund (FONTAR)

FONTAR programmes	Instrument used	Objectives	Beneficiaries	Form of allocation and financial contribution
Technological development (new products, services or production processes)	Non-repayable contributions	Increased competitiveness through innovation in products, services and processes	Micro-, small and medium-sized enterprises and brooder enterprises certified by IBEROEKA	By public competition. Up to 50% of project cost
	Loans for technological development projects	Finance for middle-income technology production projects	Micro-, small and medium-sized enterprises with research and development departments or teams, collaboration groups, and UVTs (Unidades de Vinculación Tecnológica - Technical Linkage Units) underwritten by the enterprise	Compulsorily repayable loans. Up to 80% of the total cost, allocated on an open window basis, with a maximum of 200,000 pesos for three years
Technological modernization (improvement of products and processes, training)	Fiscal credit programme	Assistance for the execution of research and development activities	Physical or juridical persons who own enterprises producing goods and services	Subsidies through Fiscal Credit Certificates obtained through public competition. Up to 50% of the total cost of the project
	Loans for modernization projects	Technological adaptation and improvement of products and processes with a low level of technical and economic risk	Enterprises with research and development department or groups. Collaboration groups, and UVTs underwritten by the enterprise	Special compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of 300,000 pesos for three years
	Loans to enterprises	To finance projects for the development of new production processes, products and modifications thereto	Enterprises, without any restrictions as regards size or sector. No finance provided for projects with a rate of return of less than 12%	Compulsorily repayable loans allocated on an open window basis. Up to 80% of the total cost of the project, with a maximum of 1 million pesos
Promotion of the technological services market (research centres and business research centres)	Subsidies for projects to develop business plans	Finance for business development projects based on research and development	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to 50% of the total cost of the project, with a maximum of 20,000 pesos, for up to one year
	Loans to institutions	To promote the establishment and strengthening of structures for the provision of technological services to research and development enterprises and institutions	Public or private institutions providing services to the private production sector. The projects may be presented on an individual or associated basis	Obligatorily repayable subsidies allocated on an open window basis, up to a maximum of 2 million pesos
Training and technical assistance	Subsidies for training and retraining projects	Subsidies to support activities for the training and retraining of human resources in new technologies	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or 20,000 pesos for up to six months
	Subsidies for project formulation	Support for the formulation of research and development projects, technology transfer or technical assistance	Micro-, small and medium-sized enterprises whose projects are executed by UVTs	Subsidies allocated on an open window basis. Up to a maximum of 50% of the total cost of the project, or 20,000 pesos for up to six months

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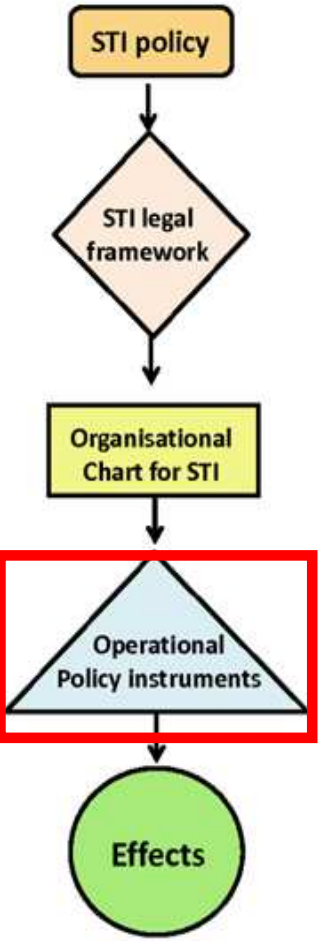

Examples of Sectoral Funds in Brazil

Sectoral funds	Objectives	Origin of financial resources	Activities
CT-PETRO (1999) Sectoral fund for the oil and natural gas sector. Instrument whereby established: Law No. 9487 of 1997	Sectoral development through promotion of research and development and human resources training	25% of value of royalties exceeding 5% of production of oil and natural gas	Collaboration in the definition of policies and the implementation of specific programmes. In 2001, 144 projects worth 7 million reales were approved by the CNPq. Expenditure between January and November 2003: 16,431,002.70 reales
CT-ENERG Sectoral fund for the energy sector. Instrument whereby established: Law No. 9991 of 2000	Sectoral development through promotion of research and development	Between 0.75% and 1% of the net income of enterprises with concessions for the generation, transmission and distribution of electricity	In 2001 the CNPq approved 132 research and development projects involving the investment of 8 million reales by the fund. In 2001 an association agreement was signed between the National Electric Power Agency and the CNPq to promote cooperation between research centres and enterprises. Total expenditure between January and November 2003: 8,397,738
CT-HYDRO Sectoral fund for water resources. Instrument whereby established: Law No. 9993 of 2000	Reduction of disparities between regions through investments in science and technology activities of importance for the sector. Strengthening of water resource sustainability	Made up of 4% of the financial compensation of electricity generation enterprises	Financing of scientific and technological development projects and programmes designed to improve water quality and use. In 2002, 28.6 million reales were invested, of which at least 4 million were for the training of specialized personnel. Expenditure between January and November 2003: 3,735,635.85 reales
CT-INFO Sectoral fund for information technology. Instrument whereby established: Law No. 10176 of 2001	Promotion of the competitiveness of the sector through research and development programmes and projects	At least 5% of the gross annual turnover in the domestic IP goods and services market of enterprises producing goods and services relating to information technology which receive fiscal incentives under the law to promote the IP industry	It is estimated that over 50 million reales are spent each year on the promotion of research and development activities in this sector. Expenditure between January and November 2003 was 9,971,983.70 reales

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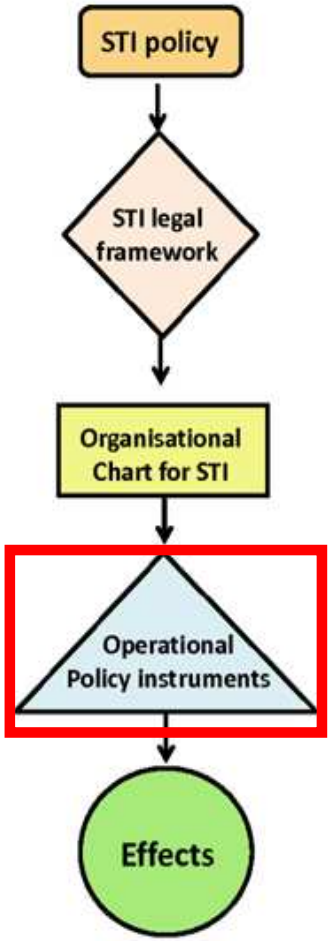

Operational Policy Instruments: example from Lebanon (21 fields)

Title of the STI operational Instruments: The Grant Research Programme (GRP)

Keywords: R&D; co-financing

Overview: The Grant Research Programme (GRP) is a National Council for Scientific Research (CNRS) tool for sponsoring research projects implemented in public and private universities, and in national or private research institutions including the CNRS affiliated research centres. The CNRS has agreement with the universities to co-fund the research projects according to defined percentages for each eligible cost category. The programme is targeted to priority areas in natural and social sciences.

Objective of the plan (or the STI policy) to which the instrument relates: Develop capacity and knowledge in priority fields that have the potential to tackle Lebanon societal needs. Improving the functioning of universities. A commitment to research, new standards based on performance and auditing, Ph.D. programmes, Post Doctorate programmes and centres.

Specific objectives: a) strengthening the production of new endogenous scientific knowledge; c) human resources for research innovation and strategic planning. Capacity building education and training of specialized human capital for (1) the production of new scientific knowledge (2) development of new technologies (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society

Sectoral or horizontal approach of the instrument: a) Sectoral: the benefits go to a specific knowledge discipline, technological area, productive sector or specific issue.

Mode of support/Type of mechanism: a) grants

Conditions to apply for the instrument: The principal researcher is a full-time professors or researchers (holding a PhD) at Lebanese universities and Lebanese research centres. The required principal investigator must have published scientific articles, connected the research during the last 3 years. The principal investigator cannot exceed 25% of time dedicated to other research project to submit more than one project or exceeding his contribution as a researcher in another project by 25%. The principal investigator cannot submit a new research project if the scientific and financial liquidation of his previous project has not been completed.

Target groups/beneficiaries: d) researchers; e) universities; f) research Centres

Eligibility/selection criteria: The selection process considers the following criteria: innovation and project objectives; the impact of the research project on the scientific scene locally and internationally; the impact of the project on society, the scientific and technical level of the research project; and level of scientific researchers and their ability to implement the project. After studying the projects at an initial stage, the Council and the University shall refer them to independent and parallel arbitration. The Council shall, in coordination with the University, inform the approved projects of successful result.

Eligible costs: Honorariums for research assistant or M.Sc. students working within the project. Consumable, experimental costs and laboratory testing. Clinical, Fieldwork or survey costs (expenses & labour) Participation in International Conferences. Publication and Results dissemination. Miscellaneous.

Source of funding: Lebanese Republic

Mode of disbursement of financial resources: LBP 10 - 20 Million (Approx. US$ 6600 – 13200) per year for a maximum of 2 years

Annual budget: LBP 1 300 Million (Approx. US$ 861 000) in 2016

Continuity of the instrument over time: Since 1962

Geographical coverage: National

Results, outcome and evidence of success of a given measure: In 2016, 82 projects were accepted. The top 3 scientific fields are medical sciences with 25 projects; environmental sciences with 20 projects; and basic sciences with 15 projects.

Field of Science and Technology Classification: 1.3; 1.4; 1.5; 2; 3; 4; 5.2; 5.4; 5.7; 5.9; 6.1; 6.2

Socio-Economic Objective Classification: 2; 4; 6; 7; 8; 10; 11;

International Standard Industrial Classification (ISIC) of All Economic Activities:

Relevant link: http://www.cnrs.edu.lb/english/call-of-interest/calls-for-proposals-by-cnrs/the-grant-research-programme

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GO→SPIN FOR SCIENCE POLICY
GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS

GO→SPIN
On-line platform

Sources of information

GO→SPIN country profiles and other STI research studies conducted by UNESCO

Open Source databases of STI policies

Databases of indicators operated by the UN system

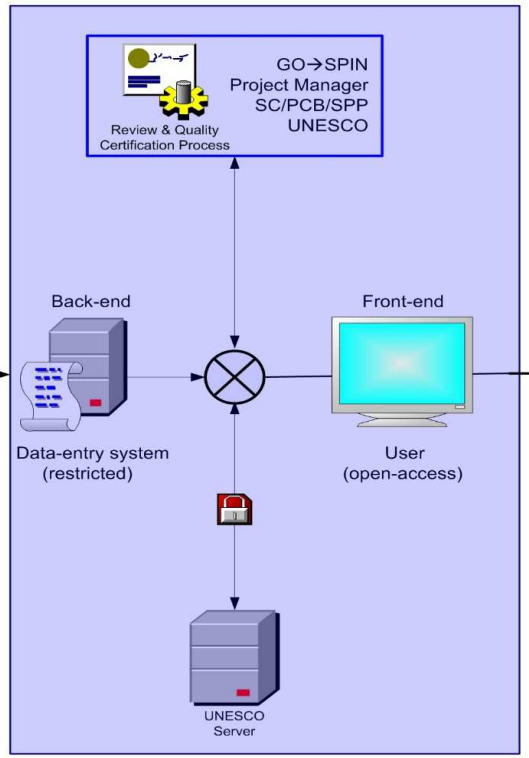
UNESCO Institute for Statistics database

Unesdoc: UNESCO repository

Links to STI and Sustainable Development National documents

GO→SPIN Surveys will be completed on-line by Member States' focal-points

GO→ SPIN Multilingual Platform



GO→ SPIN Information Modules (on-line access)

Historical background: access to national and regional STI policy review documents published by UNESCO (1960–on)

Standardized Content Analysis of National STI policies: using 14 different descriptors to analyze the text of the explicit STI national policy

Description of the national STI policy cycle: composed by (1) Agenda Setting, (2) Policy Formulation, (3) Decision Making, (4) Policy Implementation and (5) Policy Evaluation

Access to the STI organization charts organized in five levels: (1) Policy Planning Level, (2) Promotion Level, (3) Performance and Execution Level, (4) Scientific and Technological Services Level and (5) Evaluation Level

Inventory and description of the institutions from the National STI System

Inventory of STI legal framework: including public laws, decrees, policy regulations, international agreements and other legal instruments such as major contracts. Links to full texts.

Inventory of STI operational policy instruments: each one analyzed by 20 different descriptors, including despriptors for objective and goals (18 categ.), for mechanisms (14 categories) and for users (12 categories).

Special Modules to analyze STI policy instruments for the promotion of:
(1) Women in engineering and science
(2) Indigenous knowledge systems
(3) Ethics in science and engineering
(4) The status and labour regulations for researchers and technicians

Special Software for Data Analysis: including 300 temporal series of indicators for contextual analysis

UNESCO Institute for Statistics (UIS) STI country profiles: access to R&D and Innovation indicators produced by UIS

Links to external databases of documents and statistics on STI activities

Source: G.A. Lemarchand (2016)

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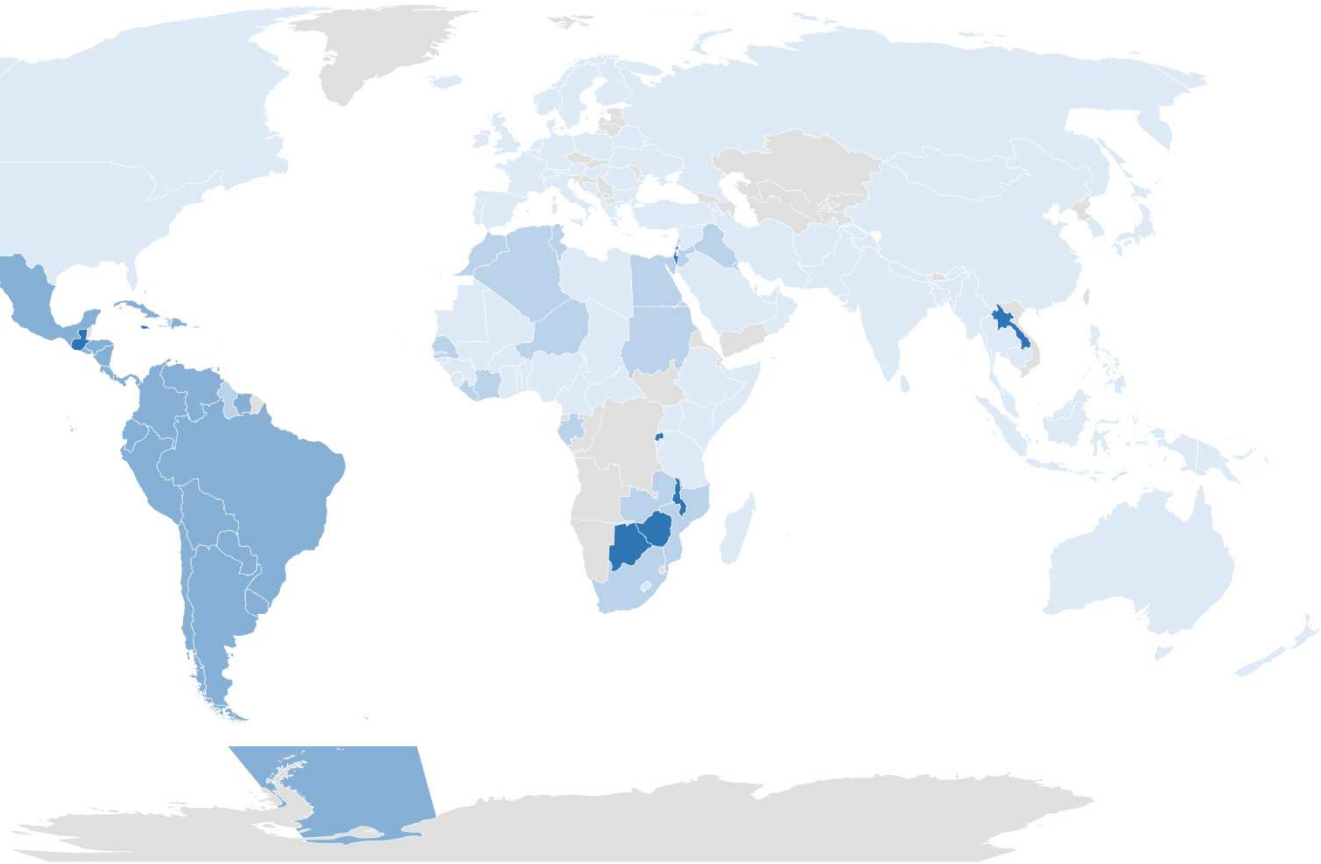
Geographical distribution of STI information available at the GO→SPIN platform

- 435 STI policy reports (1960-2015) covering 139 different countries (up to 7 different reports per country)
- 41 countries with a complete inventory of STI operational policy instruments (more than 1,000 different policy instruments, each one analysed in 24 different dimensions/fields)
- 20 countries with both, the inventory of STI operational policy instruments and legal framework inventory
- 8 countries with the complete set of inventories on STI policies, instruments, institutions, legal framework, organizational charts, STI policy cycle, content analysis of the explicit STI policy, etc



Normalised Objetiv...	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	Tot
Algeria	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Argentina	43	16	52	1	1	62	2	1	-	-	2	16	9	131
Bolivia	2	-	-	-	-	3	-	-	1	-	-	-	1	5
Botswana	-	-	2	-	-	-	-	-	-	-	-	-	-	2
Brazil	35	5	55	2	4	33	14	-	-	-	1	8	9	105
Burkina Faso	3	-	2	-	1	3	-	1	1	-	-	1	-	3
Chile	25	3	23	4	-	57	4	-	-	-	-	14	-	87
Colombia	14	1	15	-	-	17	1	-	-	1	-	3	-	34
Costa Rica	6	-	13	2	4	10	1	-	-	3	-	9	3	37
Cote D`Ivoire	2	-	1	-	1	2	-	1	-	-	-	-	-	2
Dominican Republic	2	-	2	-	-	3	-	-	-	-	-	1	-	7
Ecuador	9	-	11	1	-	2	-	-	1	-	-	-	-	20
Egypt	7	3	7	-	1	5	-	-	-	2	-	1	-	11
El Salvador	4	-	6	-	-	7	2	-	-	1	-	-	-	13
Ethiopia	2	-	-	-	1	1	-	-	-	-	-	-	-	2
Gabon	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Guatemala	6	2	6	-	1	2	-	-	-	1	1	-	1	11
Honduras	2	-	1	-	-	3	-	-	-	1	1	-	-	7
Iraq	1	-	2	-	-	-	-	-	-	1	-	-	-	3
Israel	31	19	32	5	8	26	7	-	7	-	25	17	-	53
Jamaica	1	-	-	-	-	3	-	-	-	-	-	1	-	3
Jordan	3	-	2	-	-	5	-	-	-	1	-	-	-	5
Kuwait	10	-	8	-	6	7	-	3	-	2	1	2	-	17
Lao People`s Democratic Republic	1	-	1	-	-	-	-	-	1	-	-	1	-	2
Lebanon	5	-	6	-	2	6	-	-	-	1	1	1	1	11
Liberia	2	3	4	1	-	2	1	-	-	3	-	-	-	5
Malawi	22	4	17	4	13	2	6	5	4	5	-	2	1	30
Mexico	33	4	25	2	4	14	2	-	-	-	-	3	1	51
Morocco	10	-	4	-	2	8	-	-	-	8	-	-	2	20
Mozambique	6	2	13	-	4	9	1	3	-	7	-	1	-	17
Nicaragua	2	-	1	1	-	3	-	-	-	-	-	-	3	7
Niger	2	-	2	-	-	1	-	-	-	-	-	-	-	2
Panama	11	1	25	-	-	6	2	-	-	1	-	-	1	38
Paraguay	3	1	6	-	-	4	1	-	-	-	-	1	1	13
Peru	17	3	17	1	-	28	1	-	-	-	-	7	-	46
Rwanda	4	4	6	-	2	2	2	1	-	-	2	-	-	6
Saudi Arabia	1	-	1	-	-	-	-	-	-	-	-	-	-	1
Senegal	4	2	3	1	3	4	1	2	-	1	-	-	-	6
South Africa	12	7	18	4	3	11	2	3	1	8	6	2	1	19
Sudan	1	-	1	-	-	1	-	-	-	-	-	-	-	1
Trinidad and Tobago	1	-	4	-	-	3	-	-	-	-	-	-	2	10
Tunisia	3	-	2	-	-	18	-	-	-	4	2	-	-	20
United Arab Emirates	1	-	2	-	1	4	-	-	-	3	-	-	-	6
Uruguay	19	3	28	-	4	27	4	-	-	-	-	5	-	64
Venezuela	5	-	4	-	-	1	-	-	-	-	-	2	1	6
Zimbabwe	4	-	8	4	-	2	-	-	-	-	-	-	-	10

GO→SPIN Categories by objectives and goals

a. Strengthening the production of new endogenous scientific knowledge.
b. Strengthening the infrastructure of research laboratories in the public and private sectors.
c. Human resources for research, innovation and strategic planning. Capacity building, education and training of specialized human capital for (1) the production of new scientific knowledge, (2) development of new technologies, (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society.
d. Strengthening gender equality for research and innovation.
e. Strengthening the social appropriation of scientific knowledge and new technologies.
f. Development of strategic technological areas and new niche products and services with high-added value. Promotion and development of innovation in the production of goods and services. Promotion of start-ups in areas of high technology
g. Strengthening programmes on science education at all levels (from primary school to postgraduate).
h. Promotion of the development of green technologies and social-inclusion technologies.
i. Promotion of indigenous knowledge systems.
j. Research and innovation eco-system: strengthening co-ordination, networking and integration processes which promote synergies among the different actors of the national scientific technological and productive innovation system (i.e. government, university and productive sectors).
k. Strengthening the quality of technology foresight studies to: assess the potential of high-value markets; develop business plans for high-tech companies; construct and analyse long-term scenarios and provide consulting services and strategic intelligence.
l. Strengthening regional and international co-operation, networking and promotion of STI activities.
m. Prizes and awards for individuals, institutions, etc. on STI activities

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The “Sustainability Science Paradigm” (New Social Contract of Science) and GO→SPIN

- **Effective STI policies are key to achieve SDGs and GO→SPIN is an excellent monitoring tool for them.**
- **GO→SPIN is a methodology for mapping information on STI policies, national STI systems and their organizations, STI legal frameworks, policy instruments and indicators for providing evidence-based policy analyses**
- **GO→SPIN performs capacity building activities, collects new information on STI policy, publishes country profiles, provides standard setting instruments (GO→SPIN Manual) and now is launching a new tool: a multilingual online platform**

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Time for questions

… Thank you very much
For your kind attention!