MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

United Nations Educational, Scientific and Cultural Organization

GO SPIN FOR SCIENCE POLICY

GLOBAL OBSERVATORY OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY INSTRUMENTS

UNESCO GO→SPIN Methodological and Data Collection Training Workshop – Republic of Uganda

12–16 April 2021

LECTURE 3: Evidence based policies through the analysis of temporal series of indicators. Theory and Practice

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Research KITS

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Research on Knowledge, Innovation, Technology and Science Organization

www.researchkits.org

"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)"

SETI (Science, Engineering, Technology and Innovation)

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

Research and Innovation

Open innovations ***Incremental innovations***

Radical innovations **Social innovations**

Radical second innovations *Frugal grassroots innovations*

Disruptive innovations PRO POOR INNOVATIONS

Creative destruction innovations **Inclusive innovations**

TECHNOECONOMIC PARADIGMS / Technology paradigms

The acronym SETI instead of STI was used for the first time by African experts since the nineties

Innovation without Science Policy

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African Technology Policy Studies Network
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Nairobi, Kenya

In developing economies, it is customary to see innovation as the end product of the process that runs from invention through development to commercialization and diffusion of invention. In this context, innovation is associated with the activity of individuals or firms at the frontier of technology. Ernst, Mytelka, and Ganiatsos, however, define innovation as "the process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether or not they are new to their competitors—domestic or foreign." They go on to define three basic strategies of innovative firms: catching up, keeping up, and getting ahead. This allows them to treat imitative firms, along with pioneers on the cutting edge of technology, as innovators.[1] This is the broad sense in which we use the term "innovation" in this paper.

In the industrialized and newly industrializing economies, innovation usually comes from:

1. Intrafirm innovative initiatives, which could be the result of intrafirm R&D activity or production, organizational action, or other functional activity within the firm. These processes yield a myriad of minor product and process changes.
2. Contract research, in which a firm used independent laboratories to solve defined product or process problems. It is now generally agreed that firms that utilize and benefit most from contract research activities are also those firms that have in-house R&D capabilities, so contract research complements rather than substitutes for intrafirm effort.[2]
3. University-industry research partnerships, which, although similar to contract research arrangements, involve joint R&D activity by firms and university departments in developing new knowledge, technology, or solutions to specific product or process problems. They involve the contribution of personnel, funds, facilities, etc. by both parties.
4. Alliances or consortia with other domestic or foreign firms in the development of specific products, processes, or knowledge. Usually these involve a comple-

A Framework for the Strategic Design of Science and Technology Policy for African Development*

O.A. Bamiro**

Abstract: The key role of science and technology and the ways in which it can be developed and deployed to achieve the identified goals of development in Africa are articulated in this paper. Notable projects, programmes, declarations etc. addressing issues of development of Africa are: the Millennium Development Goals (MDGs), aimed at poverty reduction over a stipulated period of time with globally defined measurable indicators of progress; the World Summit on Sustainable Development (WSSD); the Blair Commission Report for Africa; and the New Partnership for African Development (NEPAD) targeted at repositioning Africa in the world economy. During the WSSD Summit process, the Johannesburg Plan of Implementation (JPOI) identified the three pillars of sustainable development as the *economic*, *environmental* and *social pillars*, and emphasized the fact that 'science and technology must be placed at the heart of policies to promote sustainable development'.

It is shown in this paper that many of the means of implementation of the various development initiatives are not related only to science and technology, but, in reality, to *science*, *engineering*, *technology* and *innovation* (SETI). SETI is elaborated upon in order to gain a practical insight into the nature of each element. This sets the stage for the identification of two categories of technological capabilities that a country must seek to develop: (1) the firm/enterprise-level technological capability (FLTC) based on the technology of the firm, comprising six elements of capabilities that African firms and enterprises must seek to develop in varying degrees to meet the challenges in the local and global market place; and (2) the national level technological capability (NLTC) which defines the environment within which firms and enterprises operate, and has as its elements the capital goods manufacturing capability, the educational and training infrastructure

* Paper presented at the AERC International Conference on Accelerating Africa's Development Five Years into the 21st Century, held in Tunis, Tunisia, 22–24 November 2006.
** University of Ibadan, Ibadan, Nigeria. E-mail: vc@mail.ui.edu.ng

In order to understand and explain nature and society, the human mind divides the Universe (and everything) into categories (and concepts) that are not necessarily real.

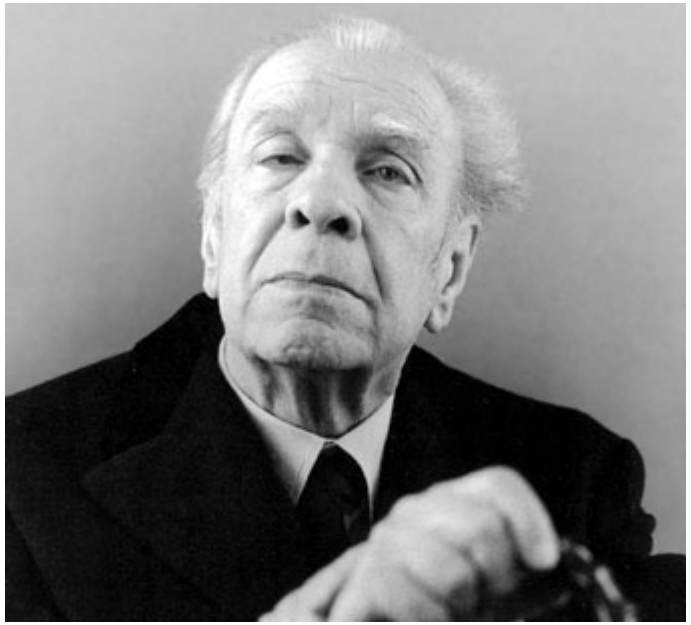
The writer Jorge Luis Borges questions this approach and suggests limiting the multiplication of categories, classes, families and species.

…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

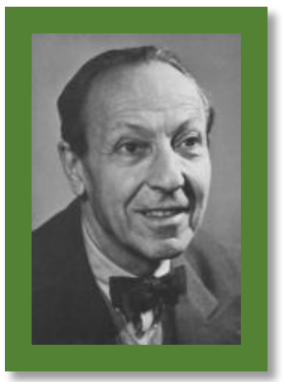
…These ambiguities, redundancies and deficiencies remind us of those which doctor Franz Kuhn attributes to a certain Chinese encyclopedia entitled *The Celestial Emporium of Benevolent Knowledge*. In its remote pages it is written that the animals are divided into:

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)

Excerpts from: “The Analytical Language of John Wilkins" (Spanish: "El idioma analítico de John Wilkins") originally published in *Otras Inquisiciones (1937–1952)*



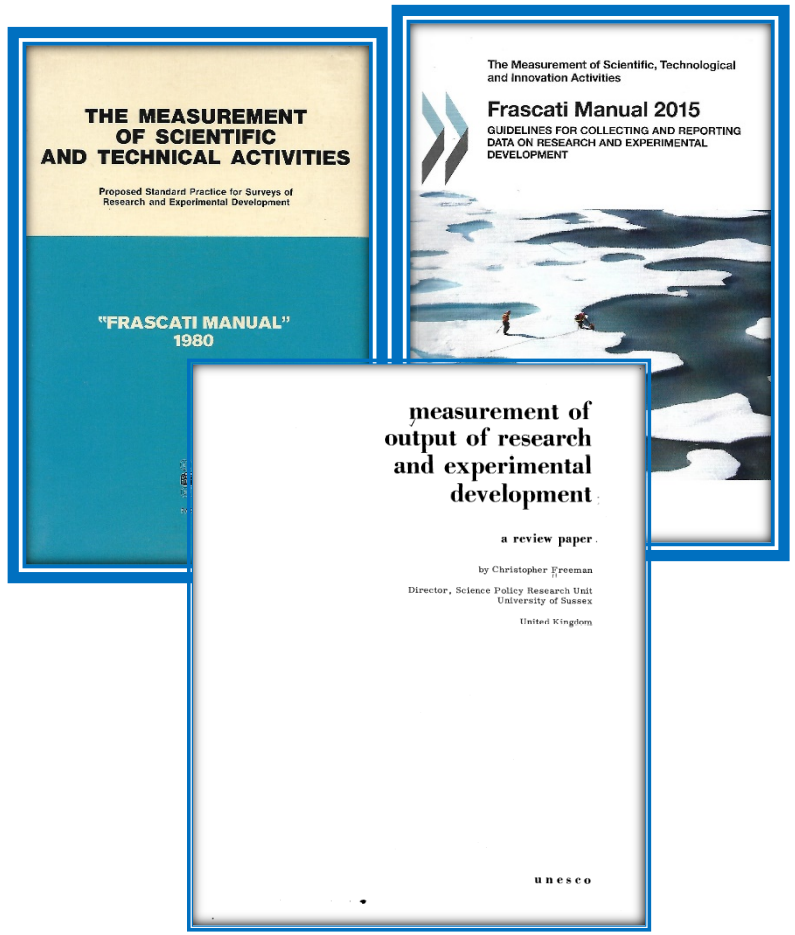
Fritz Machlup (1902 – 1983)

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

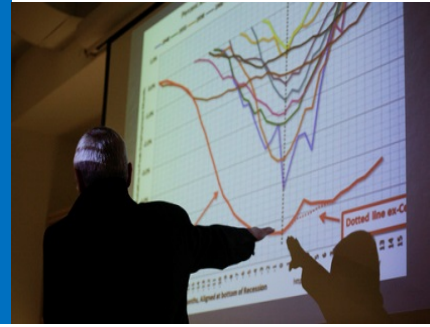
THE FLOW OF IDEAS THROUGH THE STAGES OF RESEARCH, INVENTION, AND DEVELOPMENT TO APPLICATION

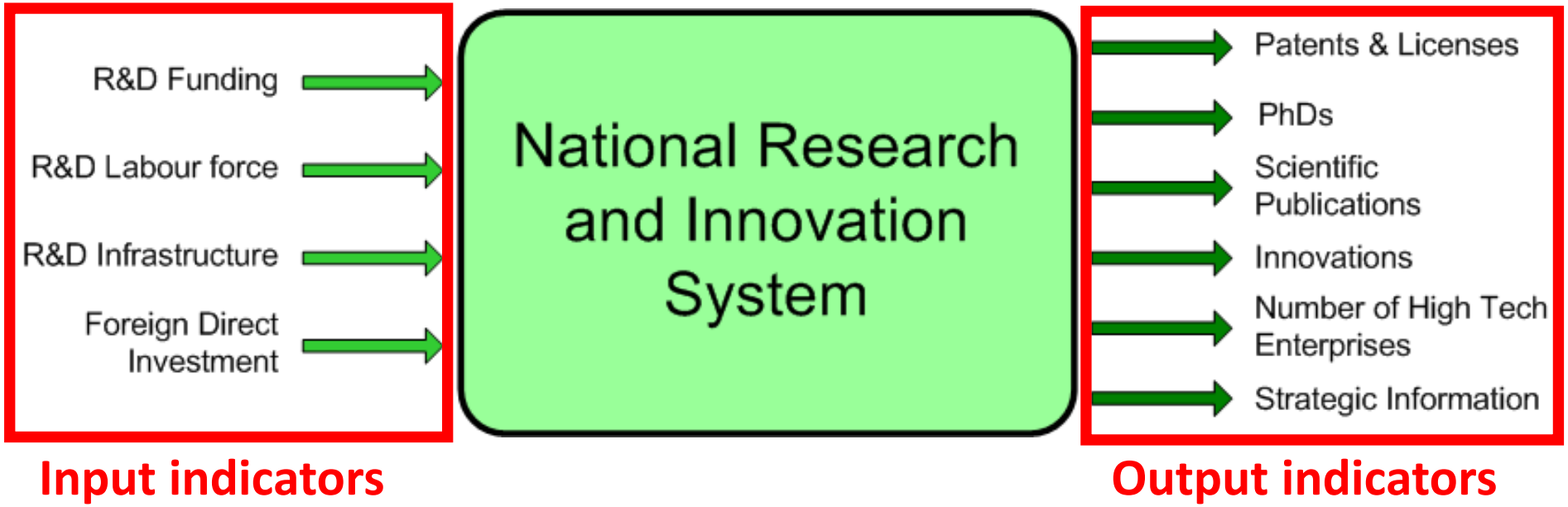
STAGE	INPUT: Intangible	INPUT: Tangible	INPUT: Measurable	OUTPUT: Intangible	OUTPUT: Measurable
I "Basic Research" [Intended output: "Formulas"]	1. Scientific knowledge (old stock and output from I-A) 2. Scientific problems and hunches (old stock and output from I-B, II-B, and III-B)	Scientists, Technical aides, Clerical aides Laboratories, Materials, fuel, power	Men, man-hours, Payrolls, current and deflated Outlays, current and deflated, Outlay per man	A. New scientific knowledge: hypotheses and theories B. New scientific problems and hunches C. New practical problems and ideas	Research papers and memoranda; formulas — —
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) 2. Technology (old stock and output from II-A and III-A) 3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A)	Scientists, Non-scientist inventors, Engineers, Technical aides, Clerical aides Laboratories, Materials, fuel, power	Men, man-hours, Payrolls, current and deflated Outlays, current and deflated, Outlay per man	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 B. New scientific problems and hunches C. New practical problems and ideas	a. Patent applications and patents b. Technological papers and memoranda c. — d. Papers and memoranda e. — f. — — —
III "Development Work" [Intended output: "Blueprints and Specifications"]	1. Scientific knowledge (old stock and output from I-A) 2. Technology (old stock and output from III-A) 3. Practical problems and ideas (old stock and output from I-C, II-C, III-C, and IV-A) 4. Raw inventions and improvements (old stock and output from II-A)	Scientists, Engineers, Technical aides, Clerical aides Laboratories, Materials, fuel, power Pilot plants	Men, man-hours, Payrolls, current and deflated Outlays, current and deflated, Outlay per man Investment	A. Developed inventions: blueprints, specifications, samples B. New scientific problems and hunches C. New practical problems and ideas	Blueprints and specifications — —
IV "New-type Plant Construction" [Intended output: "New-type plant"]	1. Developed inventions (output from III-A) 2. Business acumen and market forecasts 3. Financial resources 4. Enterprise (venturing)	Entrepreneurs, Managers, Financiers and bankers, Builders and contractors, Engineers Building materials, Machines and tools	$ investment in new-type plant	A. New practical problems and ideas	New-type plant producing a. novel products b. better products c. cheaper products

Christopher Freeman (1921 – 2010)



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





THOMSON REUTERS
WEB OF SCIENCE

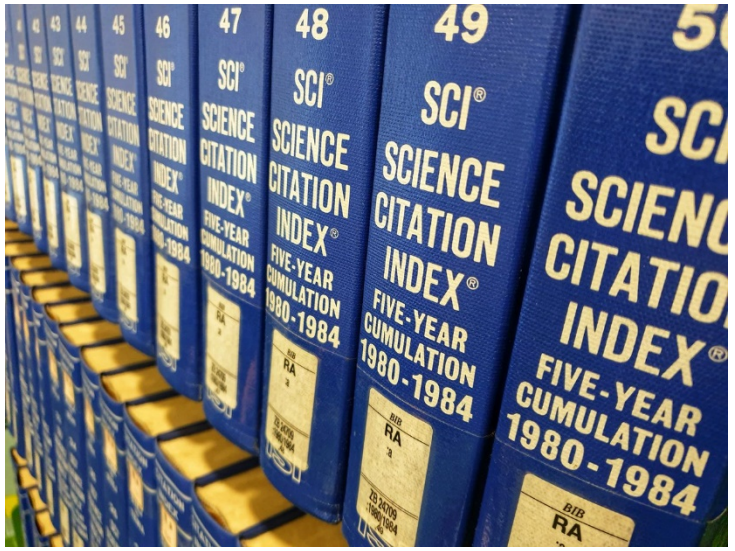
One of the most complete databases is the Web of Science, which includes the Science Citation Index (SCI) Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (A&HCI). The latter is now maintained by Thomson-Reuters a private company and covers 12 000 peer-reviewed journals.

ELSEVIER
Scopus

The other major database is SCOPUS which is maintained by Elsevier Science and covers 18 000 peer-reviewed journals.

Type of scientific documents →

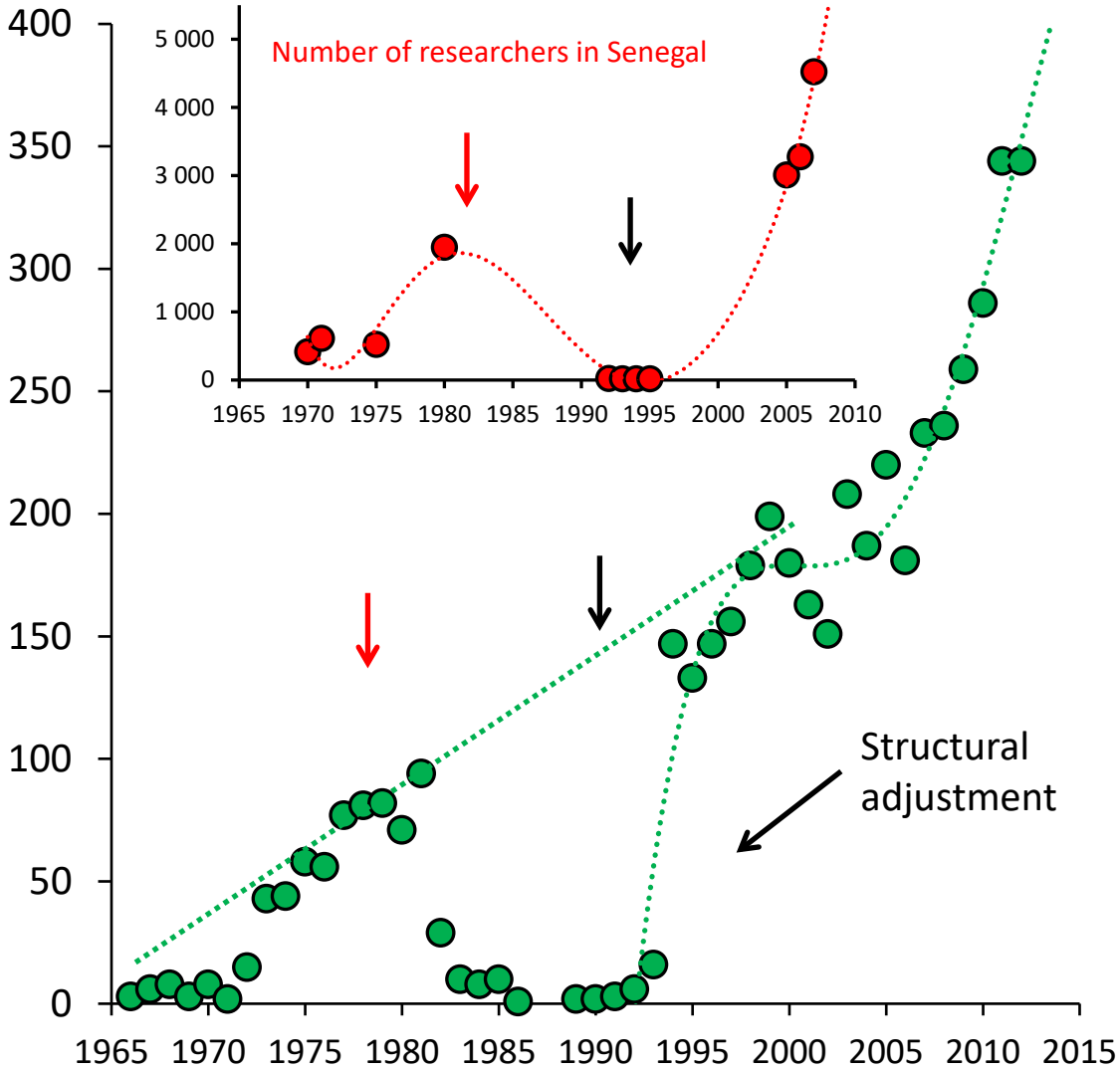
- Articles
- Meeting abstracts
- Reviews
- Letters
- Editorial material
- Proceedings papers
- Book reviews
- Corrections
- Book chapters



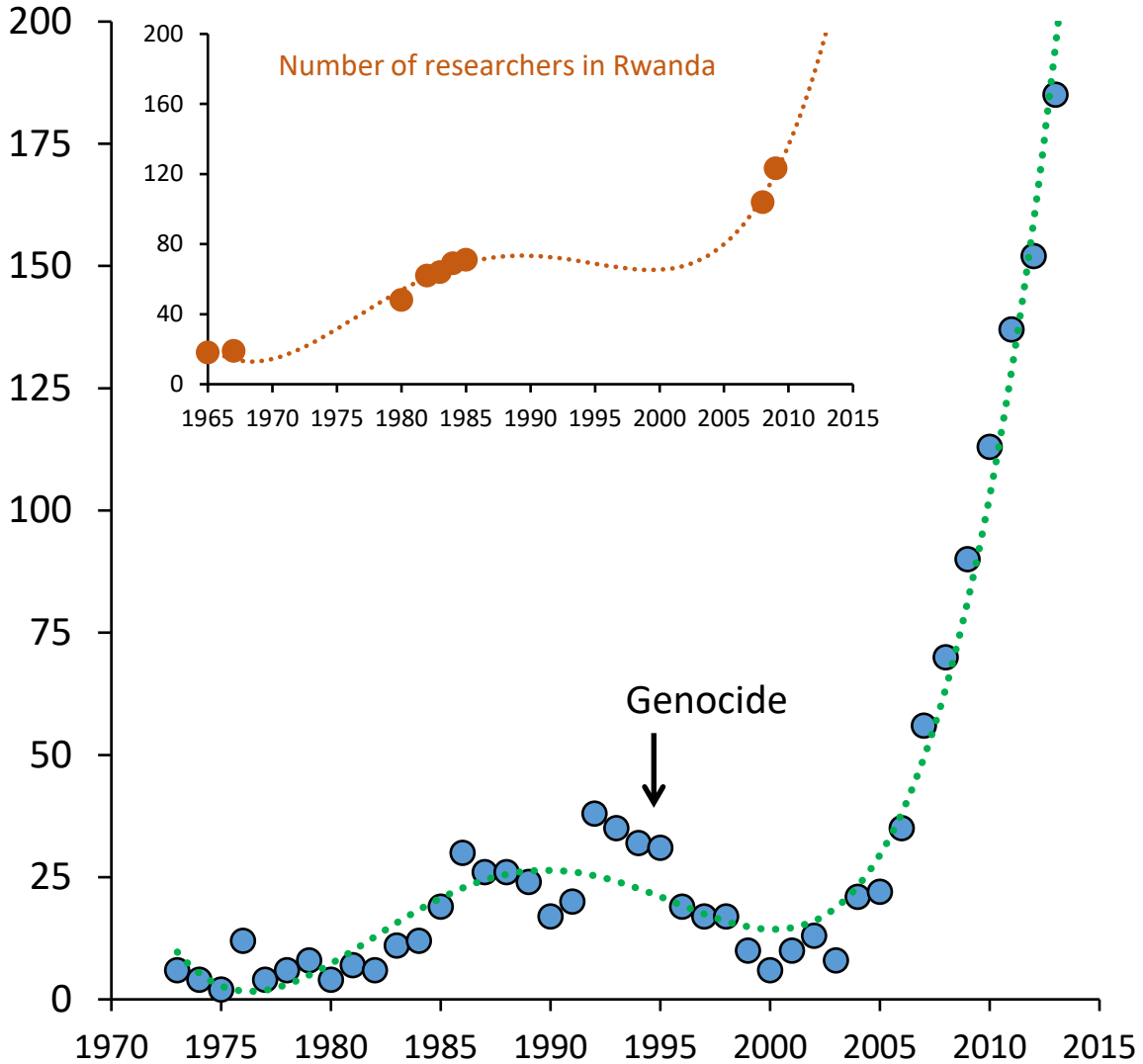
How sensitive are some temporal series of indicators to detect the influence of the national “ecosystem conditions” (contextual factors or political stability) ?

Number of scientific articles listed at SCI-EXP+SSCI+A&HCI

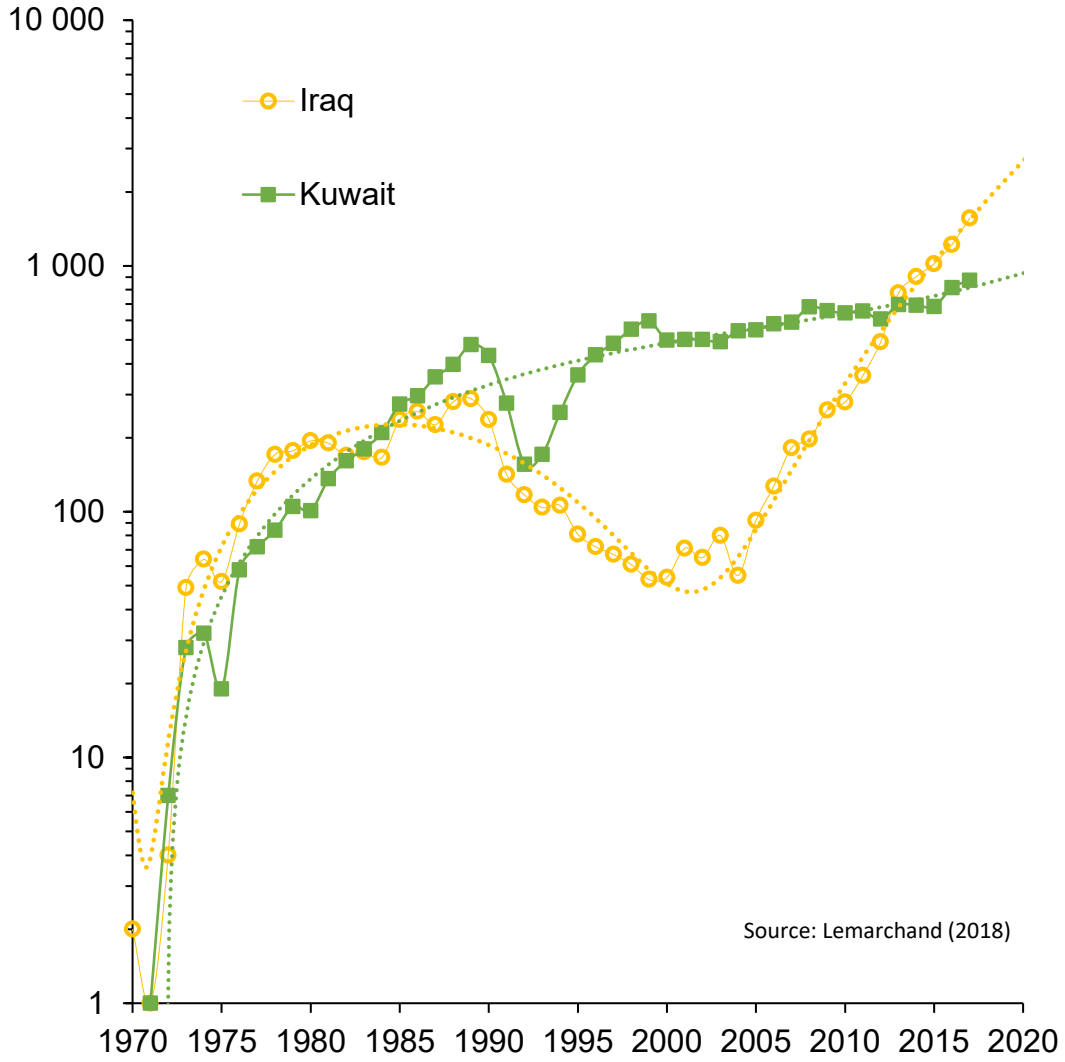
Senegal

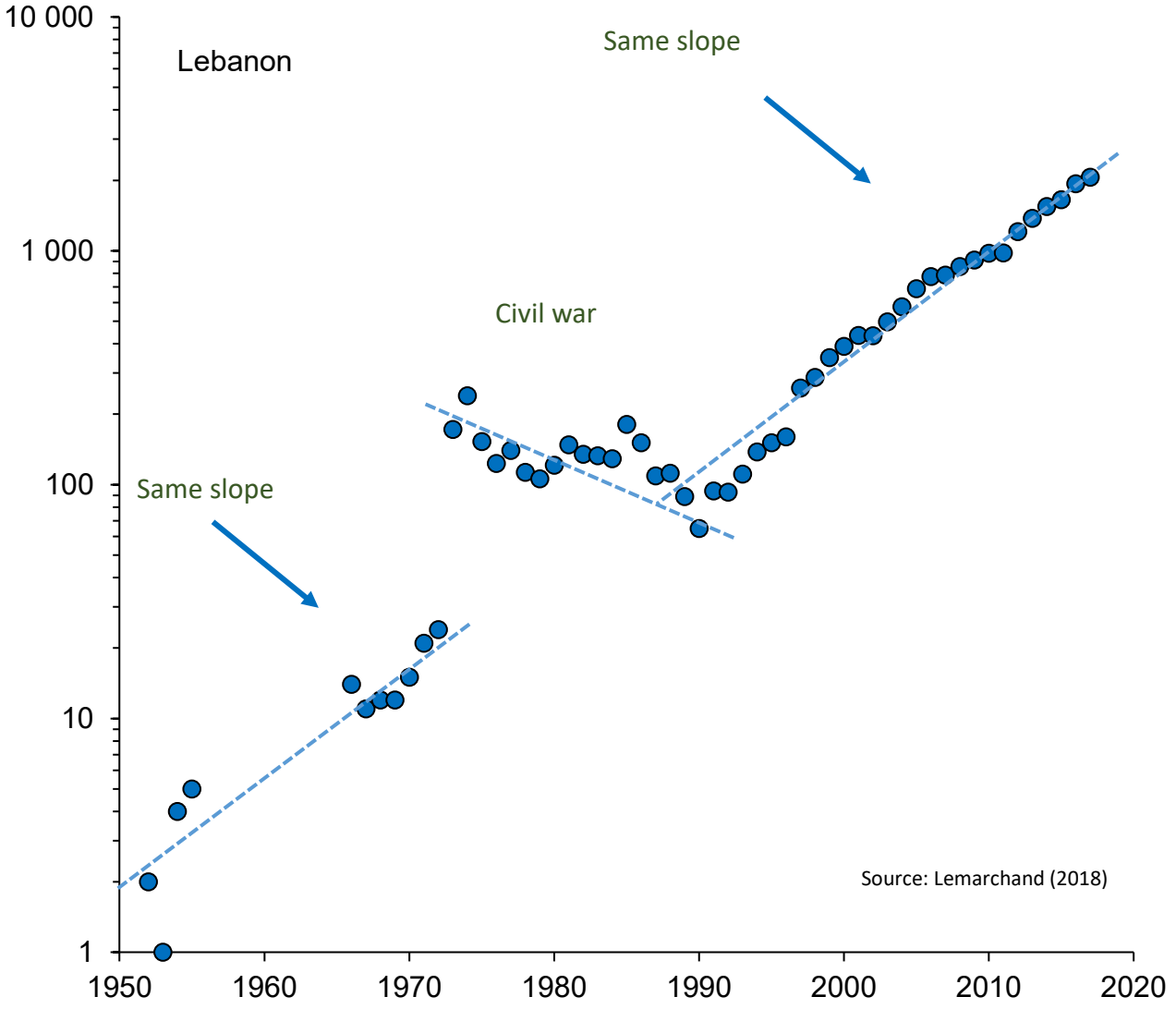


Rwanda

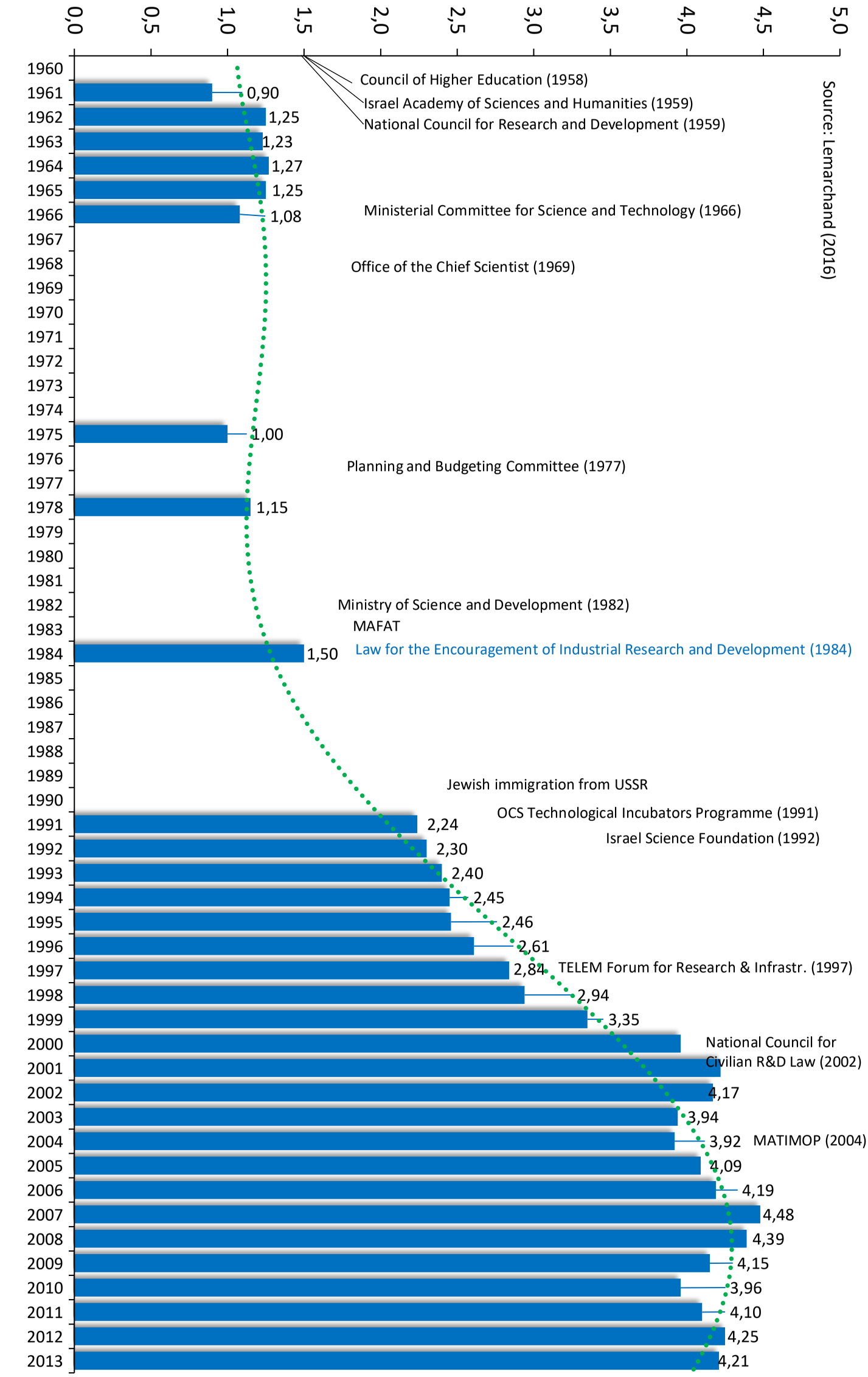


Some examples of the sensitivity of scientific productivity to political stability/absence violence

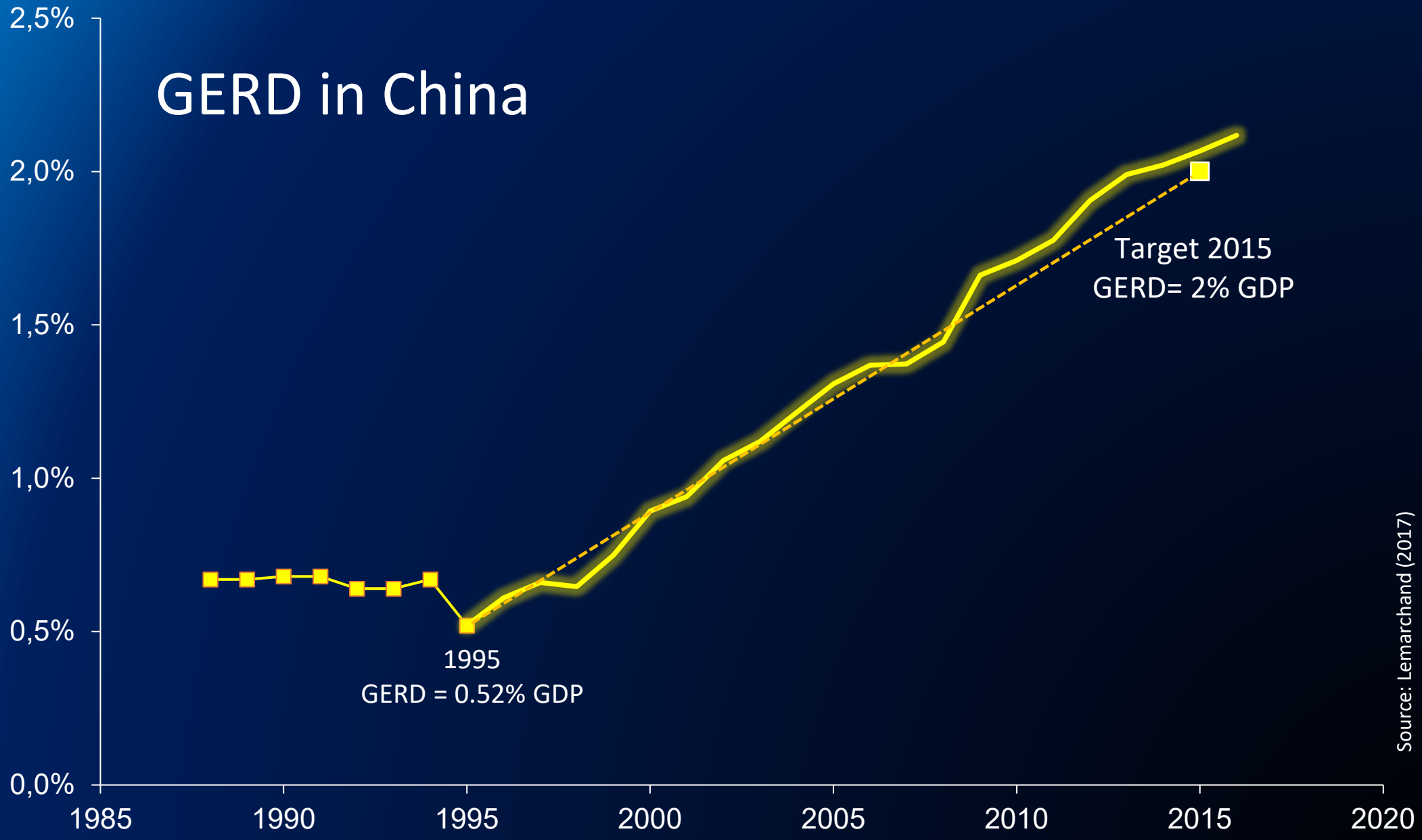




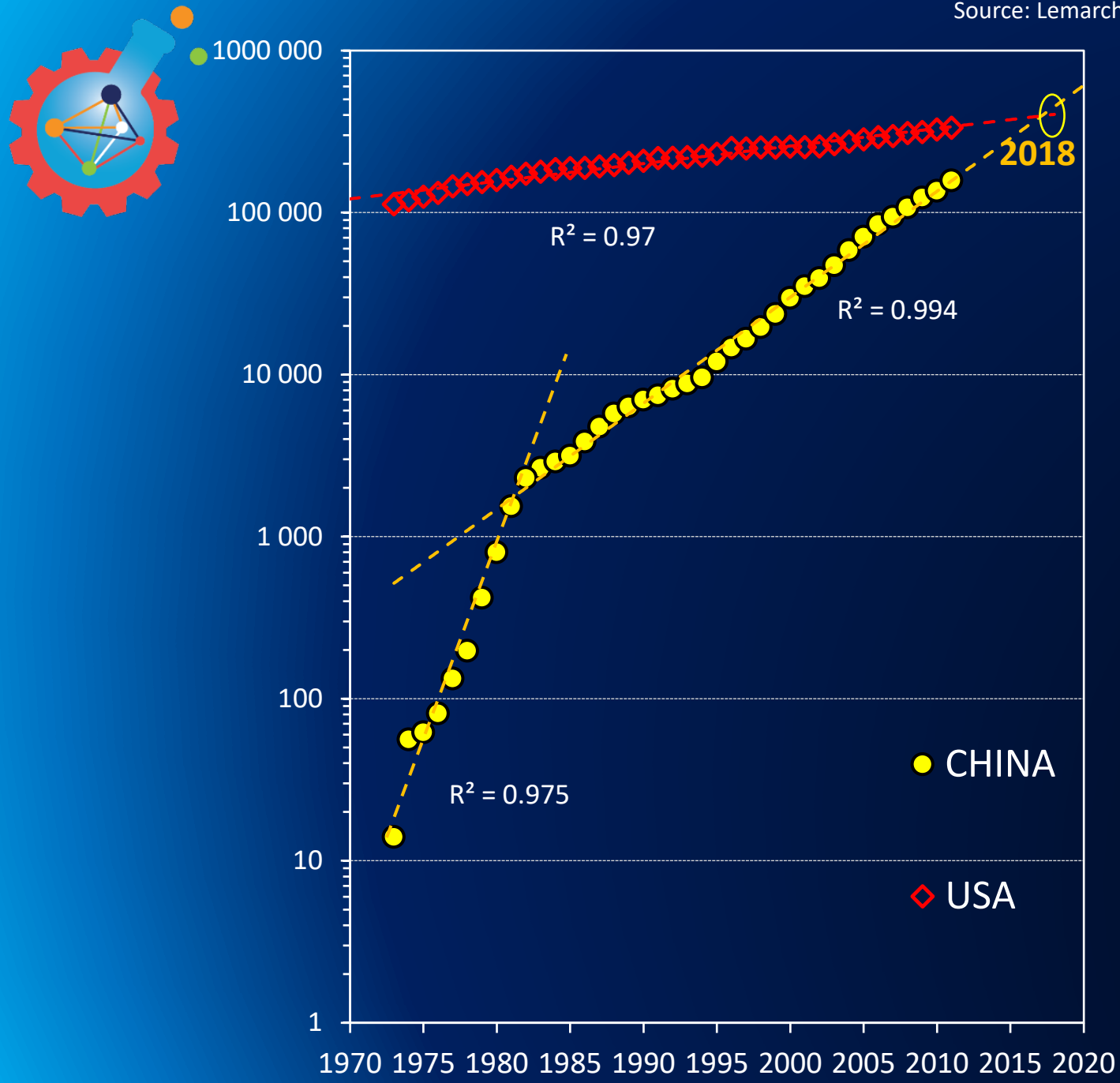
GERD in Israel (1960-2013), percentage GDP

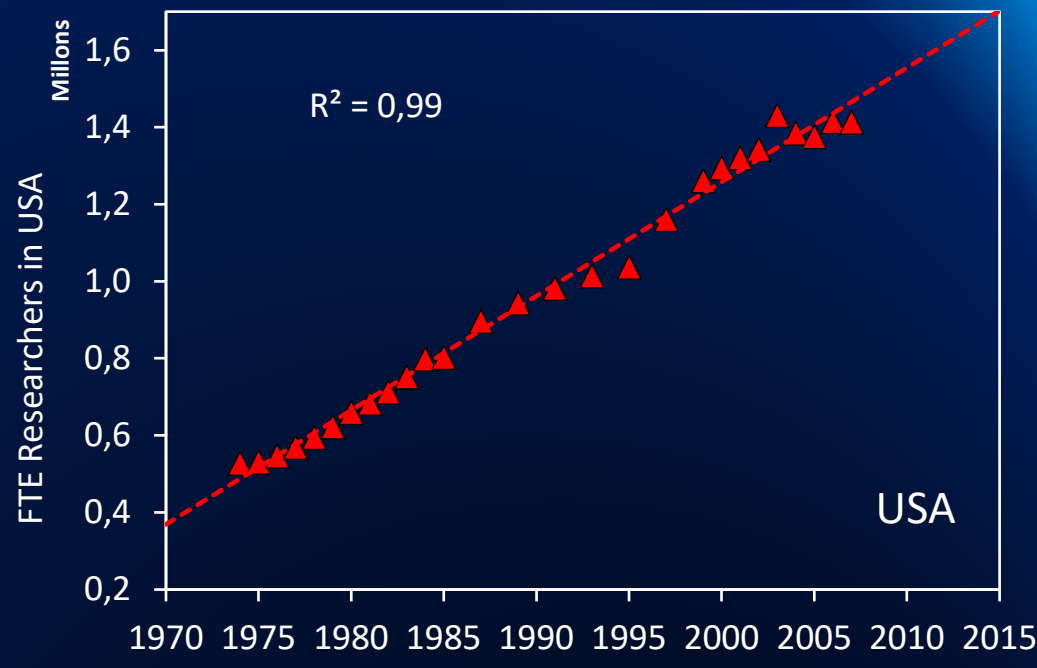


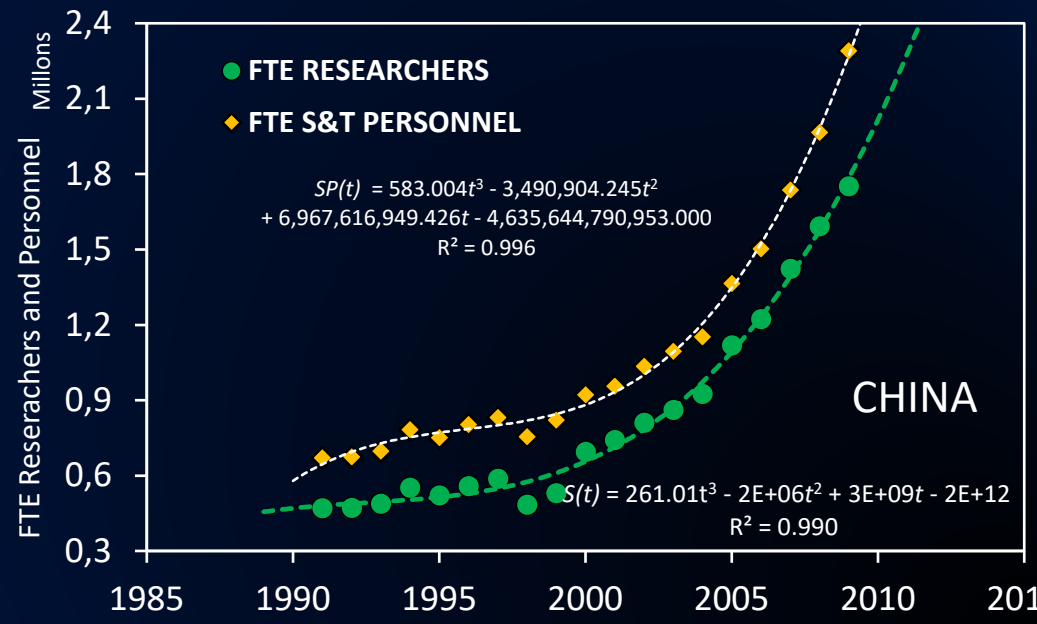
GERD in China



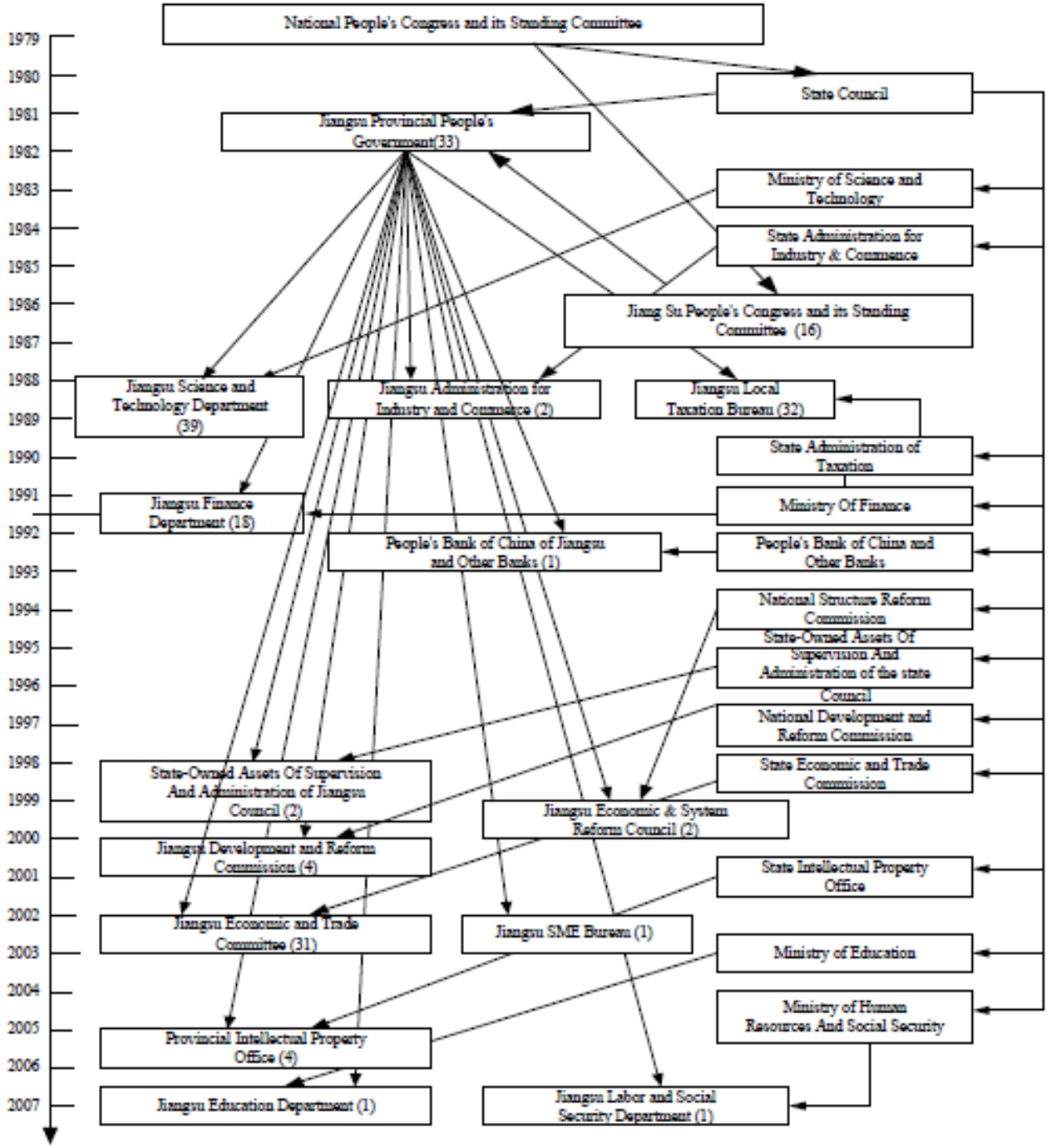
Source: Lemarchand (2012)







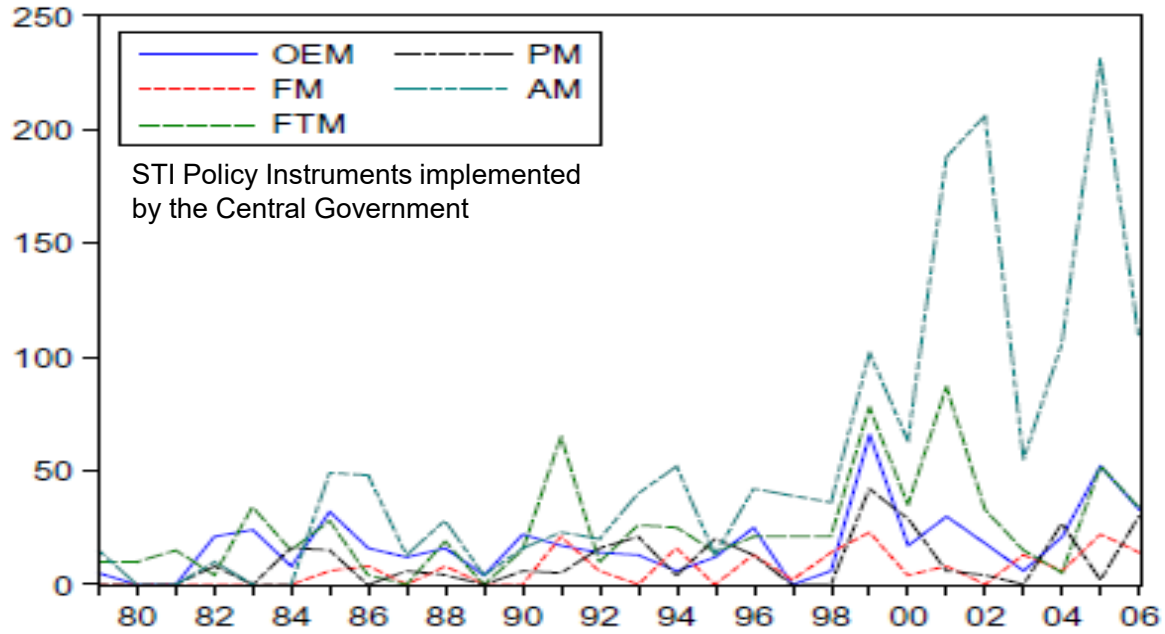
Technology Policy Framework of the Jiangsu province

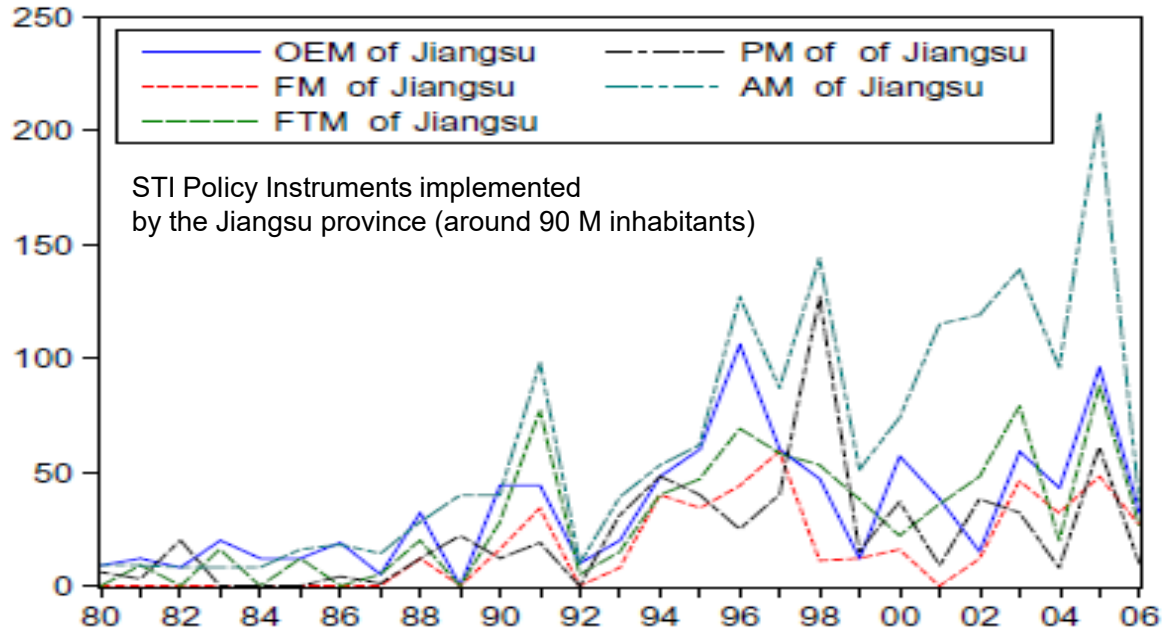


Source: Wenxiang Sun et al. (2011) *Journal of Science and Technology Policy in China*, vol. 2 (3):238-254

Evolution of Technological Policy Instruments in China

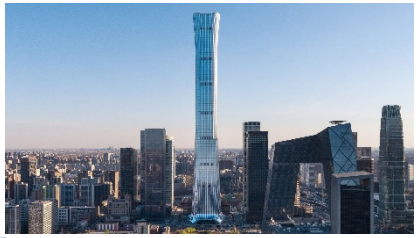
AM: Administrative Mechanisms
FM: Financial Mechanisms
FTM: Fiscal and Taxes Mechanisms
PM: Human Resources Mechanisms
OEM: Other Economic Mechanisms





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

Beijing



New York

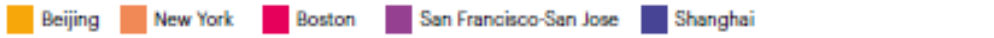
Boston

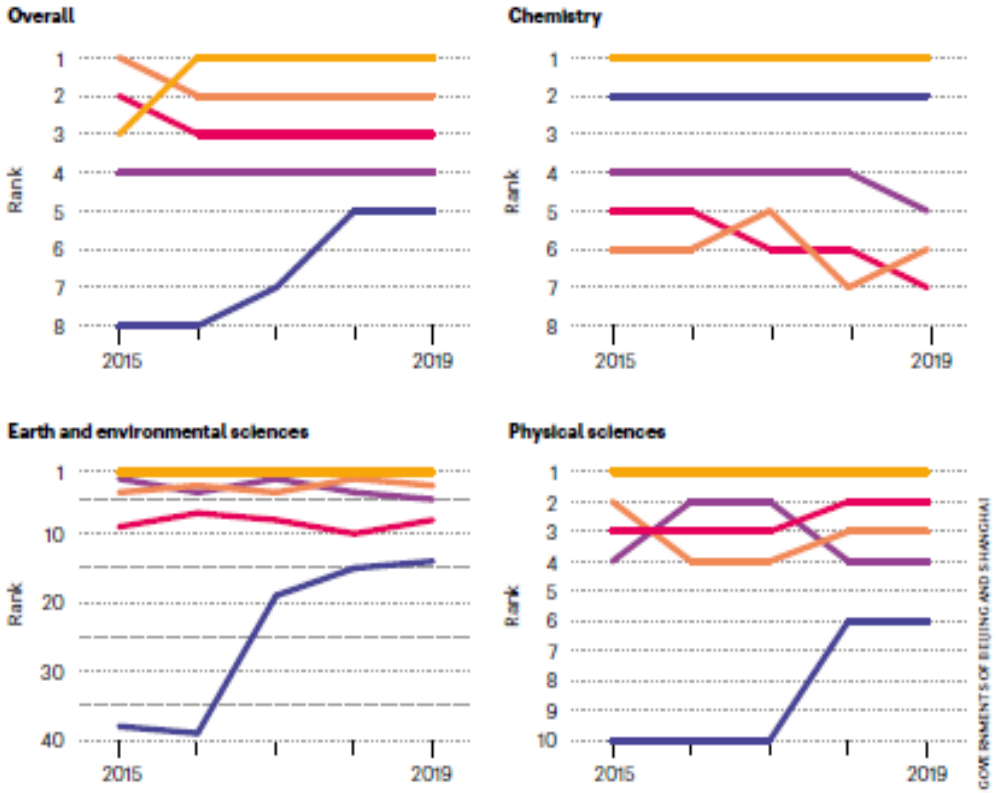
San Francisco

Shanghai

THE TOP FIVE CITIES

Increases in adjusted Share of 34.3% in chemistry, 61.0% in Earth and environmental sciences and 49.3% in life sciences between 2015 and 2019 helped Beijing reach the number one spot overall and retain it in all subjects except life sciences where it is fifth globally (see graph on page S57). Adjusted Share accounts for the small annual variation in the total number of articles in Nature Index journals.





FOCUS OF FUNDING

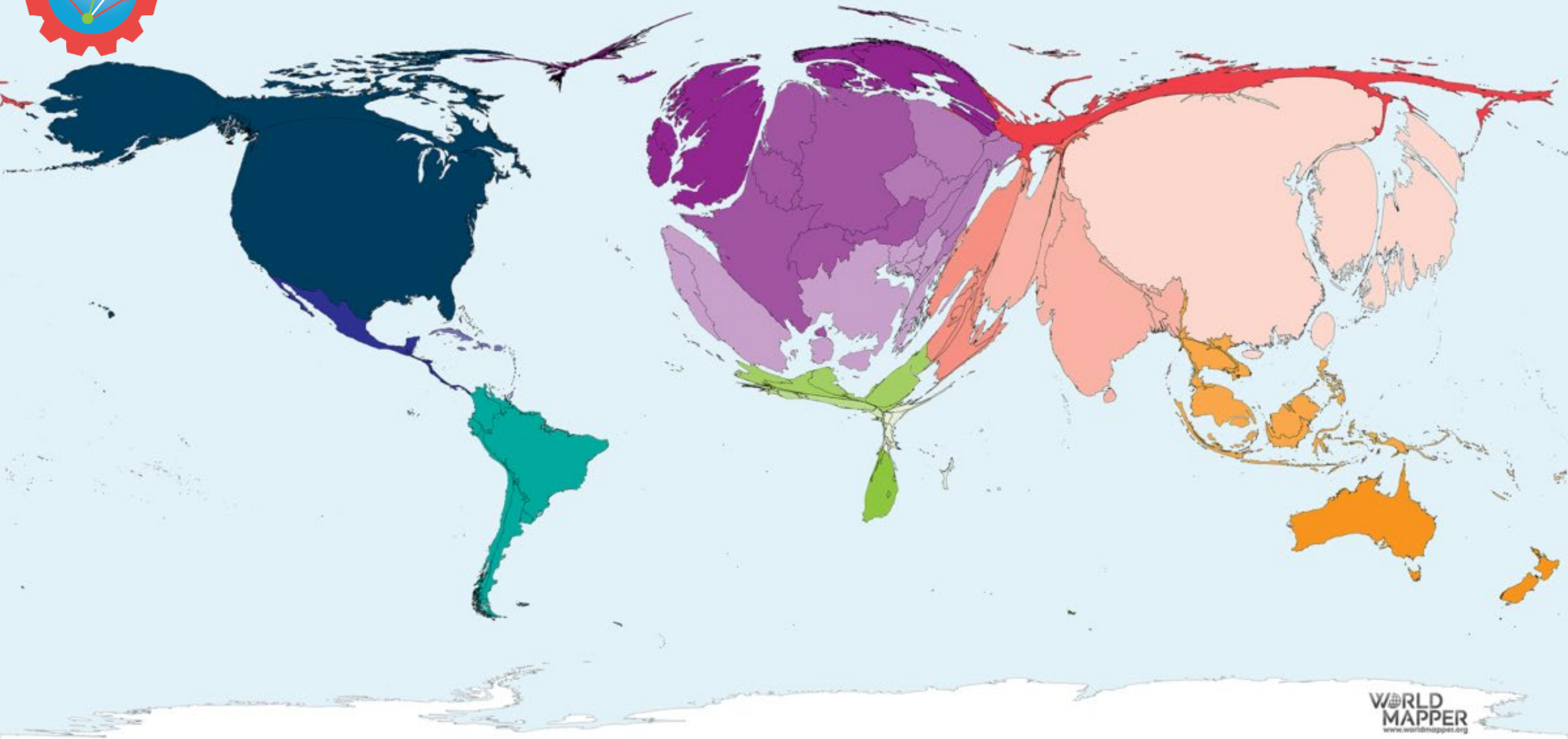
Per capita R&D spending in China's two main science hubs, Beijing and Shanghai, is far higher than the national average. The same is true for Nanjing (US$776), China's third science city, ranked 8th overall, 3rd for chemistry and 4th for Earth and environmental sciences.

	R&D per capita (US$)	R&D expenditure in 2019 (US$ billions)	R&D/GDP ratio	Graduate students in 2019
Beijing	1,478	30.3	6%	361,000
Shanghai	793	21.4	3.9%	164,900
National	217	310.5	2.2%	2,860,000

SOURCE: BUREAU OF STATISTICS AND MUNICIPAL GOVERNMENTS OF BEIJING AND SHANGHAI

September 24, 2020

World distribution of scientific articles 2016



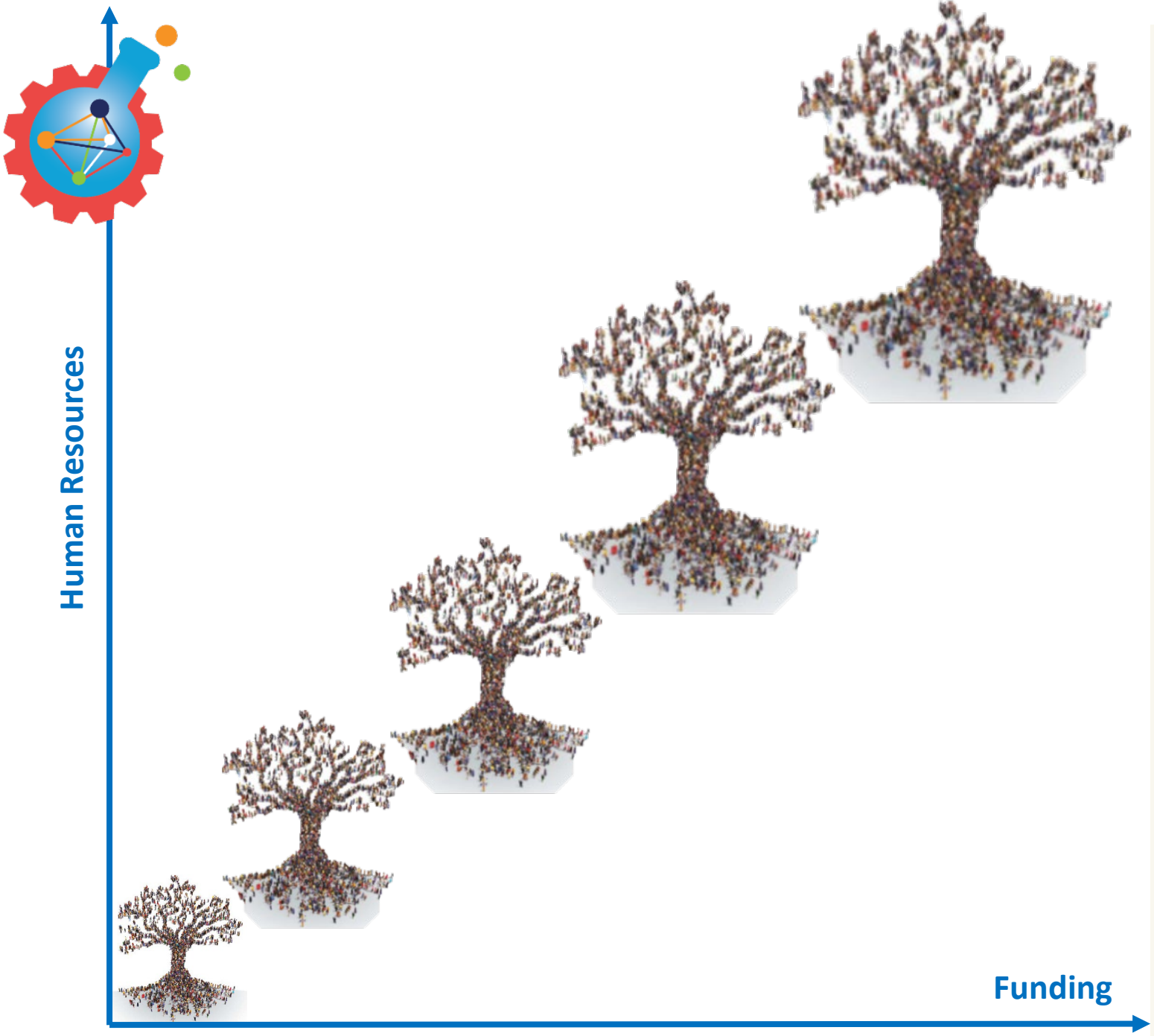
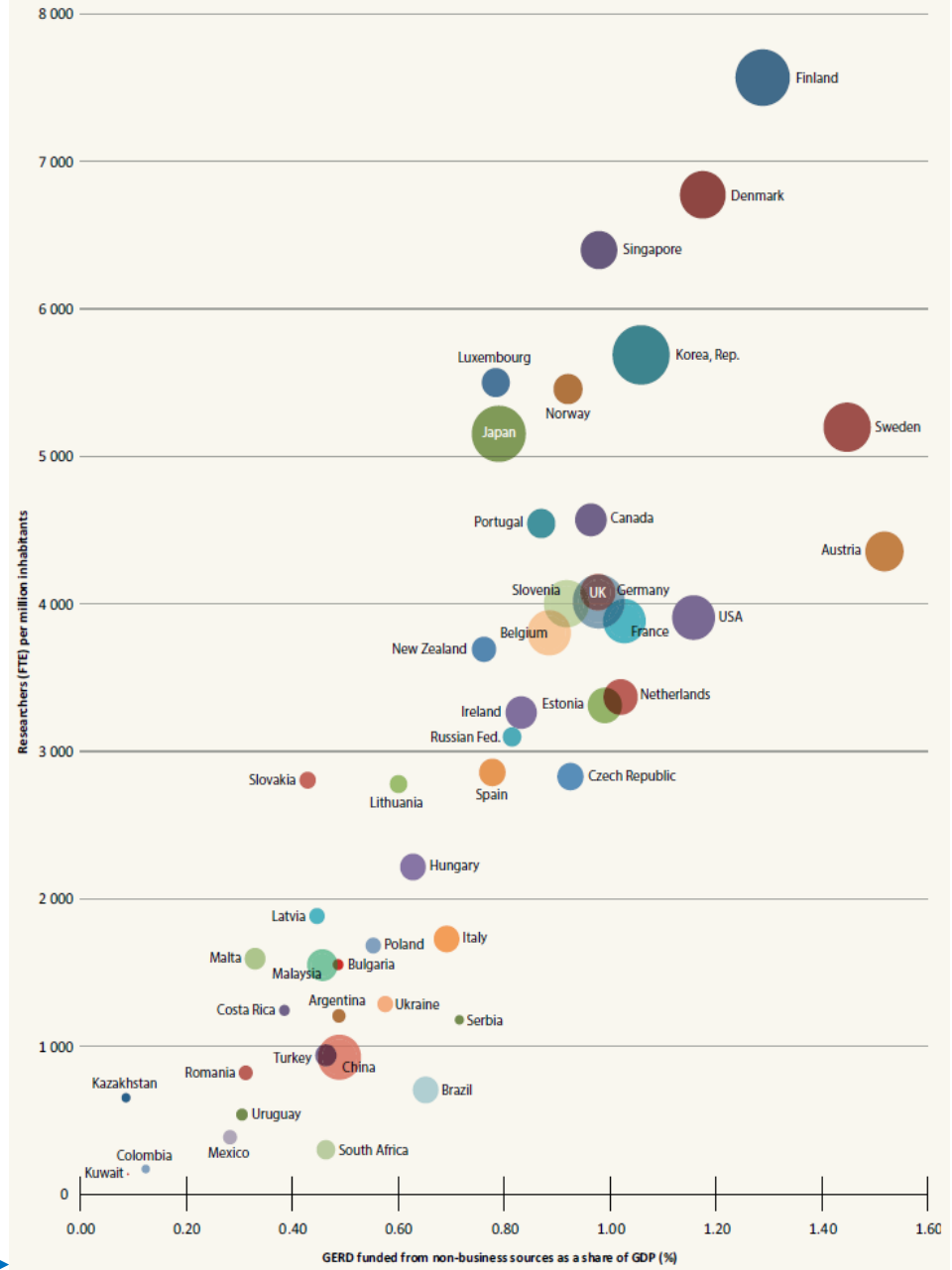


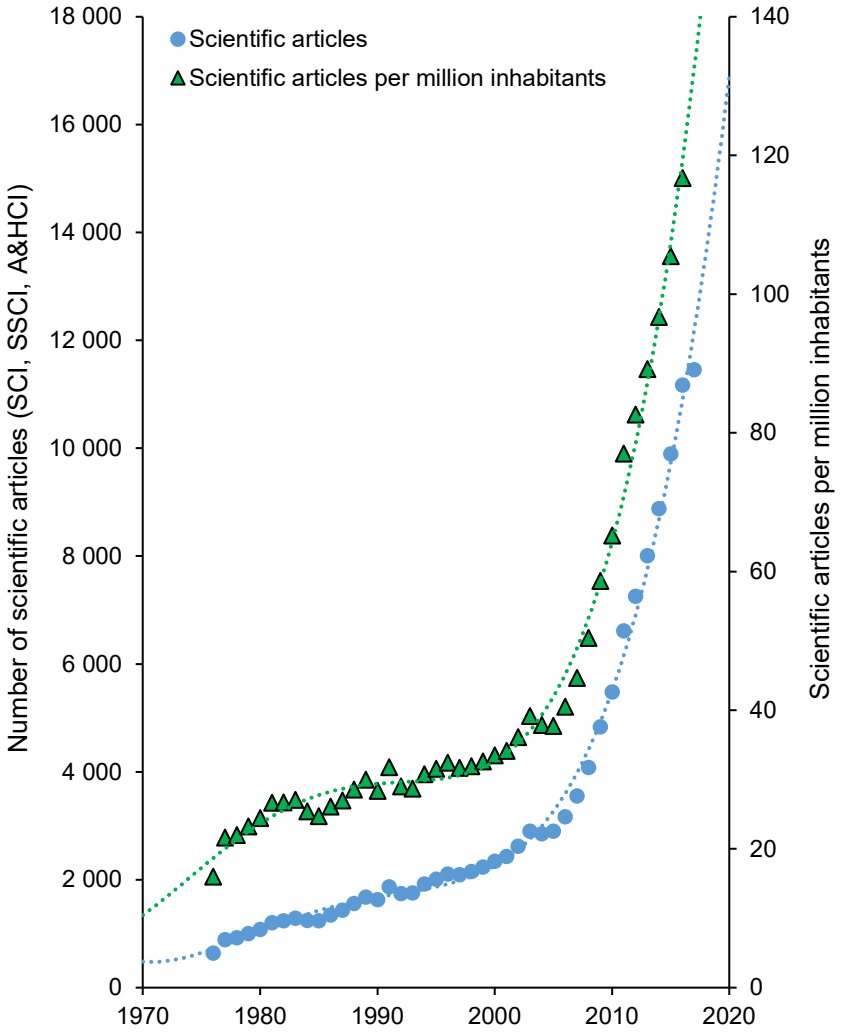
Figure 1.3: **Mutually reinforcing effect of strong government investment in R&D and researchers, 2010–2011**

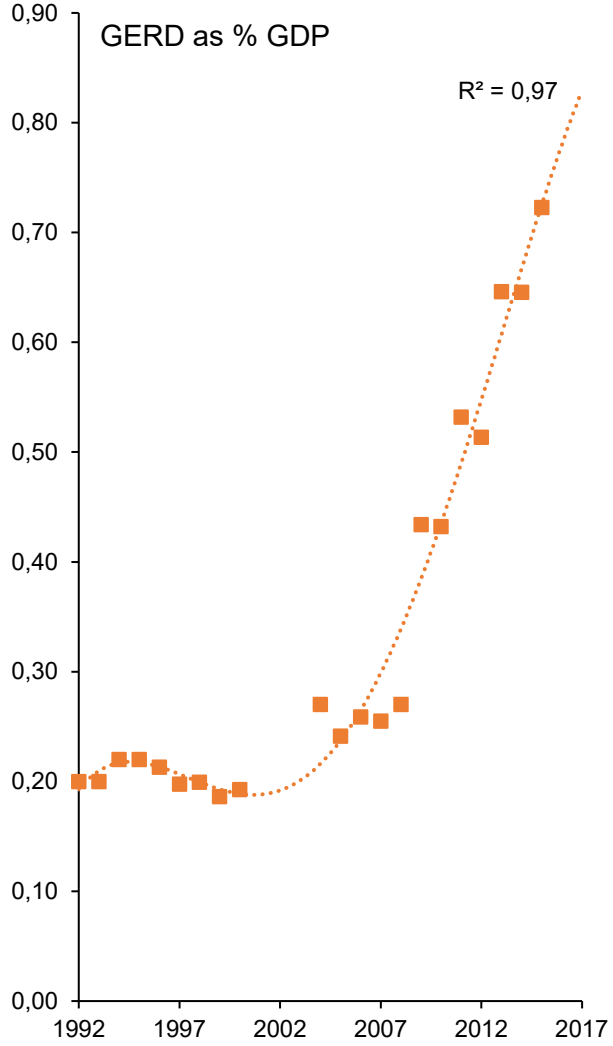
The size of the bubbles is proportionate to GERD funded by business as a share of GDP (%)

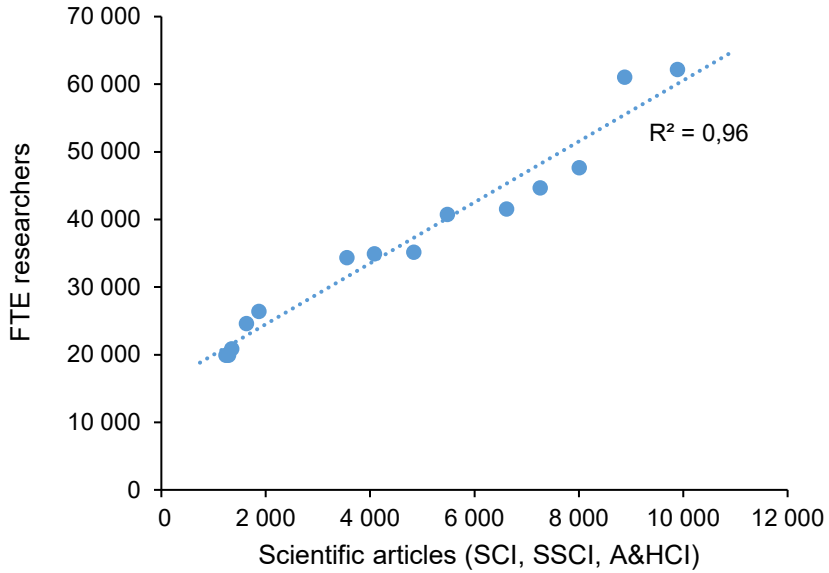


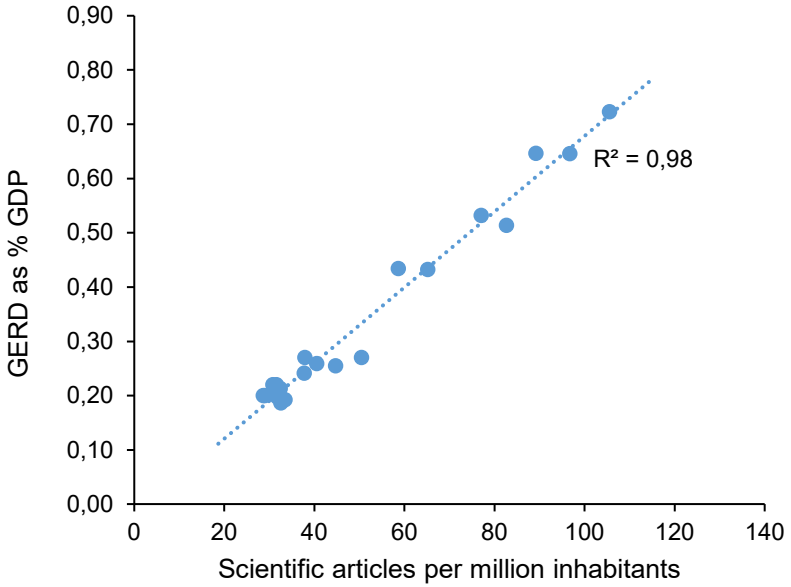
Source: UNESCO Institute for Statistics, August 2015

Scaling patterns of the scientific activities in Egypt



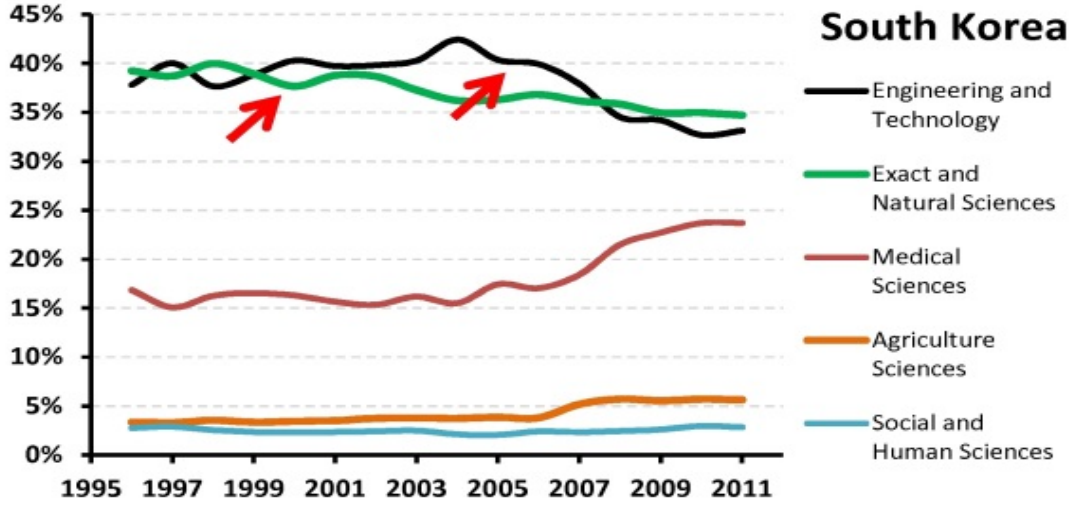


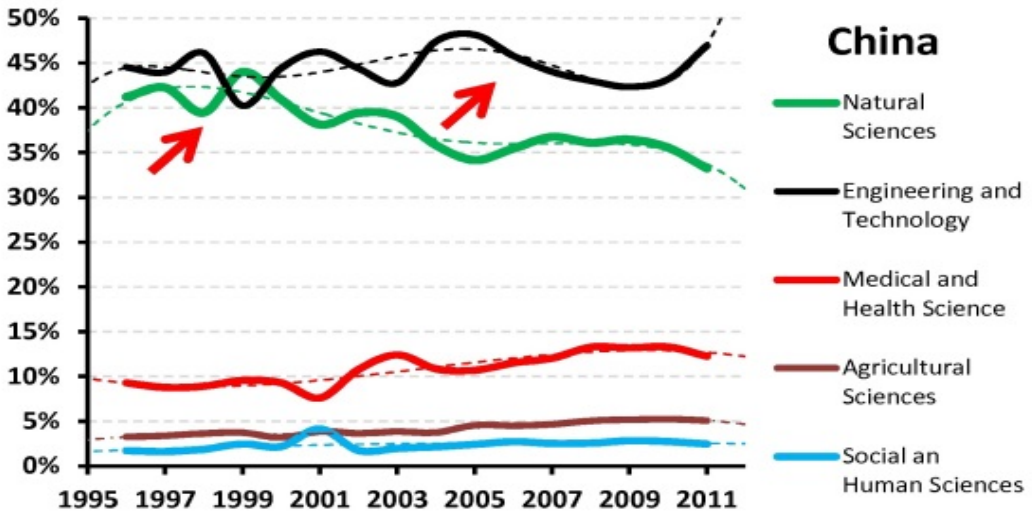


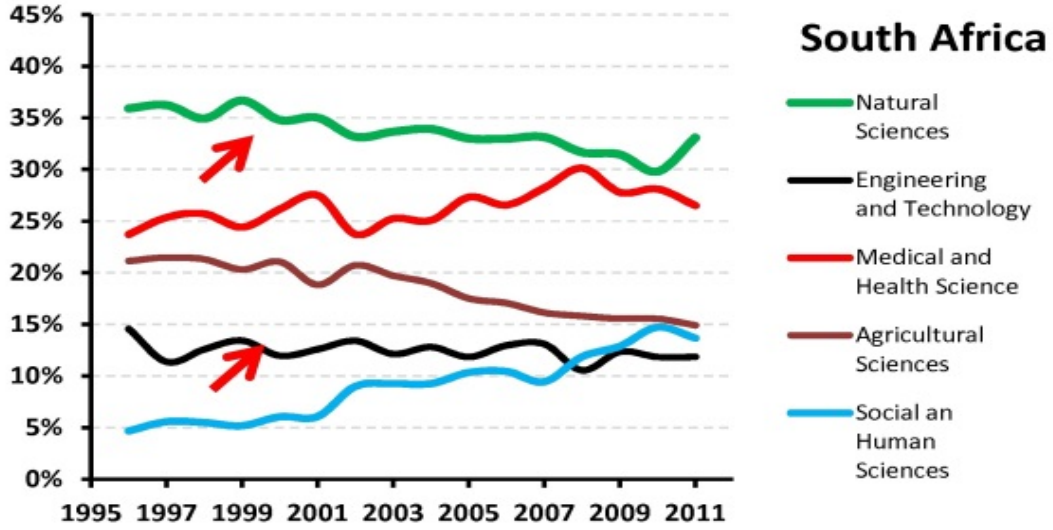


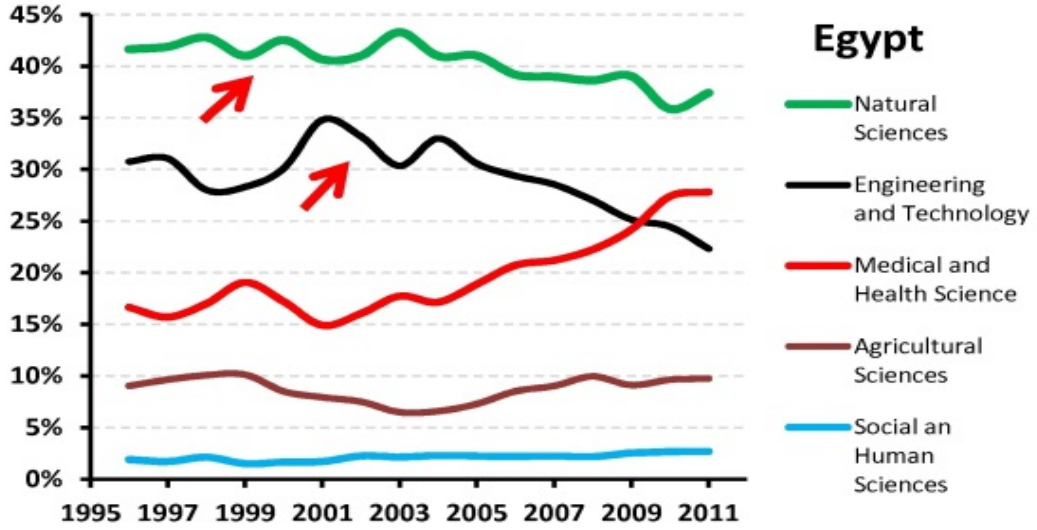
Source: Lemarchand (2018)

Articles by main field of science

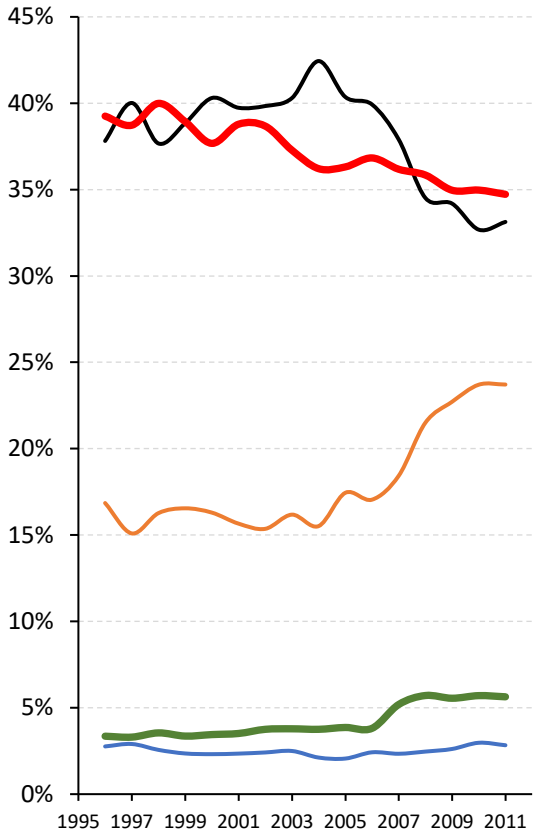




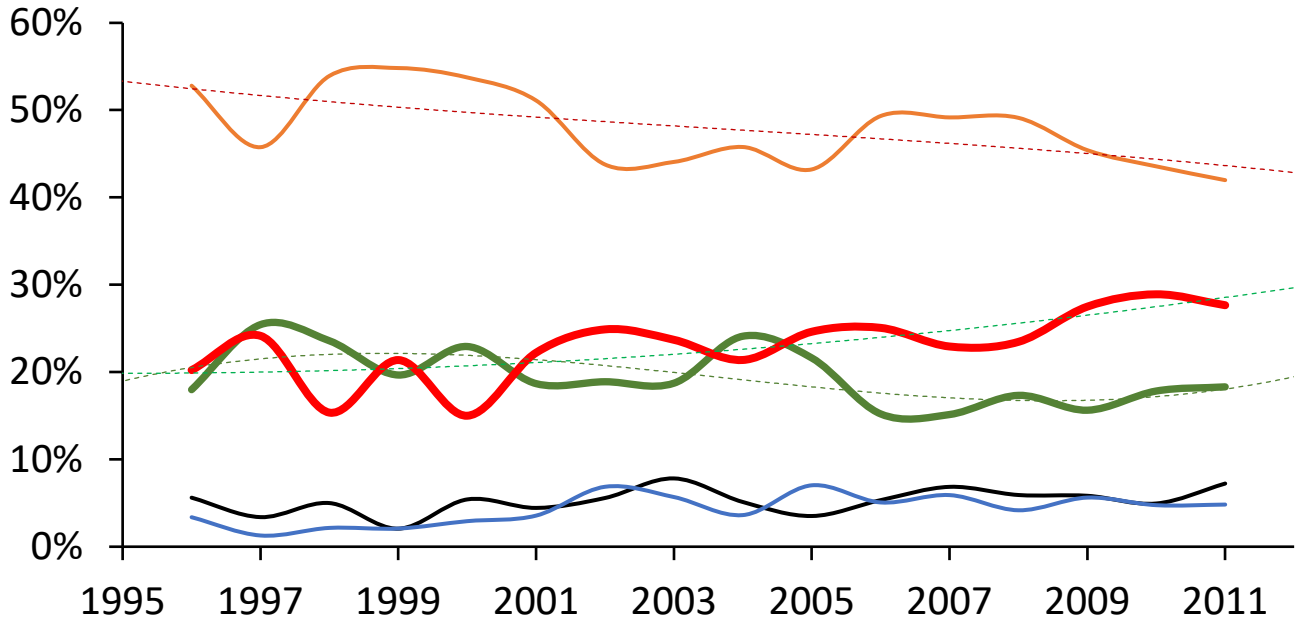




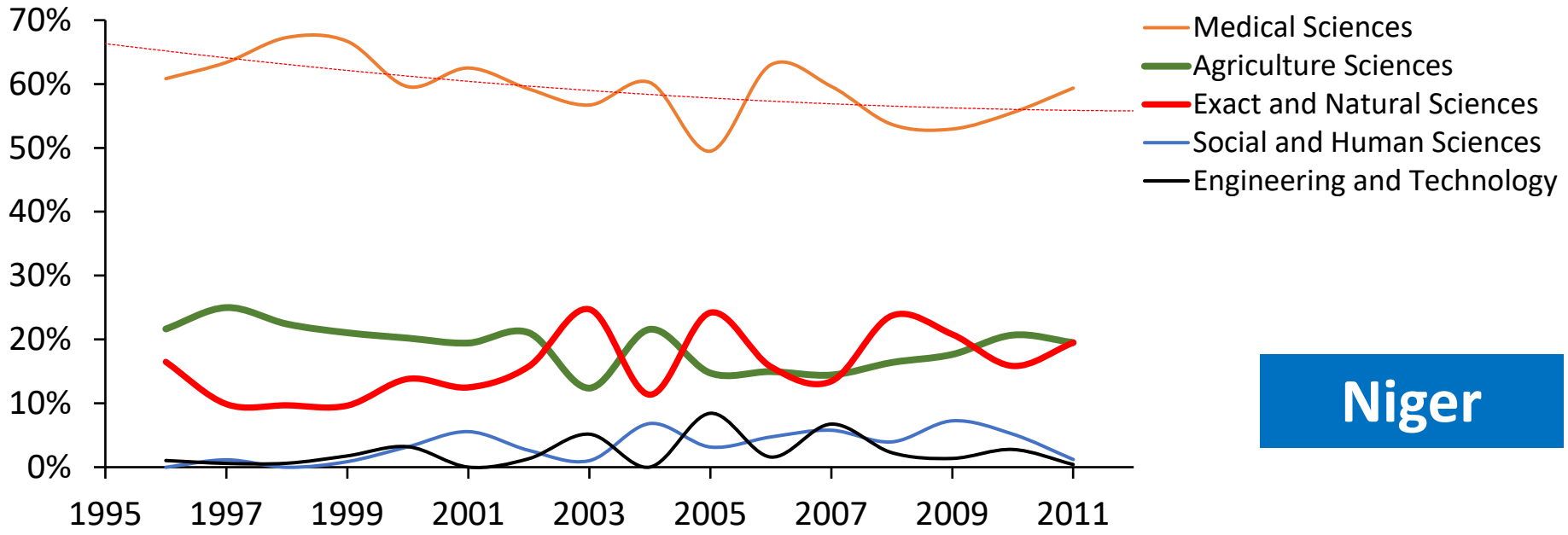
Source: Lemarchand (2013)



South Korea



Senegal



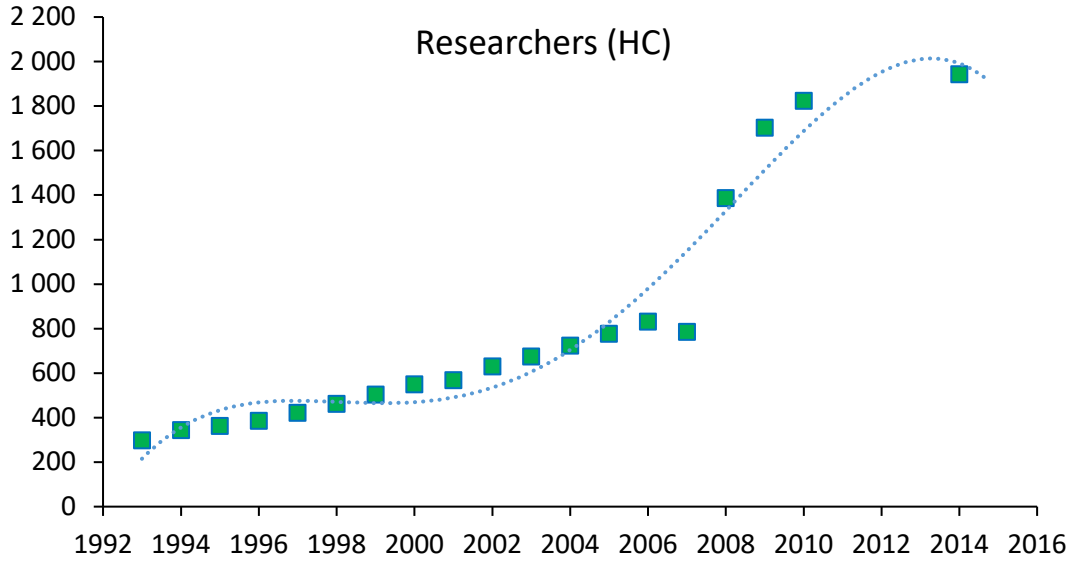
Niger

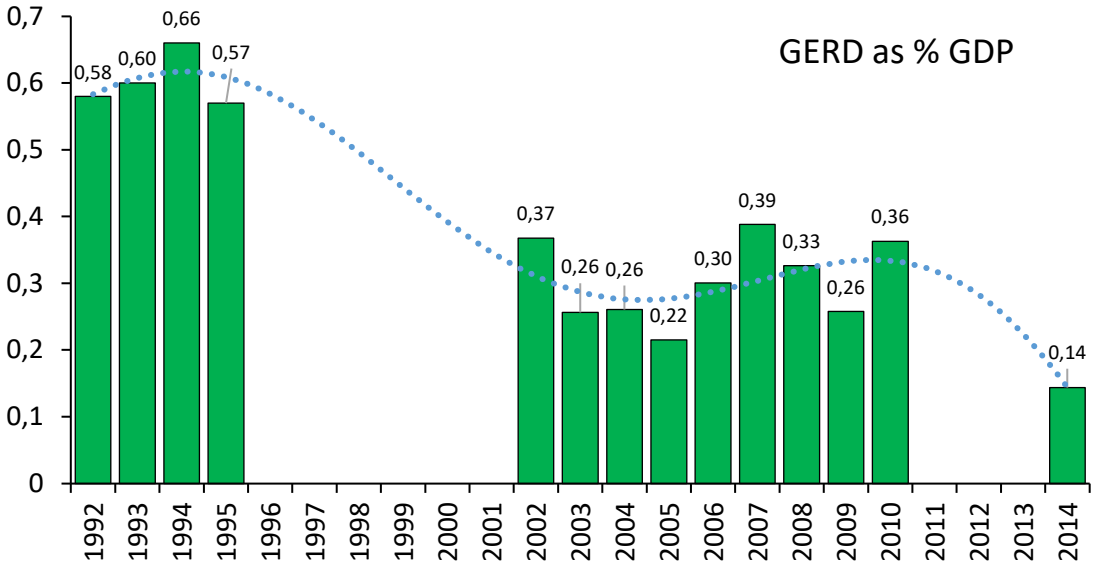
Time for questions

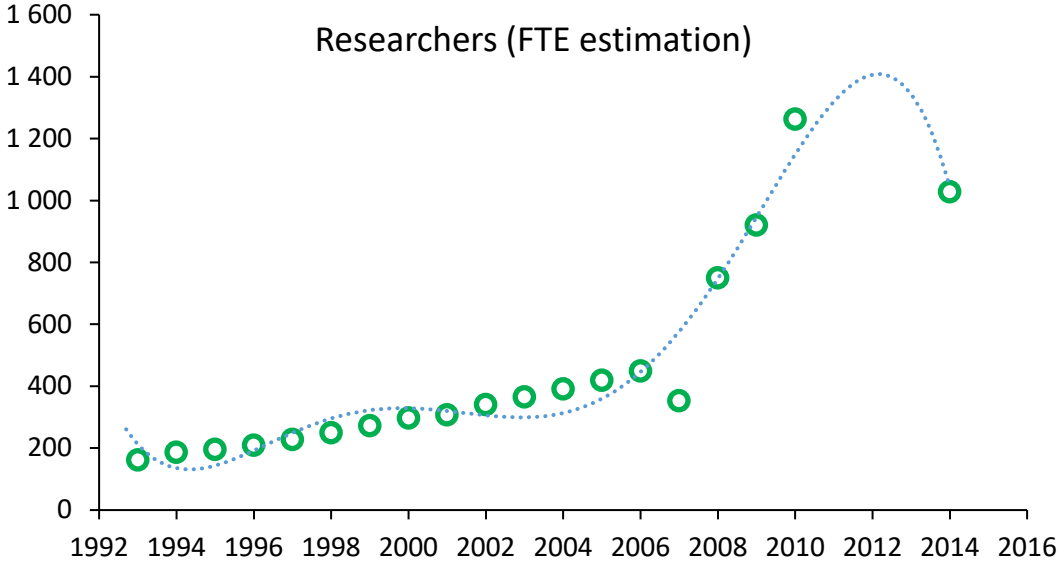
First run

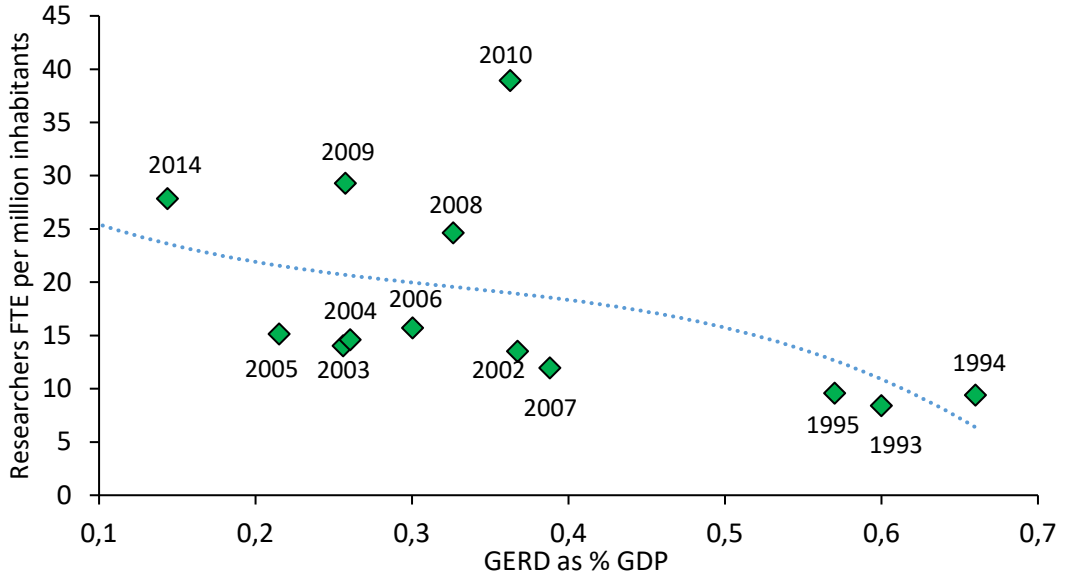
What do we know about R&D indicators in Uganda?

Main R&D Indicators in Uganda



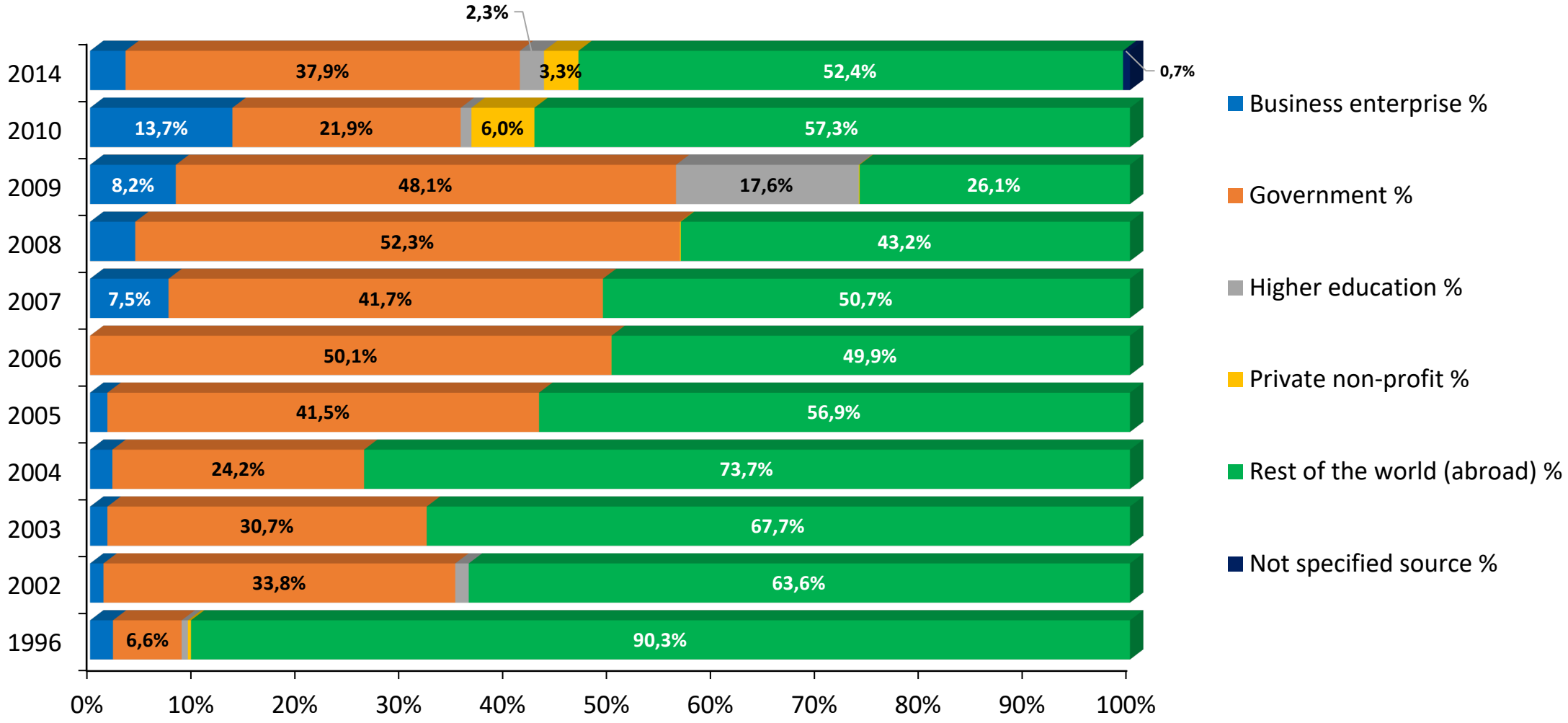






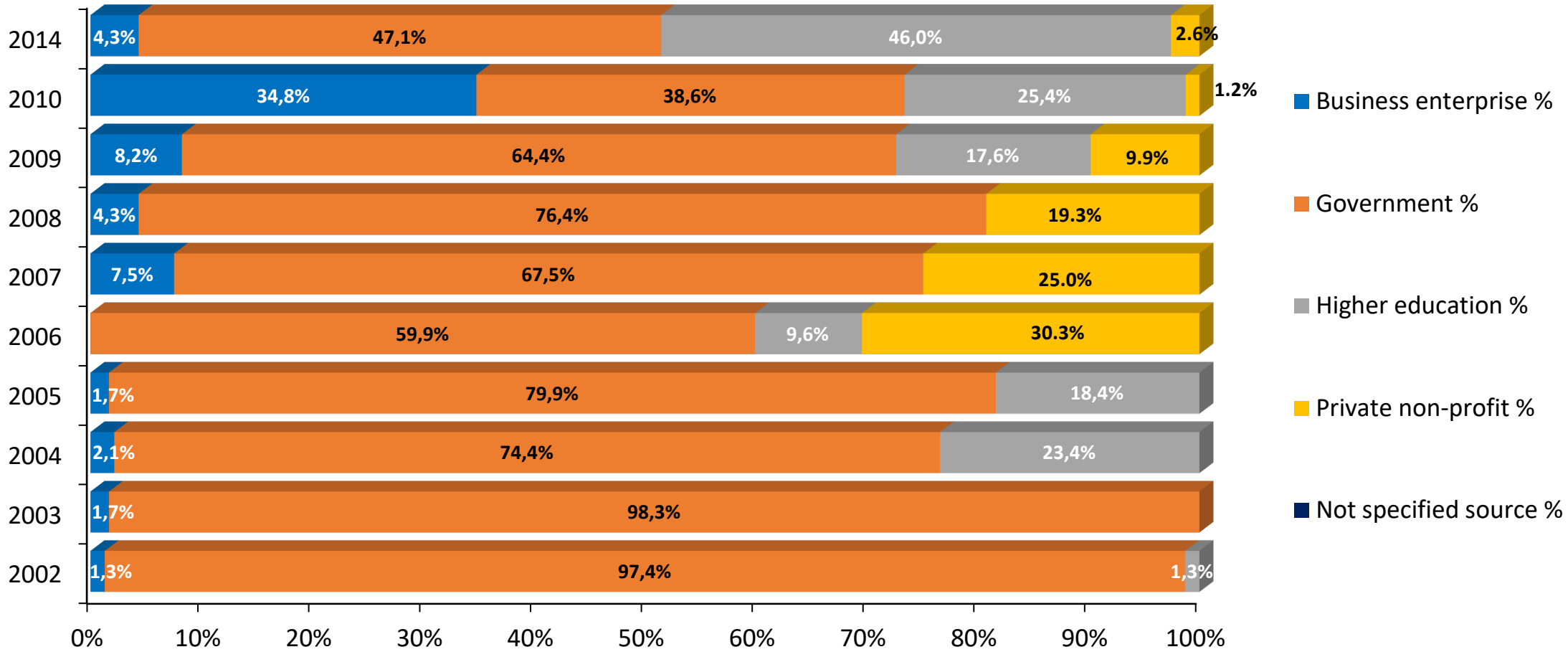
Source: Lemarchand (2021) based on raw data from Unesco Institute for Statistics and UN Statistics Division

Distribution of GERD in Uganda by financing source

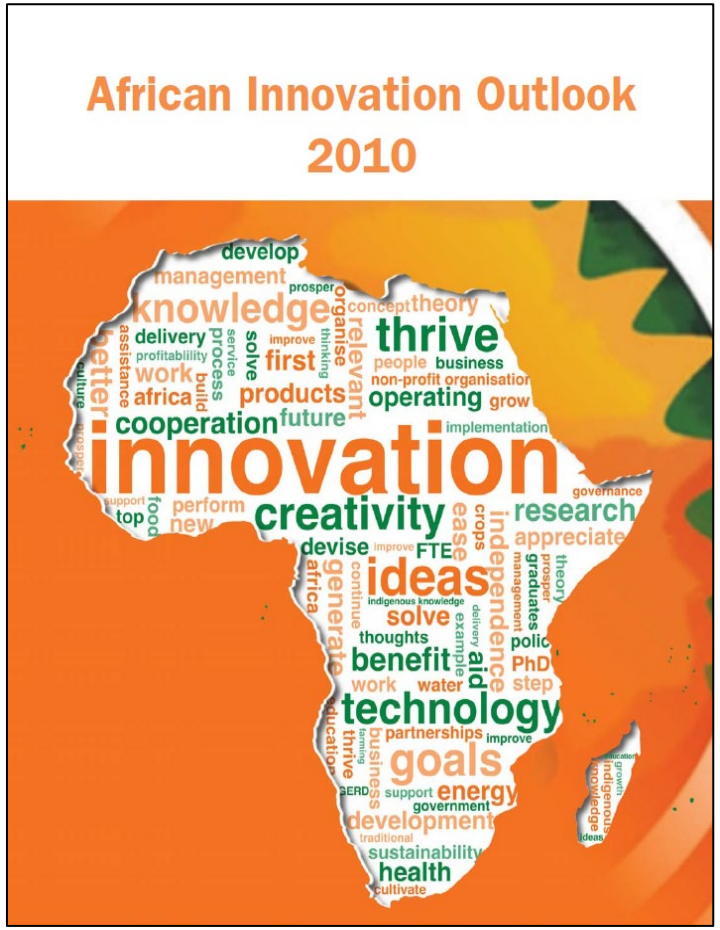


Source: Lemarchand (2021) based on raw data from UNESCO Institute for Statistics and UNESCO Statistical Yearbook 1999

Distribution of GERD in Uganda by sector of performance



Source: Lemarchand (2021) based on raw data from UNESCO Institute for Statistics



2007 R&D Survey in Uganda

Researchers HC: 785 → approx. 352 FTE

or 11.9 FTE Researchers/million inhabitants

GERD = 1.1 % GDP **(??)**

Table 3A.37: Uganda: R&D personnel full-time equivalents by occupation (2007/08)

R&D personnel full-time equivalent (FTE)	Total	Business sector	Government	Higher education	Private non-profit organisations*
Total R&D personnel by occupation	**634.75**	**58.79**	**357.52**	**218.44**	**NA**
Researchers	351.76	25.79	232.12	93.85	NA
Technicians	120.07	14.9	39.34	65.83	NA
Other	162.92	18.1	86.06	58.76	NA
Female	**267.48**	**8.86**	**192.69**	**65.93**	**NA**
Researchers	184.8	6.11	139.32	39.37	NA
Technicians	27.19	0.14	4.69	22.36	NA
Other	55.49	2.61	48.68	4.2	NA

* Sector not surveyed

Table 3.1: Gross domestic expenditure on R&D (GERD) (2007/08)

	Year	GERD million PPP$	GERD per capita PPP$	GERD as % of GDP
Gabon	2008	78.7	58.3	0.47
Ghana	2007	120.1	5.0	0.38
Kenya	2007	277.8	7.4	0.48
Malawi	2007	180.1	12.9	1.70
Mali†	2007	37.4	3.0	0.28
Mozambique*‡	2007	42.9	2.0	0.25
Nigeria*†	2007	583.2	3.9	0.20
Senegal	2008	99.0	8.0	0.48
South Africa	2007	4 976.6	102.4	1.05
Tanzania*	2007	234.6	5.8	0.48
Uganda†	2007	359.8	11.6	1.10
Zambia	2008	55.3	4.6	0.37

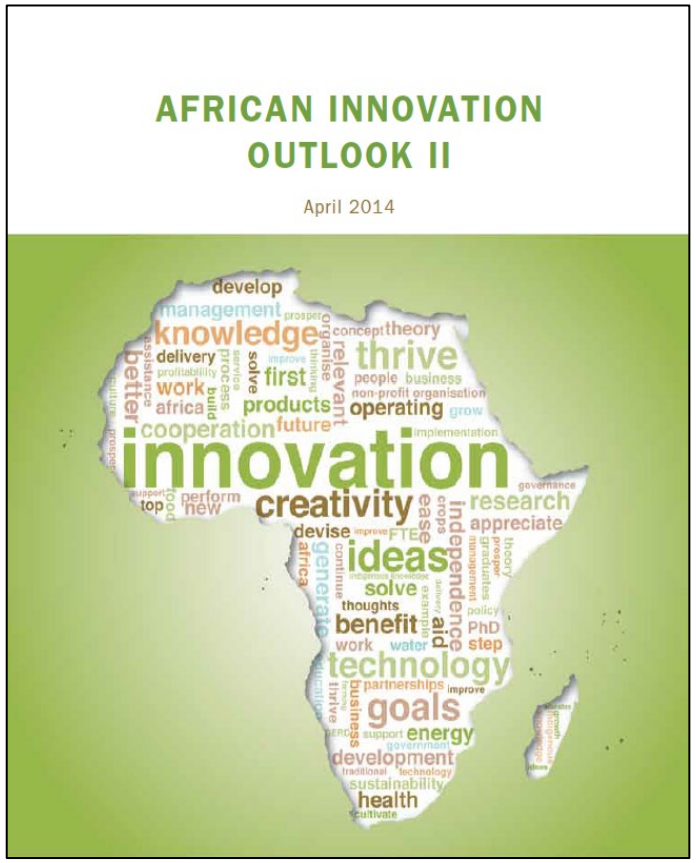
Sources: ASTII R&D Surveys; PPP data from UNDP (2010); population and GDP data from AfDB (2010)

Note:

* Data do not include the business enterprise sector

† Data do not include private non-profit institutions/organisations

‡ Data do not include the higher education sector

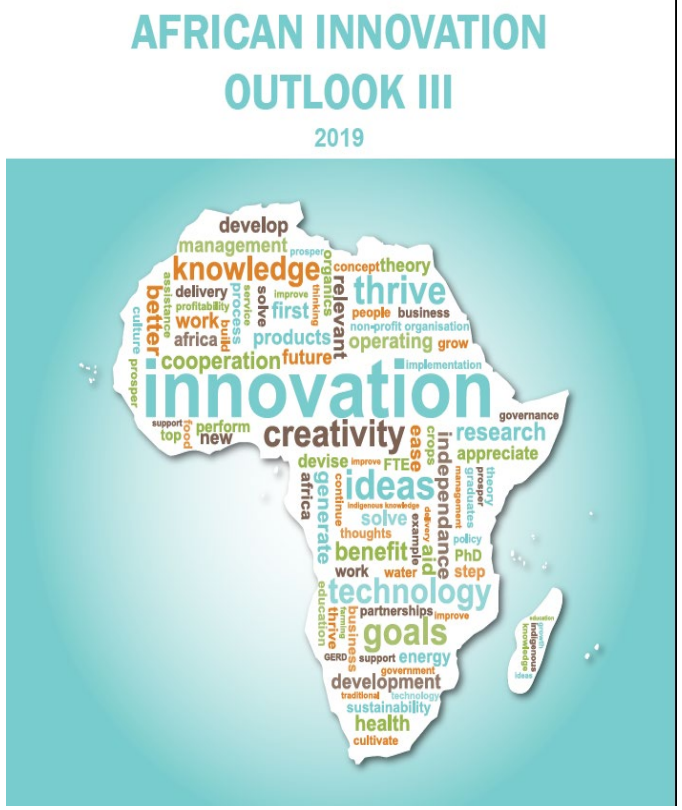


2010 R&D Survey in Uganda
Researchers HC: 2,823 → 1,263 FTE
or 39 FTE Researchers/million inhabitants
GERD = 0.50% GDP

TABLE 3A.81: UGANDA: RESEARCHER FTES BY LEVEL OF EDUCATION AND FIELD OF SCIENCE (2010)

RESEARCHERS FTE BY LEVEL OF EDUCATION	TOTAL	BUSINESS	GOVERNMENT	HIGHER EDUCATION	PRIVATE NON PROFIT
TOTAL	**1 263.2**	**639.2**	**264.7**	**325.0**	**34.3**
ISCED 6	307.6	112.3	72.4	122.0	0.9
ISCED 5A	826.0	427.8	176.2	192.0	30.0
ISCED 5B	8.8	0.0	5.3	3.0	0.5
Other	120.8	99.1	10.8	8.0	2.9
RESEARCHERS FTE BY FIELD OF SCIENCE	**1 263.0**	**639.0**	**264.6**	**325.0**	**34.4**
Natural sciences	189.7	85.3	42.5	61.0	0.9
Engineering and technology	120.7	55.4	32.3	32.0	1.0
Medical sciences	92.4	0.0	28.1	63.0	1.3
Agricultural sciences	164.6	26.2	107.1	28.0	3.3
Social sciences	596.4	450.7	48.2	79.0	18.5
Humanities	99.2	21.4	6.4	62.0	9.4
Not elsewhere classified	0.0	0.0	0.0	0.0	0.0
FEMALE	**331.6**	**161.0**	**75.4**	**81.0**	**14.2**
Natural sciences	32.9	5.9	10.5	16.0	0.5
Engineering and technology	22.9	0.4	14.4	8.0	0.1
Medical sciences	20.2	0.0	7.2	13.0	0.0
Agricultural sciences	37.1	5.3	25.1	6.0	0.7
Social sciences	180.0	141.5	15.6	17.0	5.9
Humanities	38.5	7.9	2.6	21.0	7.0
Not elsewhere classified	0.0	0.0	0.0	0.0	0.0

2019 African Innovation Outlook III



2014 R&D Survey in Uganda
Researchers HC: 1,942 → 1,028 FTE
or 25.8 FTE Researchers/million inhabitants
GERD = 0.18% GDP

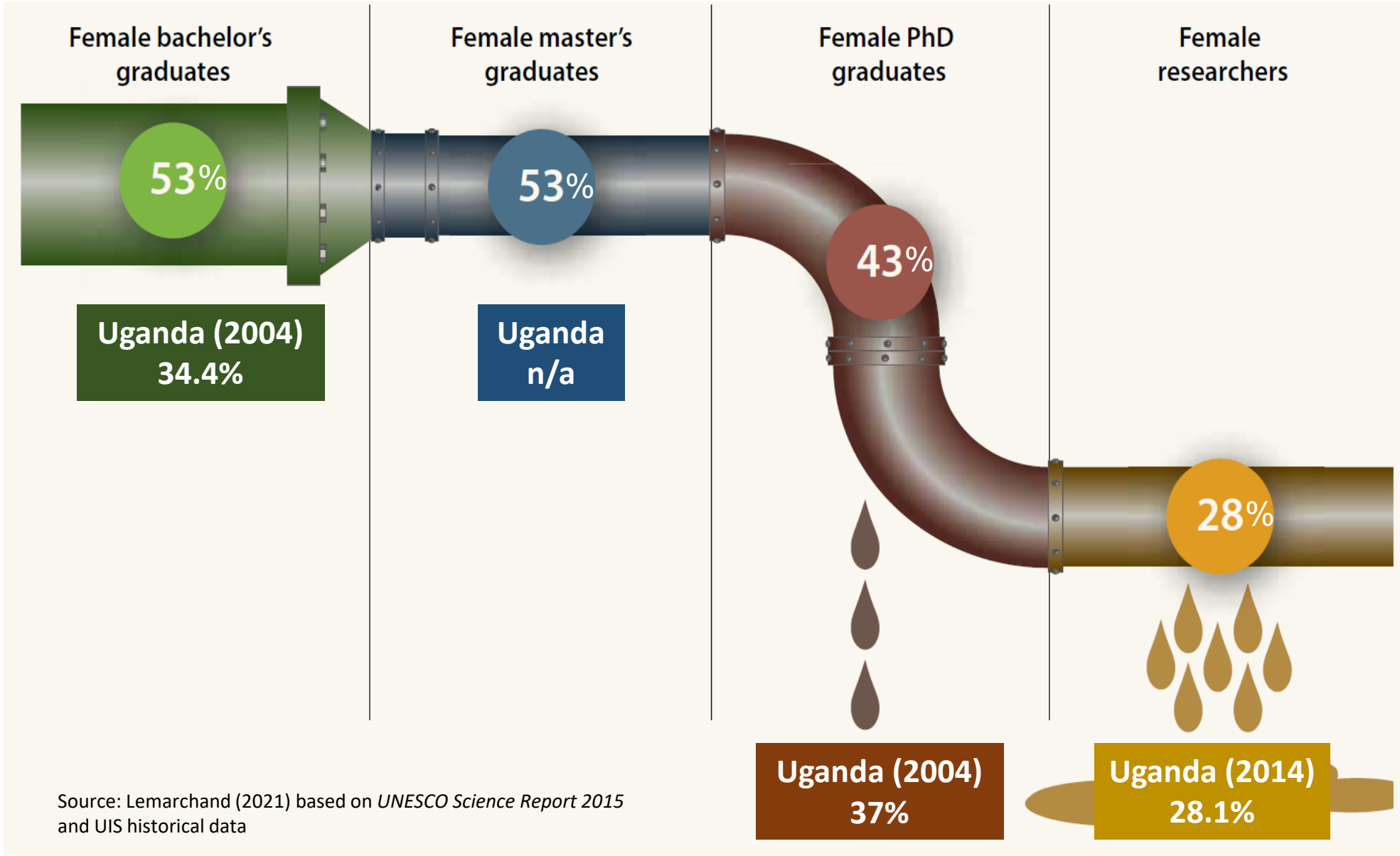
Tab. 2A-23. 5 Uganda - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	1027,8	40,7	456,6	467,8	62,7
Natural sciences	105,2	5,6	33,4	65,4	0,8
Engineering and technology	97,4	7,8	20,7	58,5	10,4
Medical sciences	200,9	5,5	108,3	84,8	2,3
Agricultural sciences	210,9	9,1	155,6	45,1	1,1
Social sciences	291,6	10,4	110	136,6	34,6
Humanities	121,8	2,3	28,6	77,4	13,5
Not elsewhere classified	0	0	0	0	0
Female	289,1	8,1	133,4	131	16,6
Natural sciences	24,5	0,5	10	14	0
Engineering and technology	19,9	0,9	8,1	10,2	0,7
Medical sciences	58,9	2	28	28,8	0,1
Agricultural sciences	48,2	0,8	39,3	7,7	0,4
Social sciences	101,1	3,7	37,4	48,5	11,5
Humanities	36,5	0,2	10,6	21,8	3,9
Not elsewhere classified	0	0	0	0	0

The leaky pipeline: share of women in higher education and research in the world (2013) and in Uganda (2004-2014)

Women in the world →

75 members in Uganda



Source: Lemarchand (2021) based on *UNESCO Science Report 2015* and UIS historical data

Women in science and engineering in Uganda

The back page

Where I work

Dorothy Okello

In this photo, taken in December 2020, I am reviewing students' progress in a computer networking course at Makerere University in Kampala, Uganda, where I teach electrical engineering and telecommunication policy. The students are learning to configure computers to accommodate Voice over Internet Protocol, or online telephony. We've also explored the programming language Python, and technologies for radio and wireless applications.

The six-month programme is part of a first-ever partnership with the Jesuit Refugee Service (JRS), an international Catholic organization that advocates for people who have been forcibly displaced. Uganda, where I was born and raised, hosts one of the largest refugee populations in Africa.

The JRS selected the course's 2 female and 17 male participants, and we completed it in January, despite a delay to in-person teaching caused by the pandemic. The students' new skills will help them to compete in the job market.

When I'm not teaching, I research ways to improve network connectivity. I'm mainly interested in ensuring internet access in rural communities, where most Ugandans live.

As a woman who works in science, I try to promote initiatives that will boost female inclusion in science and technology. One example is the Uganda Women Entrepreneurs Association, which supports aspiring female business leaders.

I've also launched projects to get more women into engineering. In 2017, when I was president of the Uganda Institution of Professional Engineers (UIPE), I founded its Committee of Women Engineers, Technologists and Technicians. I also helped to organize training for female engineers that tripled women's share of the UIPE's membership to 10% of the total.

Inclusion is a revolution that is yet to be accomplished.

Dorothy Okello is an electrical engineer and dean of the college of engineering, design, art and technology at Makerere University in Kampala, Uganda. **Interview by Sara Moraca.**

Photographed for *Nature* by Esther Ruth Mbabazi.

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Volume 591 Issue 7851,
25 March 2021

Inconsistencies within the number of FTE Researchers in Agricultural Sciences…

Researchers FTE in Agricultural Sciences (ASTI-IFPRI)

Researchers HC in Agricultural Sciences (UIS-Uganda R&D Surveys)

ASTI Led by IFPRI

NARO

UNCST

260,8
246,5
328,6
348,8
346,8
484,6
325
2010
332
2014
223
159
124
2007
9

700
600
500
400
300
200
100
0

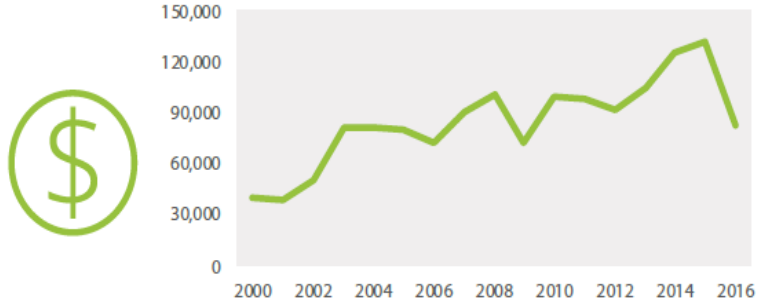
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018

Source: Lemarchand (2021) based on raw data from UNESCO Institute for Statistics, UNCST and ASTI-IFPRI

Recent data on agricultural science indicators in Uganda by IFPRI-ASTI

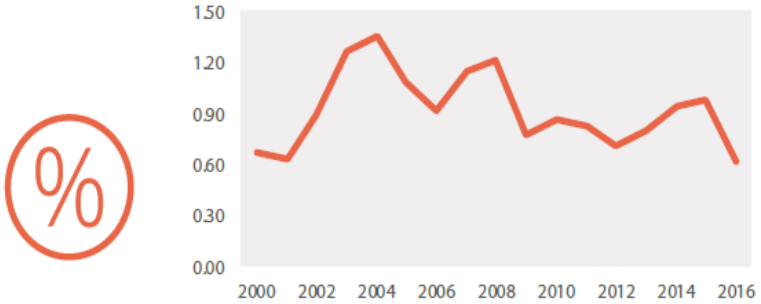
Source: Agricultural R&D Indicators Factsheet Update | November 2018

AGRICULTURAL RESEARCH SPENDING



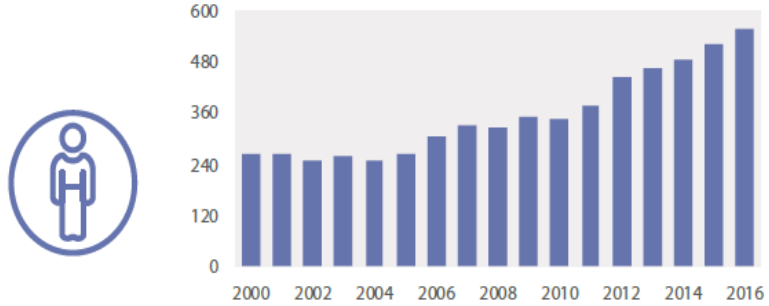
	UGANDA	ETHIOPIA	KENYA	TANZANIA
Million Ugandan shillings (2011 constant prices)	82,817.3			
Million PPP dollars (2011 constant prices)	99.4	162.1	222.7	68.5

SPENDING INTENSITY



	UGANDA	ETHIOPIA	KENYA	TANZANIA
Agricultural research spending as a share of AgGDP	0.62%	0.29%	0.48%	0.17%

AGRICULTURAL RESEARCHERS



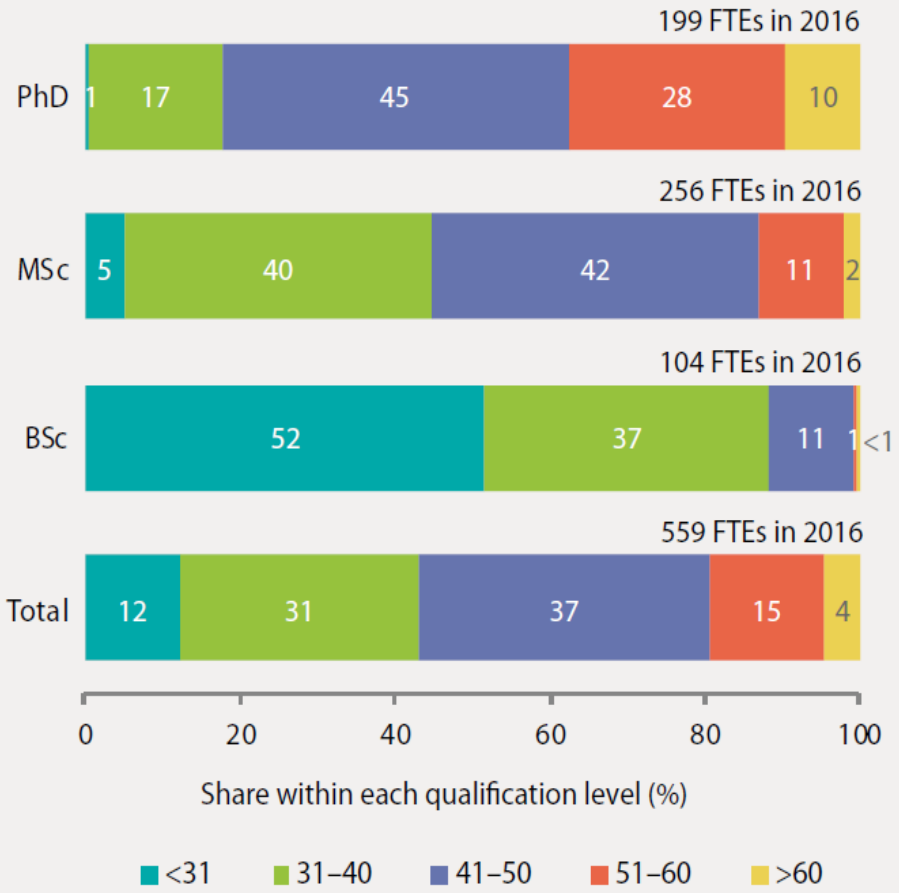
	UGANDA	ETHIOPIA	KENYA	TANZANIA
Full-time equivalents	558.7	3,024.6	1,157.6	785.0
Share of researchers with MSc and PhD degrees	81%	47%	85%	77%

Notes: Data in the table above are for 2016. Research conducted by the private for-profit sector is excluded from this factsheet due to lack of available data. Information on access to further resources, data procedures and methodologies, and acronyms and definitions are provided on Page 4. See **www.asti.cgiar.org/uganda/directory** for an overview of Uganda's agricultural R&D agencies.

Recent data on agricultural science indicators in Uganda by IFPRI-ASTI

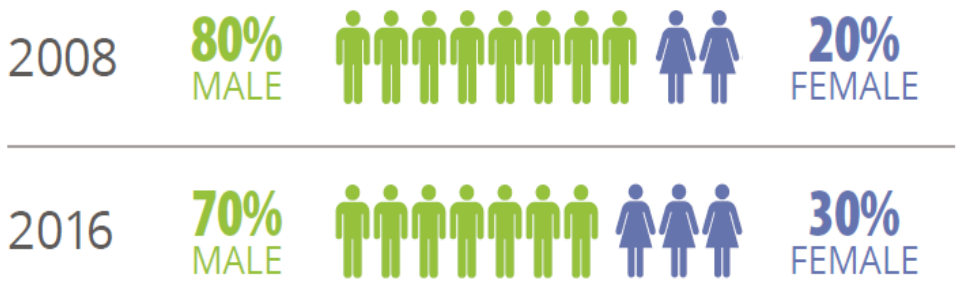
Distribution of agricultural researchers by qualification level and age bracket

As of 2016, 38 percent of PhD-qualified researchers were in their 50s or 60s. Although significant, this share is considerably lower than in most other African countries. Unsurprisingly, researchers with BSc- and MSc-degrees were comparatively younger.



Agricultural researchers by gender

Overall, the share of female agricultural researchers rose from 20 percent in 2008 to 30 percent in 2016. NARO and the other government agencies employed comparatively more women than did the higher education and nonprofit agencies. As of 2016, female researchers were generally younger and less well-qualified than their male colleagues.



Share of women within each qualification level, 2016

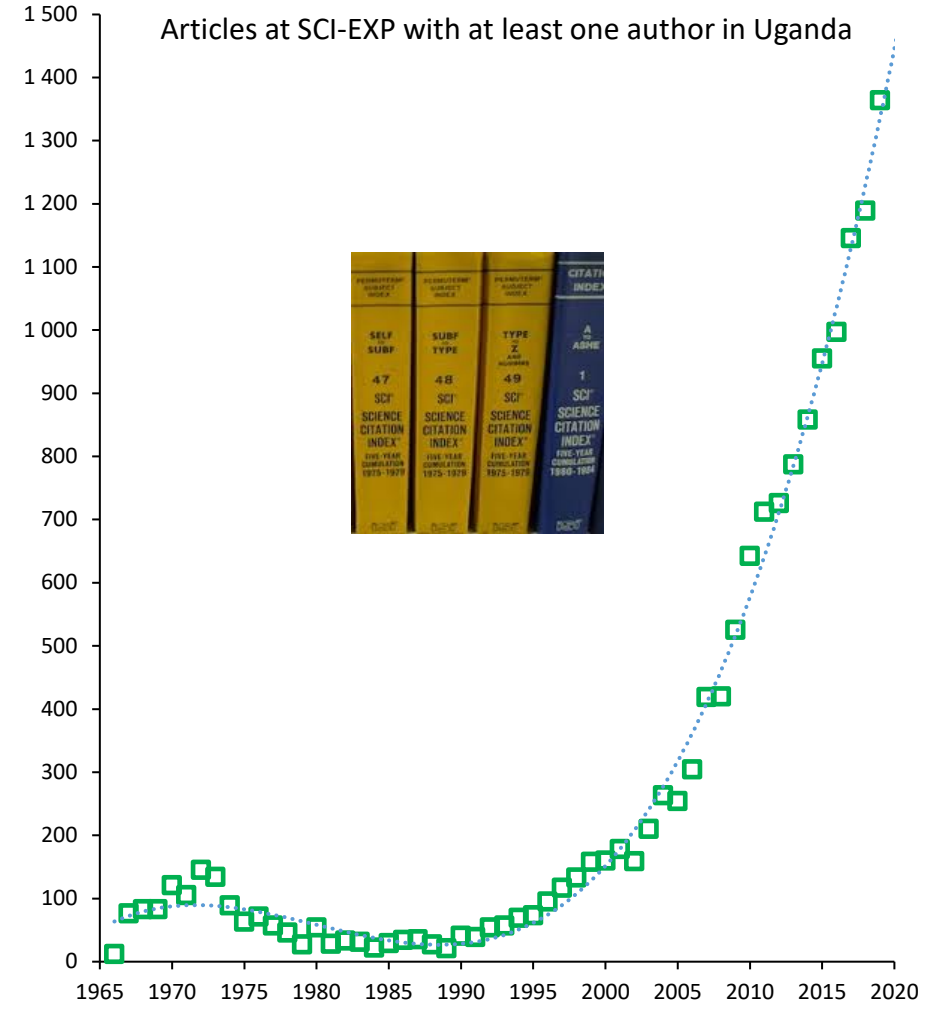
BSc **44%**	MSc **41%**	PhD **21%**

Share of women by age bracket, 2016

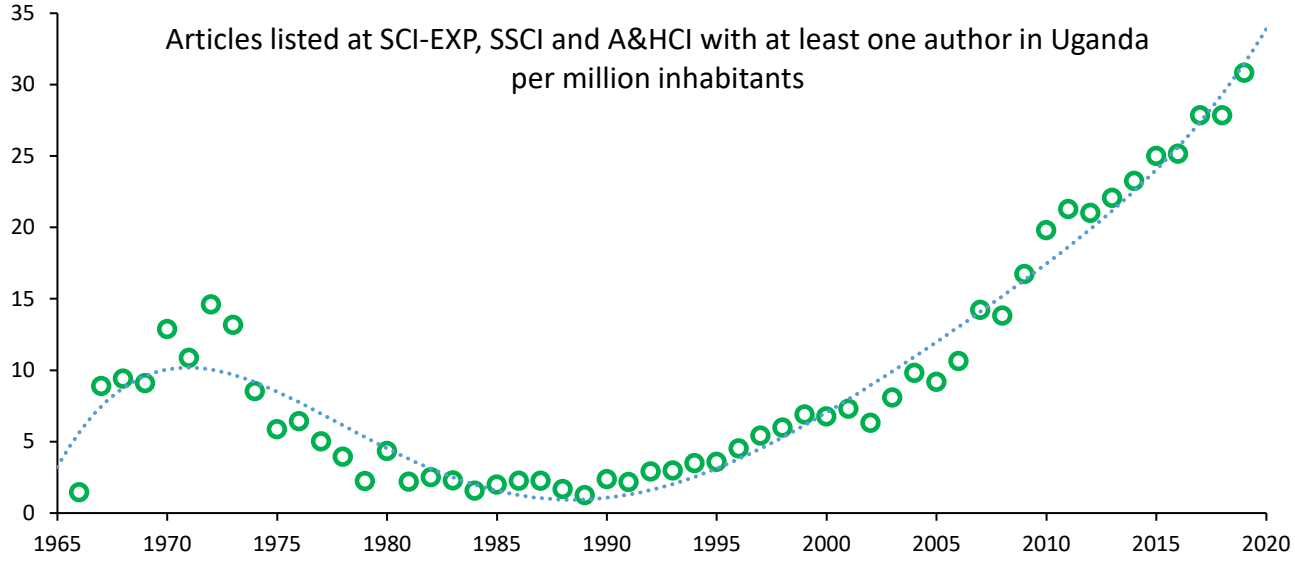
< 41 **36%**	41–50 **30%**	> 50 **16%**

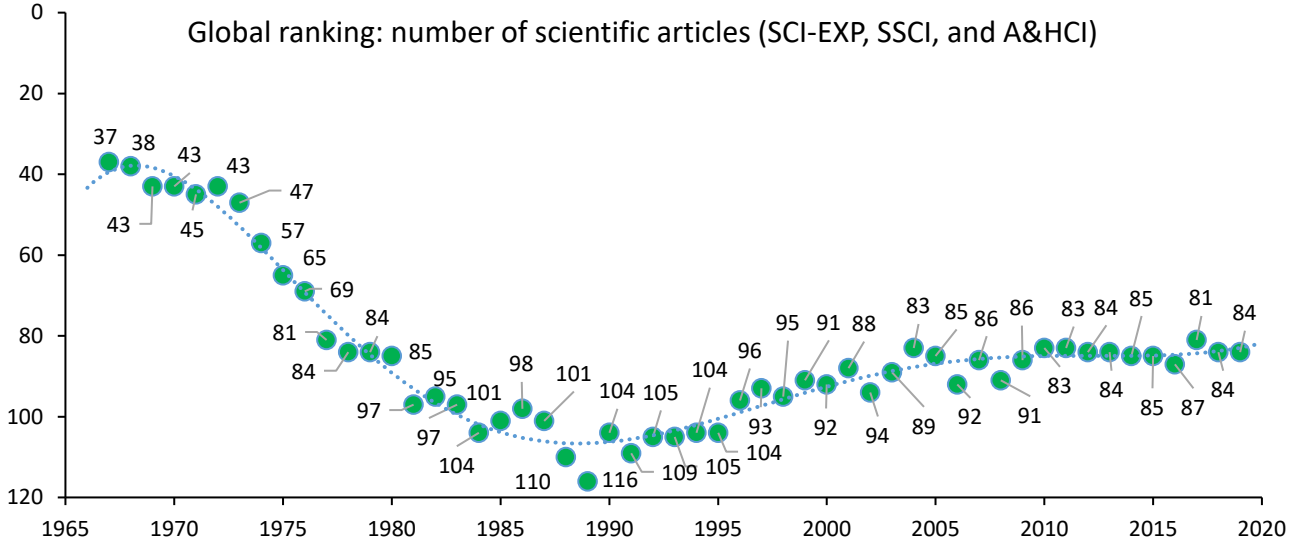
Source: Agricultural R&D Indicators Factsheet Update | November 2018

Uganda: Scientific articles in mainstream journals



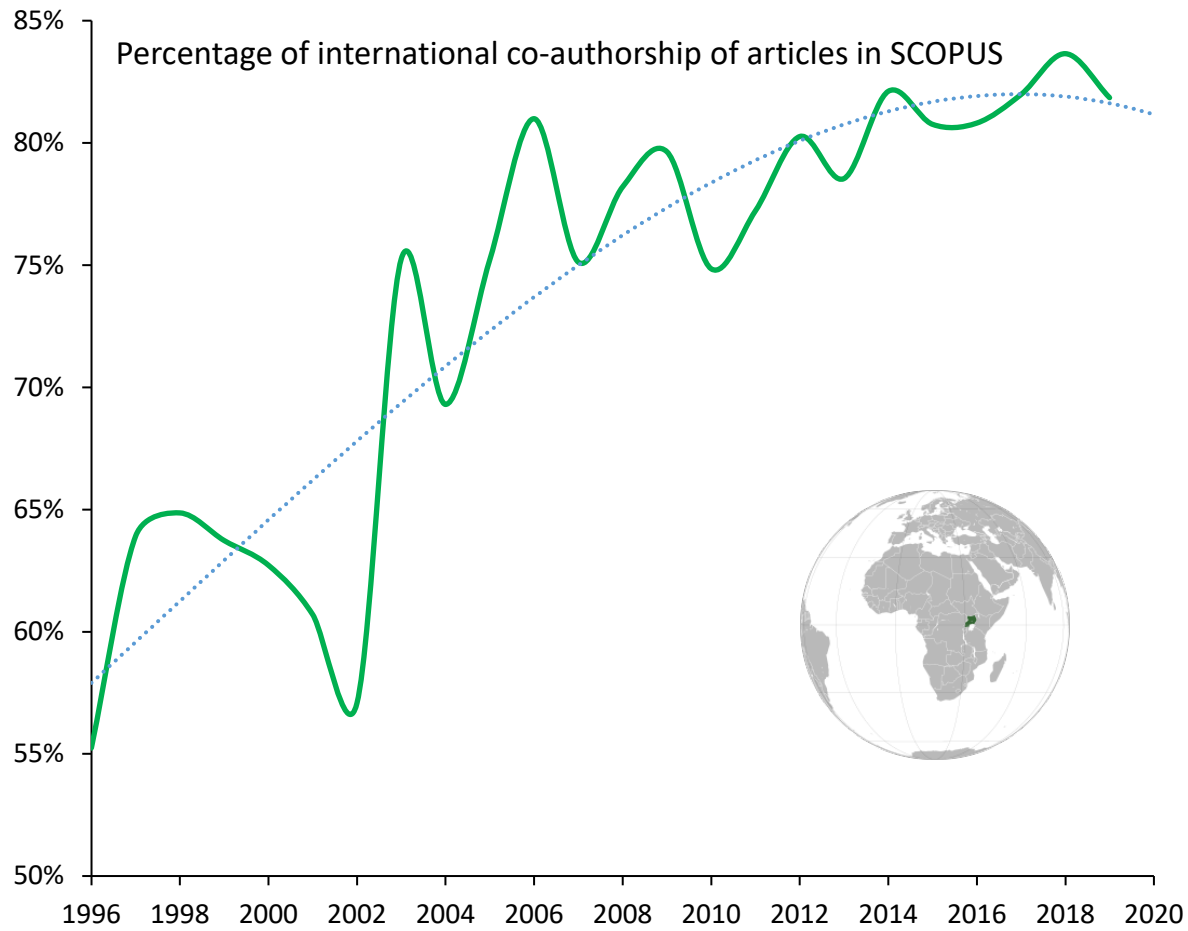
Source: Prepared by Lemarchand (2021) based on raw data from SCI-EXP

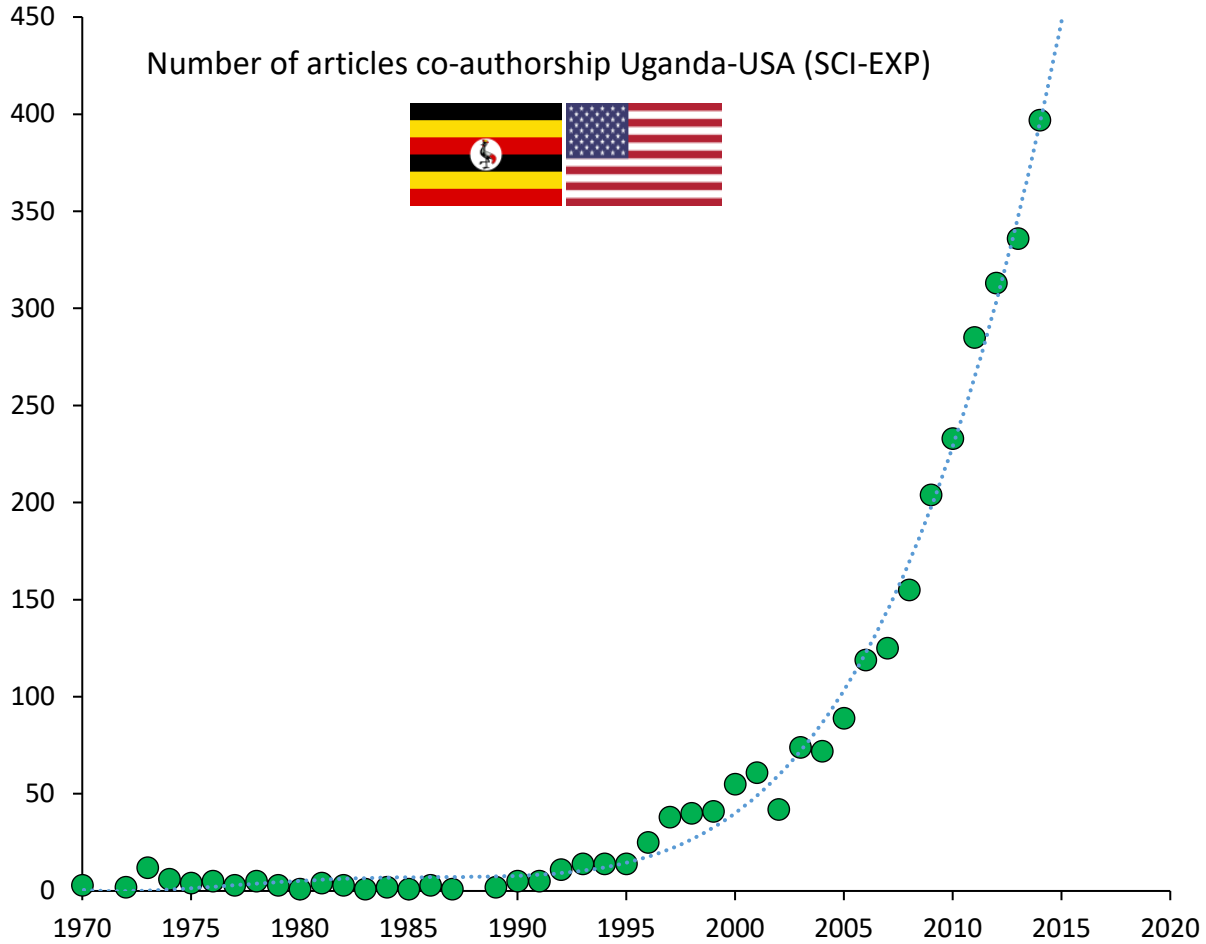




Source: Prepared by Lemarchand (2021) based on raw data from SCI-EXP, SSCI, and A&HCI

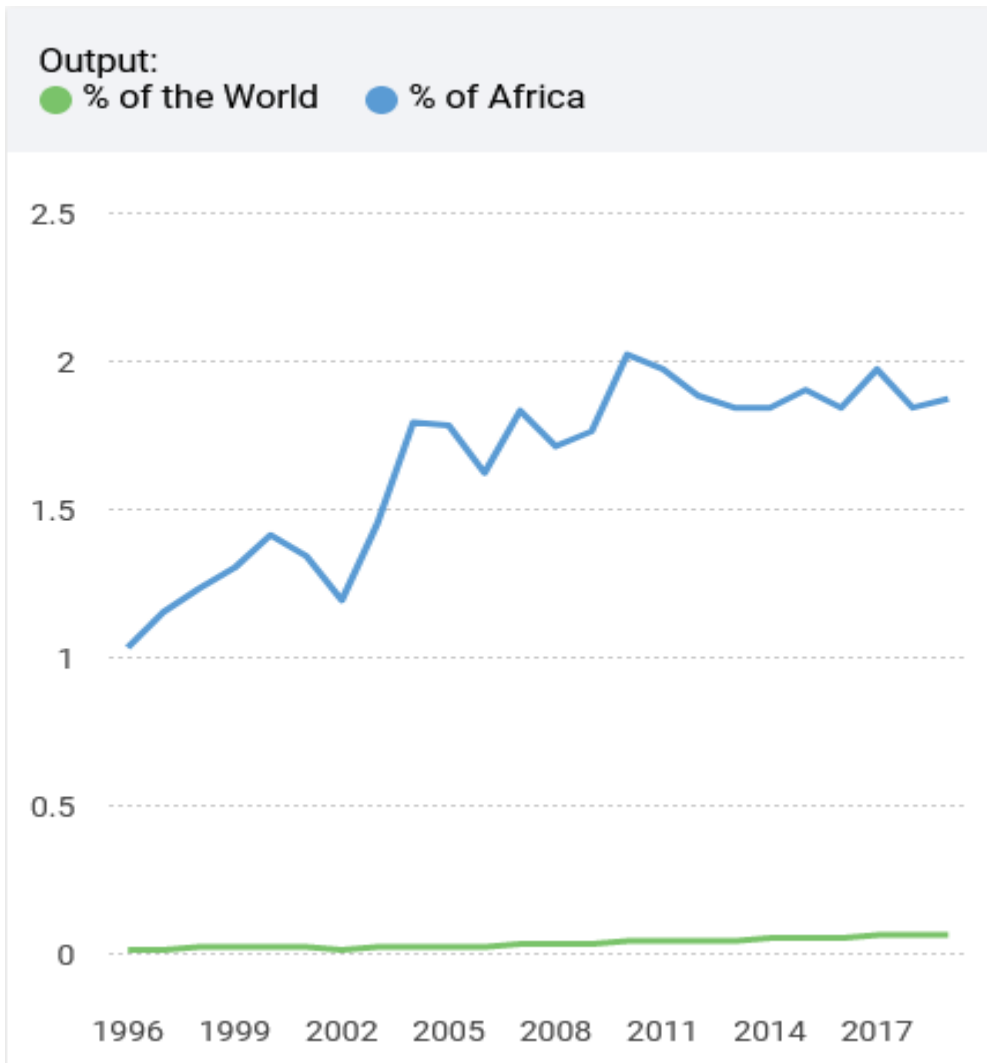
Co-authorship of scientific articles in mainstream journals





Source: Prepared by Lemarchand (2021) based on raw data from SCI-EXP, and SCOPUS

Uganda: Evolution of the global and regional rank at SCOPUS

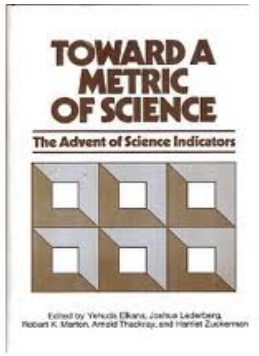


Source: www.Scimagojr.com (2021)

World's rank (1999)	African Country	Number of Articles (1999)	Average cites per article	African Rank (1999)
35	South Africa	5,051	27.8	1
39	Egypt	2,963	15.9	2
55	Nigeria	1,172	14.5	3
59	Tunisia	743	12.1	4
63	Kenya	620	34.4	5
67	Algeria	495	12.1	6
76	Zimbabwe	378	18.5	7
79	Ethiopia	279	26.0	8
82	Senegal	260	15.9	9
83	Tanzania	255	24.1	10
85	Ghana	236	21.8	11
90	Cameroon	205	23.4	12
91	Uganda	195	40.5	13

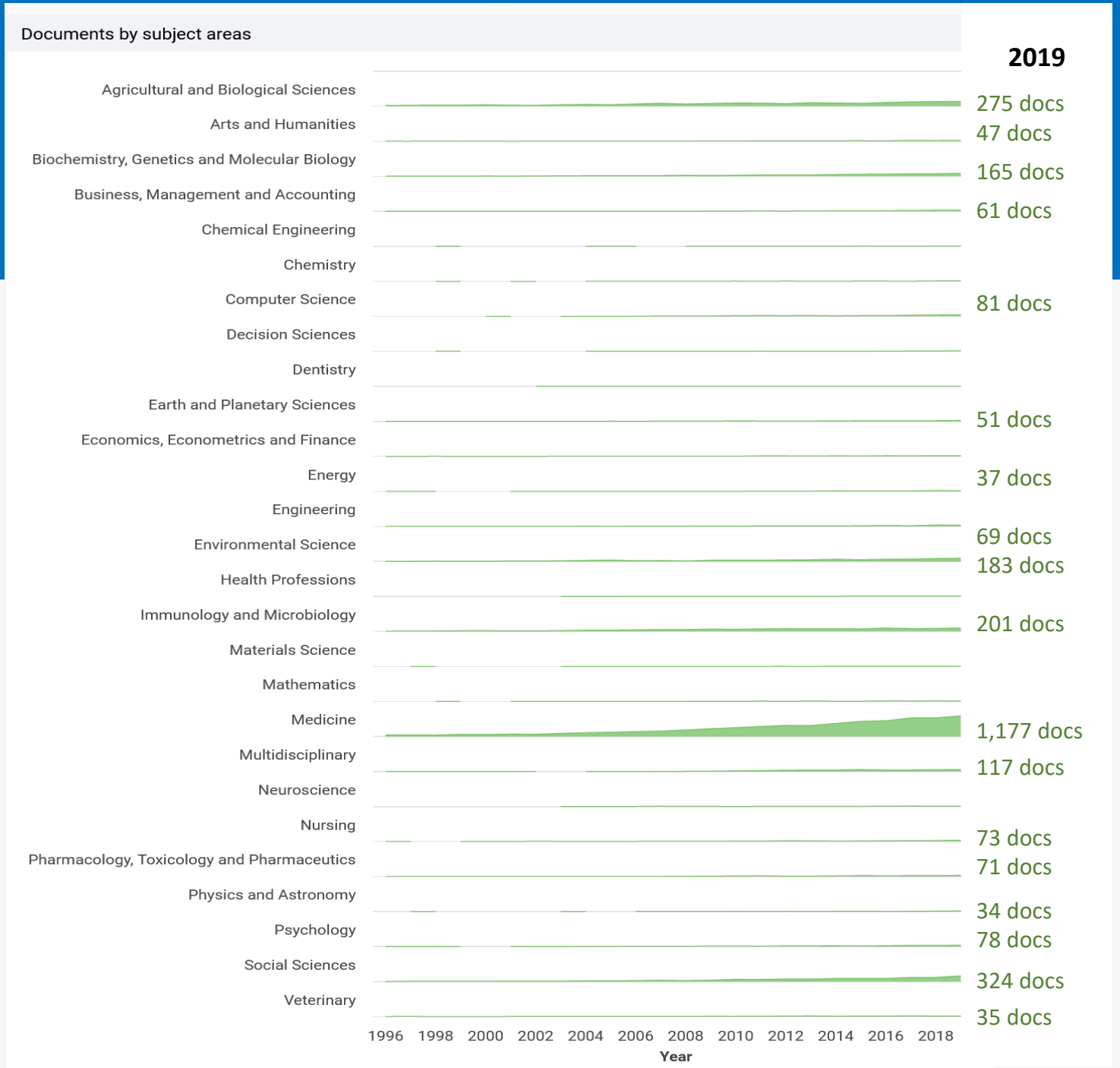
World's rank (2009)	African Country	Number of Articles (2009)	Average cites per article	African Rank (2009)
36	South Africa	10,611	21.3	1
41	Egypt	8,307	15.2	2
47	Nigeria	4723	9.8	3
52	Tunisia	4,265	13.4	4
55	Algeria	3,136	12.4	5
58	Morocco	2,138	11.7	6
67	Kenya	1,376	27.1	7
82	Ethiopia	723	23.6	8
83	Tanzania	716	33.0	9
84	Uganda	699	28.7	10
84	Ethiopia	723	23.6	11
85	Cameroon	689	19.4	12
86	Ghana	676	19.9	13

World's rank (2019)	African Country	Number of Articles (2019)	Average cites per article	African Rank (2019)
28	South Africa	26,263	0.7	1
32	Egypt	24,356	0.7	2
51	Nigeria	10,679	0.5	3
54	Algeria	8,110	0.5	4
56	Morocco	7,888	0.5	5
57	Tunisia	7,757	0.5	6
66	Ethiopia	4,196	0.5	7
72	Ghana	3,357	0.6	8
73	Kenya	3,321	0.7	9
83	Tanzania	1,918	0.7	10
84	Uganda	1,912	0.7	11
89	Cameroon	1,741	0.7	12
97	Zimbabwe	935	0.9	13

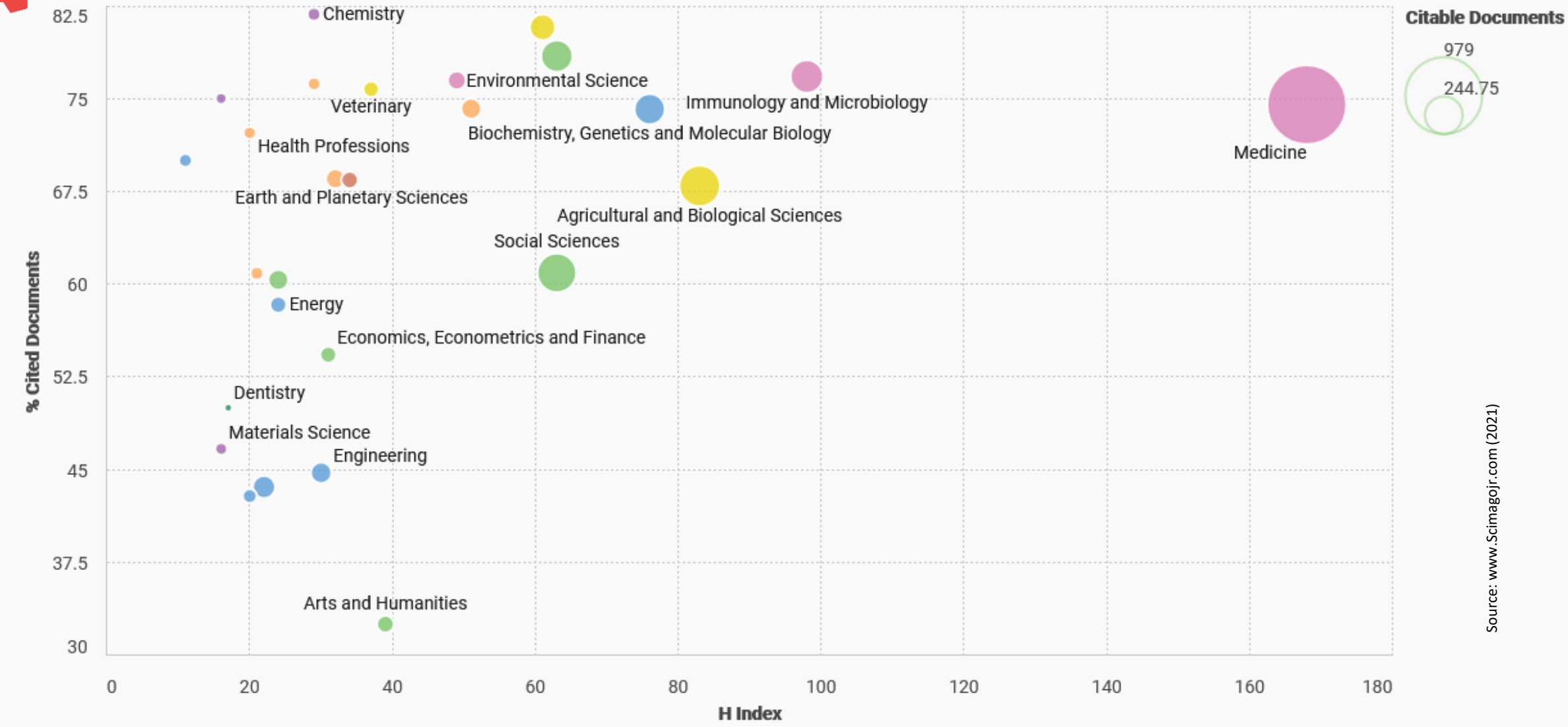


Uganda: scientific articles against field of science in SCOPUS

Source: www.Scimagojr.com (2021)

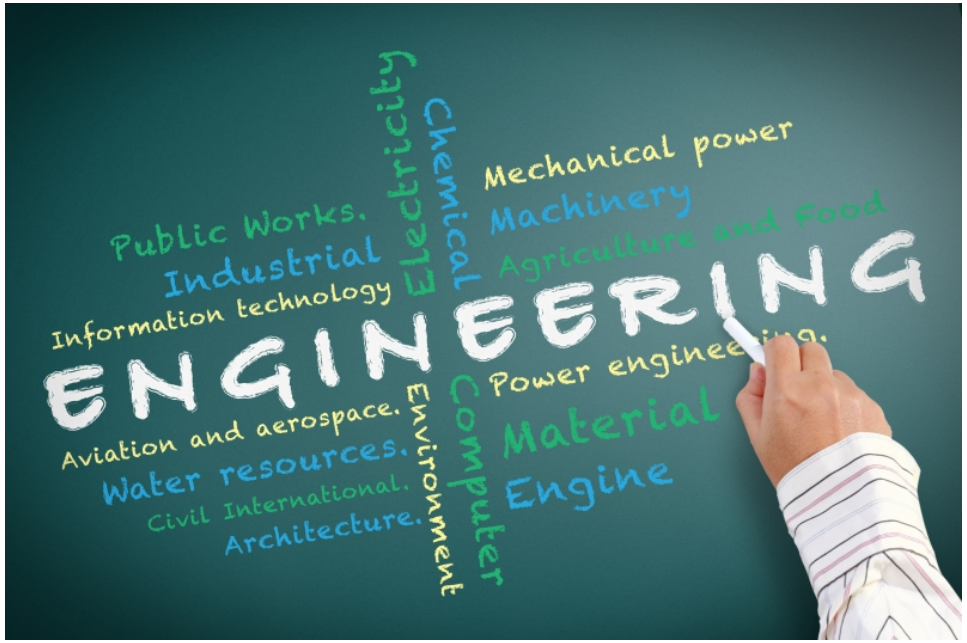


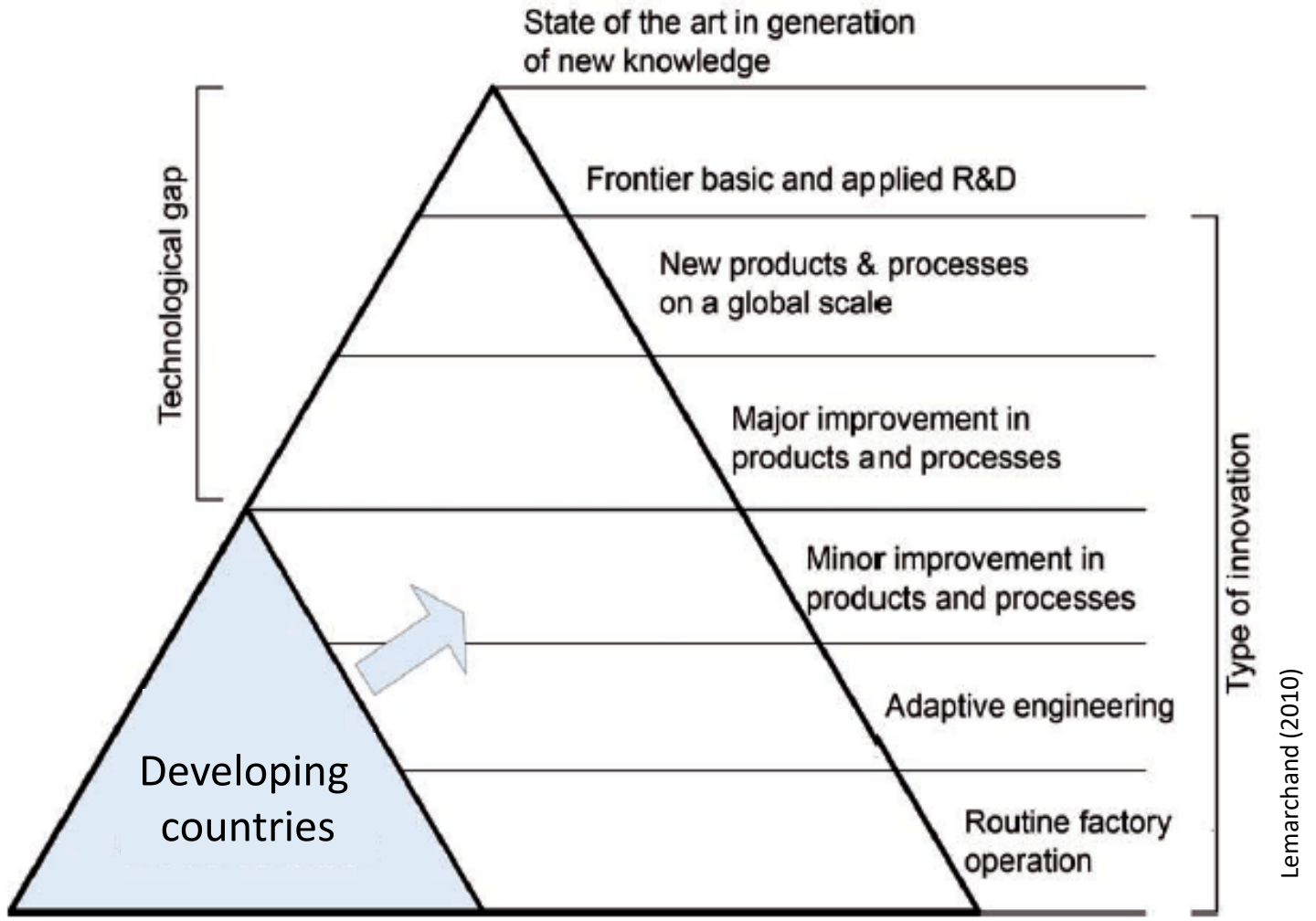
Uganda (2018): Impact of scientific articles against field of science



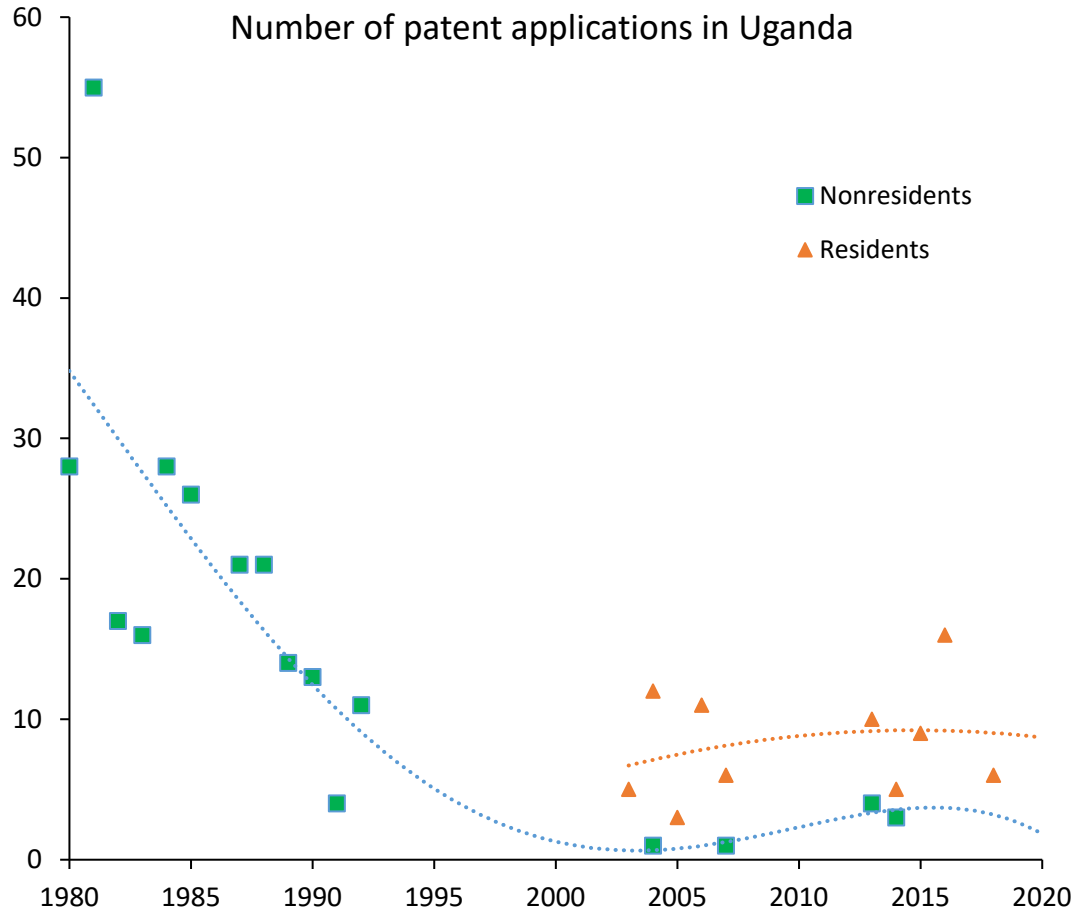
Source: www.Scimagojr.com (2021)

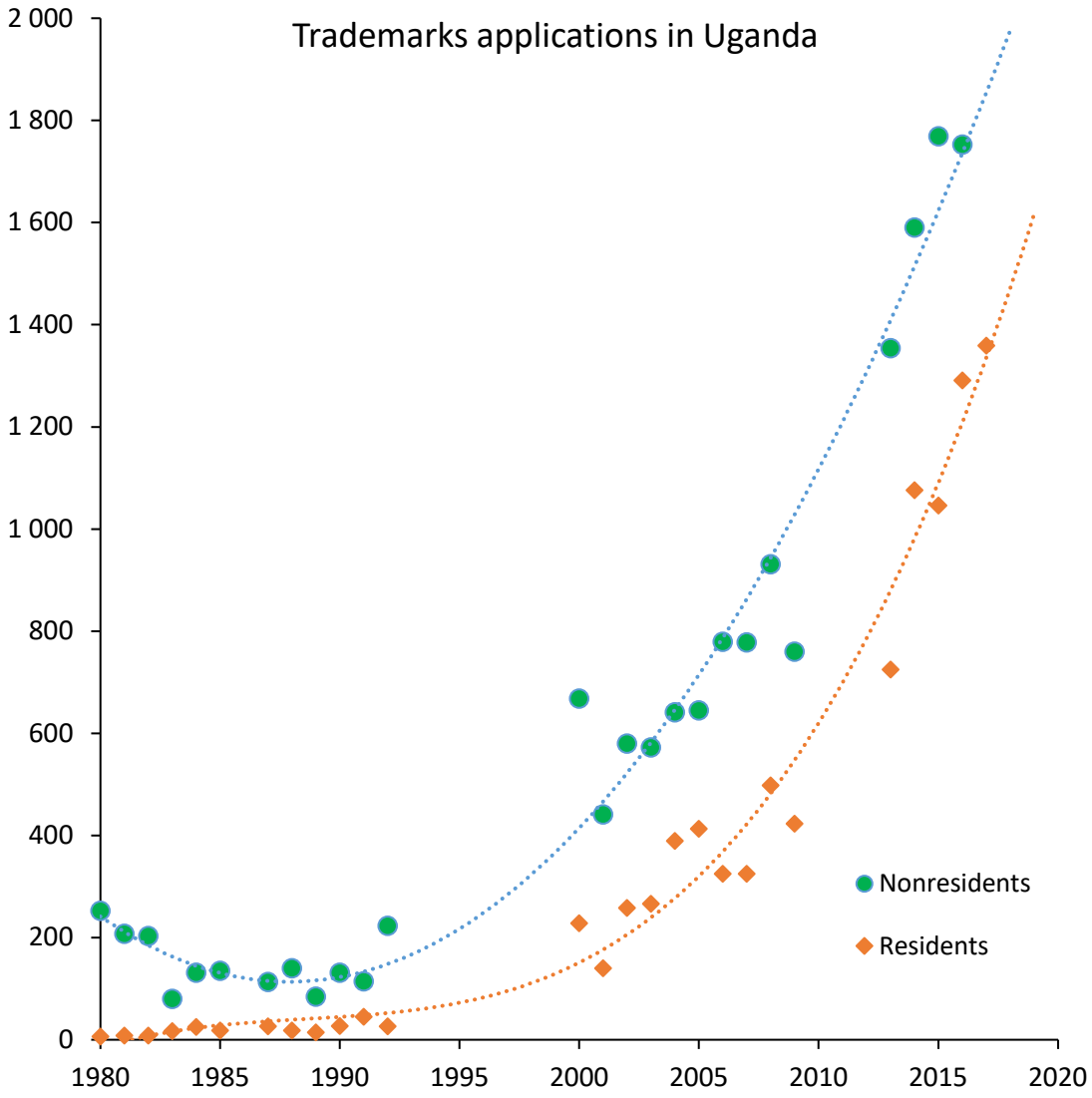
Technological gap according to the type of innovation and technological capacity: A need for specific engineering policies





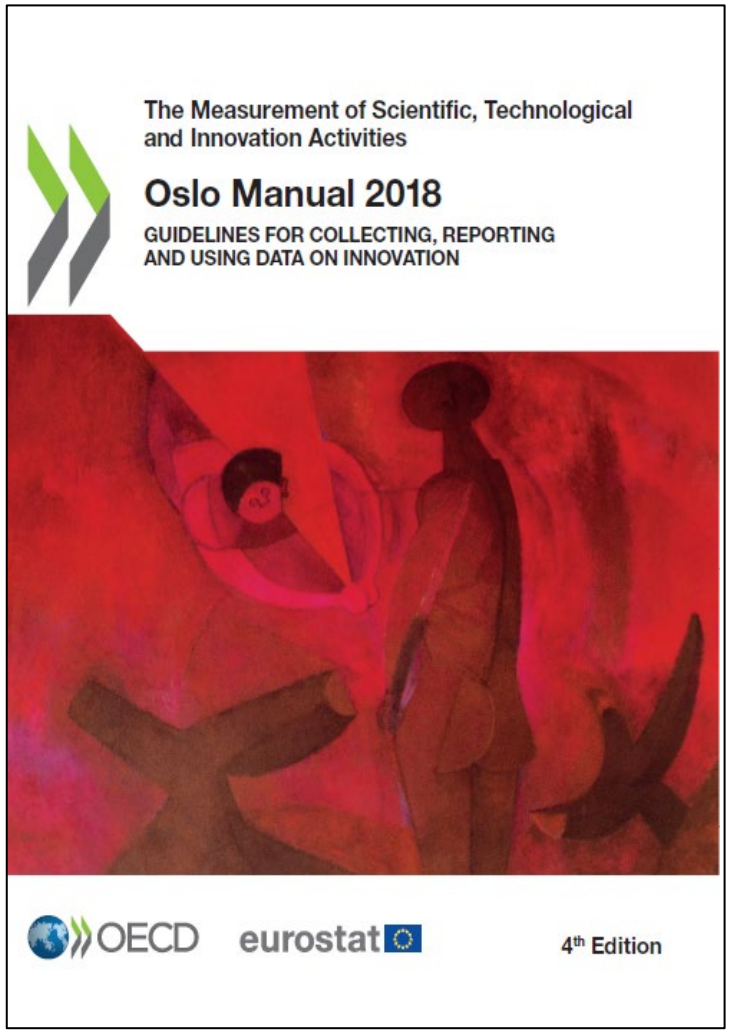
Evolution of the number of patents and trademarks in Uganda

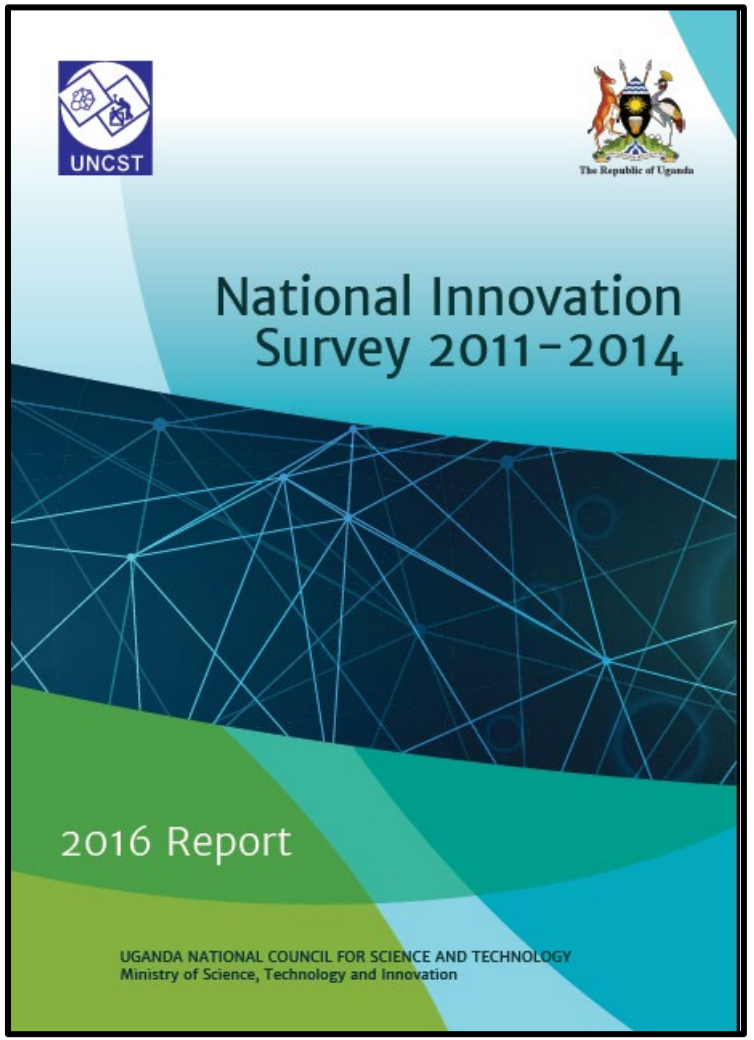




Source: Prepared by Lemarchand (2021) based on raw data historical statistics of WIPO

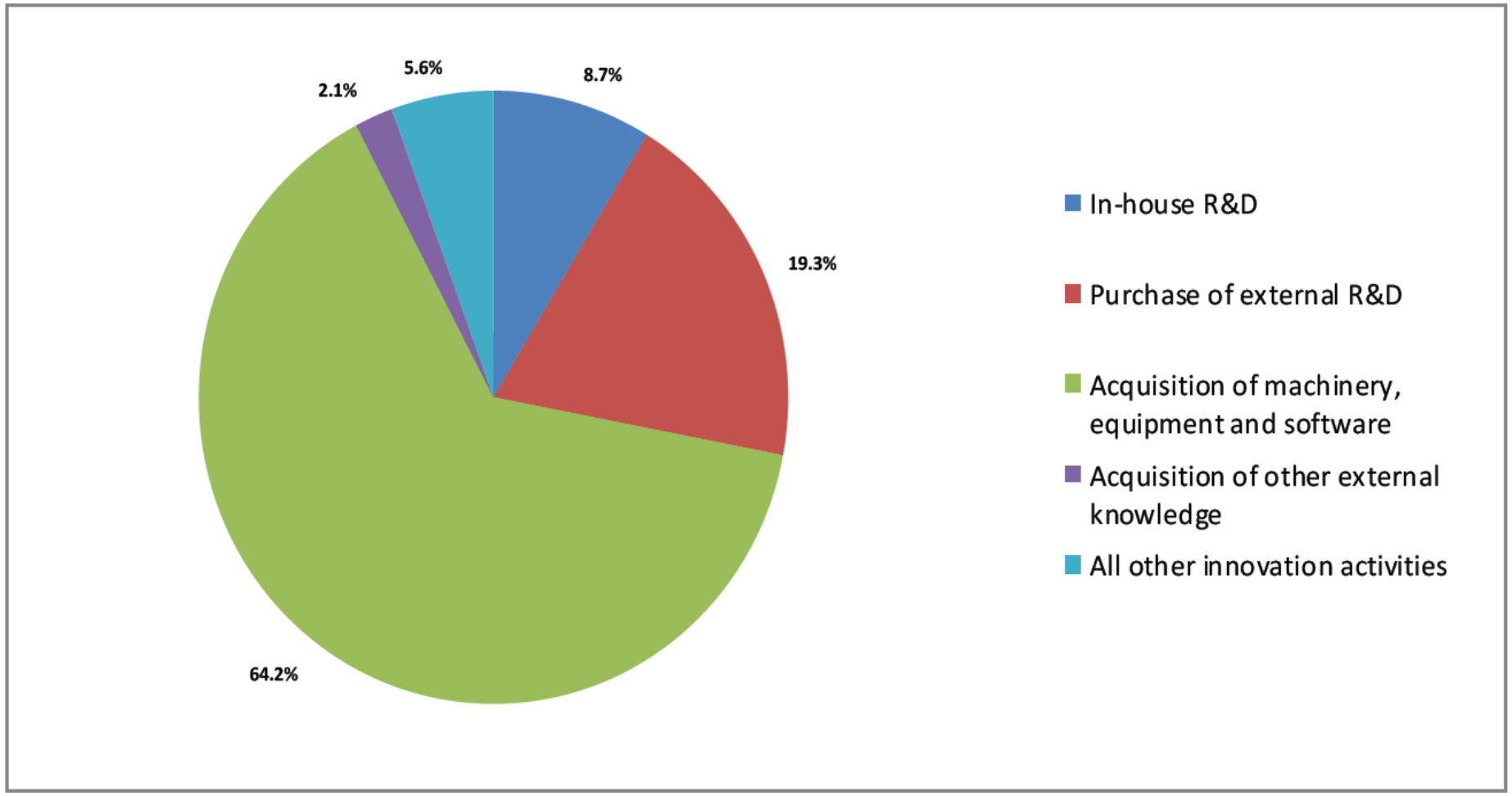
Measuring innovation through “innovation surveys”





Measuring innovation through “innovation surveys”

Figure 3.4: Percentage share of innovation expenditure by type of expenditure for all enterprises, 2014



Source: UNCST – National Innovation Survey 2011–2014; Appendix D Table 1.18

Measuring innovation through “innovation surveys”

Table 3.19: Percentage of enterprises engaged in technological innovation expenditure by nationality of ownership, sector and number of persons engaged, 2014

%

	Nationality of ownership		Sector of activity		Number of persons engaged				
	Ugandan	Foreign	Industry	Services	250+	50-249	20-49	1-19	All Enterprises
Engaged in:									
In-house R&D	31.6	36.3	33.3	31.6	29.0	28.7	31.7	33.6	32.1
Purchase of external R&D	14.4	26.8	11.1	17.9	14.1	16.6	15.6	15.8	15.8
Acquisition of machinery, equipment and software	47.6	56.7	48.3	48.8	31.7	51.4	55.5	46.0	48.7
Acquisition of other external knowledge	24.5	39.5	22.4	27.9	16.3	17.3	28.2	28.7	26.2
All other innovation activities	31.3	42.7	33.0	32.4	24.0	42.2	31.1	31.1	32.6
Total[1]	**62.4**	**58.8**	**62.2**	**61.9**	**36.7**	**56.4**	**62.9**	**65.1**	**62.0**

Source: UNCST – National Innovation Survey 2011–2014; Appendix D Table 1.18

[1]Respondents could engage in more than one innovation expenditure category, hence the sum of the categories does not equal the total

Measuring innovation through “innovation surveys”

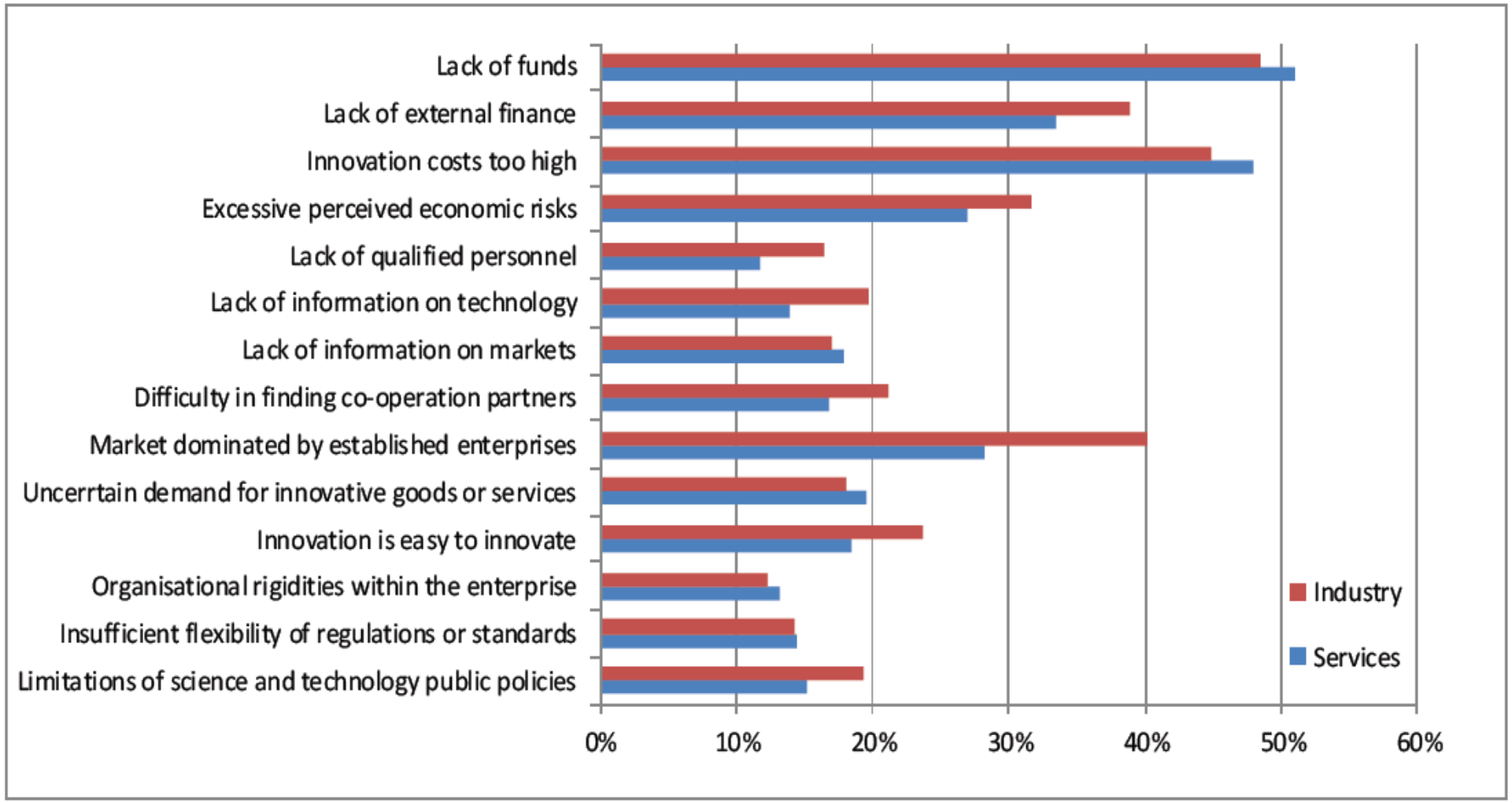
Table 3.23: 'Highly Important' Effects of Innovation on Objectives for Innovative Enterprises, 2011 – 2014

Percentage of enterprises	Total	Industry	Services
Objectives			
Increase range of goods or services	45.9	44.2	46.6
Replace outdated products or processes	30.9	26.3	32.9
Enter new markets	29.0	24.1	31.1
Increase market share	34.1	28.6	36.5
Improved quality of goods or services	52.7	52.0	53.0
Improve flexibility for producing goods or services	36.5	36.0	36.7
Increase capacity for producing goods and services	33.8	34.6	33.5
Reduce production costs per unit output (labour, materials, energy)	23.1	22.9	23.2
Improve working conditions – health and safety	29.3	31.4	28.3

Source: UNCST – National Innovation Survey 2011–2014; Appendix D Tables 1.24a & 1.24b

Measuring innovation through “innovation surveys”

Figure 3.13: Highly important hampering factors to innovation activities for innovative enterprises by sector, 2011 - 2014



Source: UNCST - National Innovation Survey 2011-2014; Appendix D Tables 1.26a & 1.26b

ASANTE SANA


Gracias
Ngiyabonga
Merci
Hvala
Thanks
Danke
Obrigado
Grazzie
Arigato
Mahalo
Tack
Takk
Dankon
Bedankt
Tesekkür
Blagodaram
Evgaristó
Eskerrik
Kiitos
Spaisiva
Marahaba
Trugarez
Shukuriyyaa
Dziakuju
Rahmet
Dios
Dekoju

Time for questions

… Thank you very much
For your kind attention!

Last run