Investimentos em Ciência & Tecnologia: prioridades e avaliação de resultados

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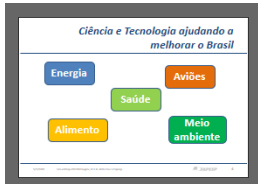
Outline

- S&T impact and benefits to society
- The S&T system and some challenges
- R&D funding and some data on articles, citation impact, university-industry collaboration in Brazil
- Assessing impact and RoI
- Conclusion

S&T benefits Brazilian society: a long list of examples……



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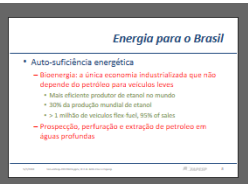

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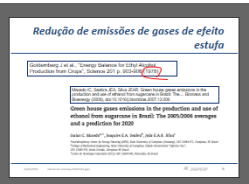

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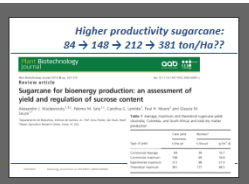

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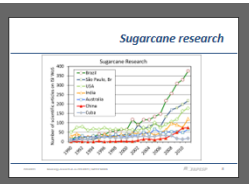

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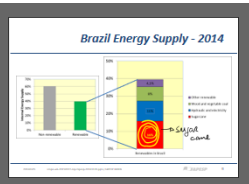

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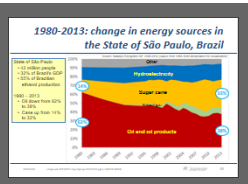

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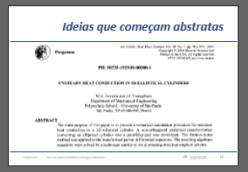

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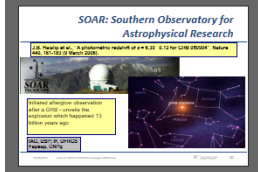

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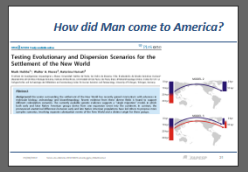

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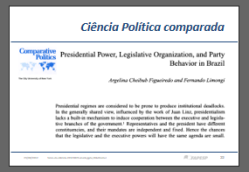

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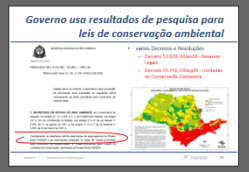

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PARA QUÊ ISSO SERVE?
AINDA NÃO SABEMOS. FAZEMOS PESQUISA BÁSICA...
QUE BONITO! A GENTE SE MATANDO CARREGANDO PEDRAS E ARRASTANDO ANIMAIS SELVAGENS, E OS SENHORES SE DIVERTINDO FAZENDO COISAS QUE NÃO SERVEM PARA NADA!
TROPEK 2011

The three impacts challenge

- Social impact
  - Ideas that assist/help/enhance public policy
  - Ideas directly applied to societal benefit
- Economic impact
  - Ideas that create companies
  - Ideas that increase bussiness competitivity
  - Ideas that create industries
- Intellectual impact
  - Ideas that create more and better ideas
  - Ideas that make humankind wiser
  - Ideas that are cited in the literature

Science: what for?

23 FEBRUARY 2017 | VOL 542 | NATURE | 391

THIS W

EDITORIALS

SPACE Battle of the planets could see a new moon p.392

WORLD VI scienti their w

niconductor a has eagle- ision p.395

Beyond the science

Research leaders in the United States and elsewhere shou yment prospects of taxpayers who have seen little benefit from s

"The needs of millions of people in the United States are not well enough served by the agendas and interests that drive much of modern science."

Research impact

Research carried out by Oxford's staff, students and alumni has made an enormous impact on the world over the centuries. You can explore some of the more recent examples in the Oxford Impacts case studies and films. These range from impact on culture, business and policy to environment and health.

The impact of some research is evident immediately, whereas in other cases it can take years, or even decades, before the true value becomes apparent. There are no simple predictors of potential benefit or outcomes, and no single measure of impact. This is where the funding of Research Councils and charities is vital in supporting research which increases our fundamental understanding of the world and allows us to apply that improved knowledge.

Started in Oxford

The Oxford region is one of the most innovative in the UK, with new enterprises continuing to join a growing band of spinouts, startups and

Classics for the people

The Iris Classics Centre popularises study of the ancient world, enriching the lives of students and adults alike.

Poetry in motion

Nature's designs can be more efficient, elegant and powerful than anything yet built by man. A University of Oxford spin out aims to disrupt vehicle design by taking inspiration from the movement of animals

RESEARCH IMPACT

- Impact case studies
- Impact films
- Excellence with Impact
- REF 2014 results
- RAE 2008 results
- RAE 1992-2001

RELATED WEBSITES

- Arts & Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- The Engineering and Physical Sciences Research Council (EPSRC)
- Economic and Social Research Council (ESRC)
- Medical Research Council (MRC)
- The Natural Environment Research Council (NERC)
- Science & Technology Facilities Council (STFC)
- Wellcome Trust
- Learned Societies

Components in a S&T system

- Universities, Res. Institutes, Business, Government
- Selection of promising projects/programs
  - High impact discovery, increase the stock of knowledge;
  - Discoveries with visible application (problem solving), with societal and/or economic impact
- Defining the adequate balance to maximize societal benefits
  - No stock → no application; but
  - Too much stock → less support for applications.

Create new knowledge (stock) and apply knowledge

- Universities → creation of ideas, stock, education
- Business and Government → creation of ideas, application
  - "There is no kind of science that could be given the name of applied science. There is science and the applications of science, bound to each other as the fruit to the tree that bore it" (L. Pasteur, Oeuvres completes, Vol. 7)
- It is essential to have R&D in all three: U-B-G
  - Relevant restriction: to truly understand and use research one must have done research
    - Researchers must be also in Business and Government
  - Training in research: additional role for universities
- Standards are international, not local

Dichotomies, Trichotomies, choices, priorities….

- Address type (where research happens) trichotomy
  - Universities, Institutes, Business
- Objective type trichotomy
  - Basic, Applied, Development
- Origin type dichotomy
  - Investigator initiated, mission oriented
  - Problem driven, curiosity driven

Added complication…. Do we know where are we trying to get to?

- What was the plan anyway??? Who wrote it?
  - Training graduate students
  - More Engineers…?
  - More R&D in the business sector – innovation
  - More University/Institute research collaboration with Business
  - Higher impact research
  - International research collaboration

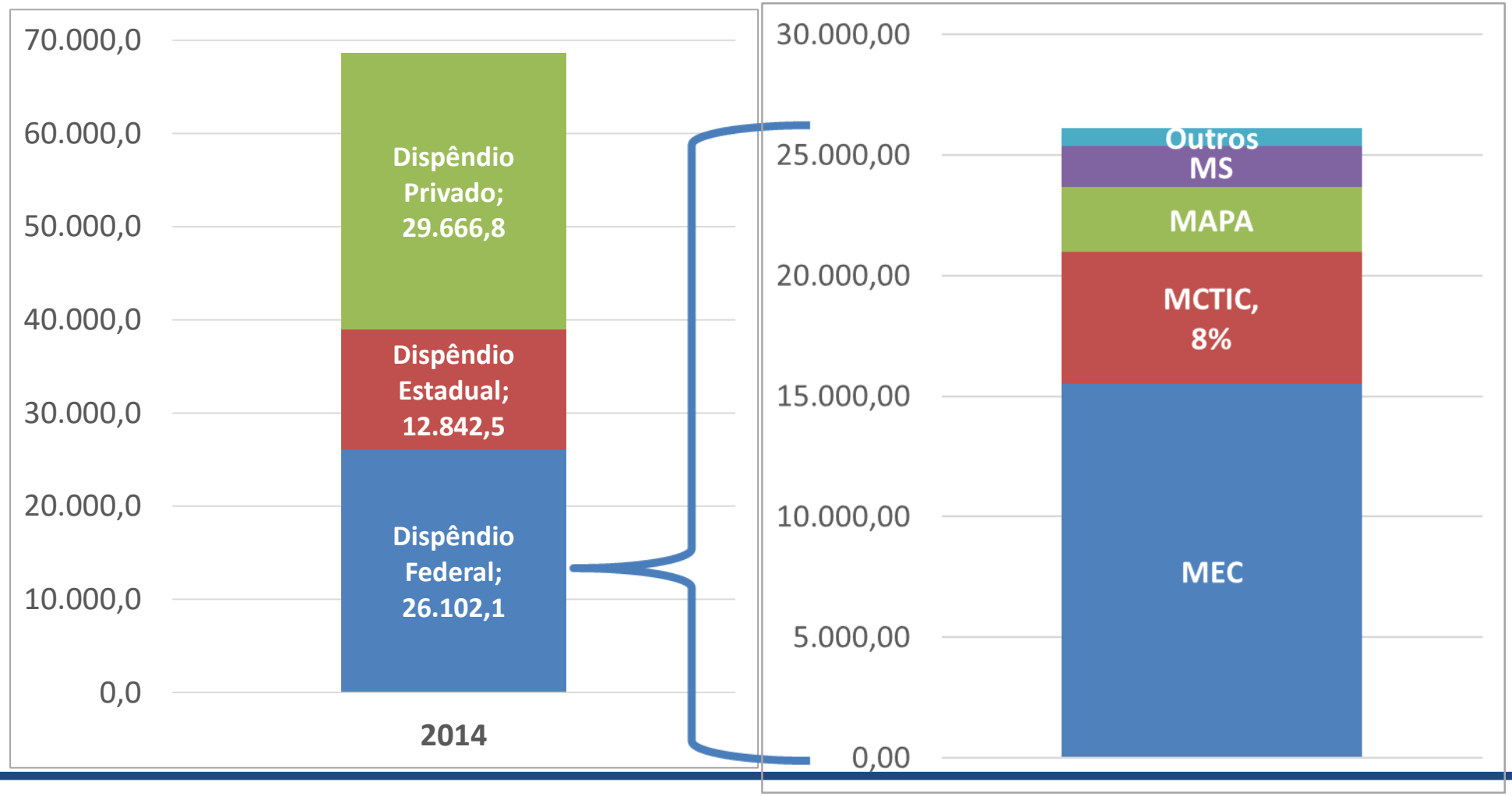
A possible taxonomy of objectives for actions in a national S&T system

- Training researchers
- Keeping a number of research groups/labs running
- Advanced research projects (transformative?bold?)
- Application oriented research – with Business, Government
- Strategic Problem/Opportunity Oriented Research

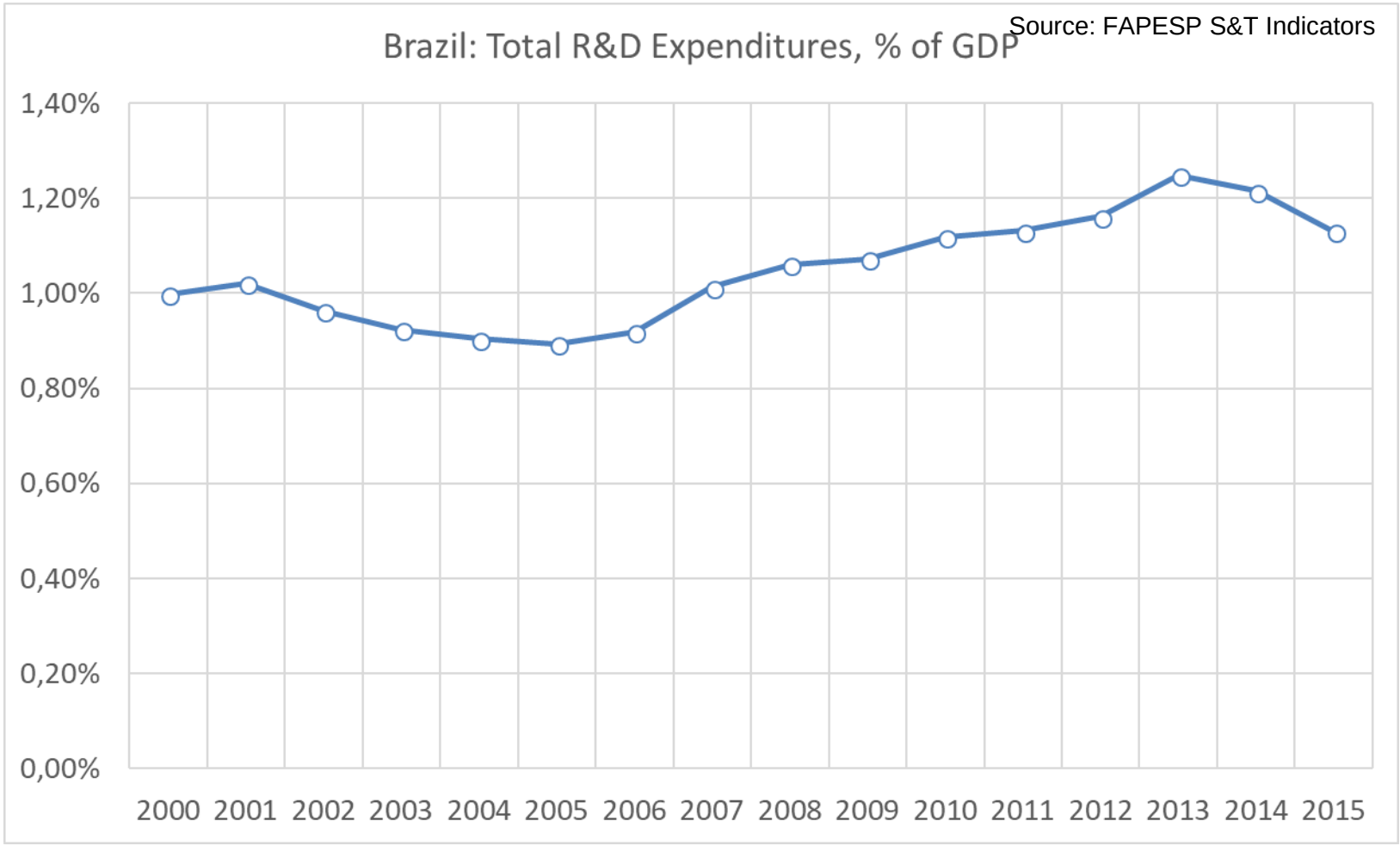
- Challenge: how to define percentages for each line?

EXPENDITURES: SOME THINGS WE KNOW ABOUT BRAZIL'S S&T SYSTEM?

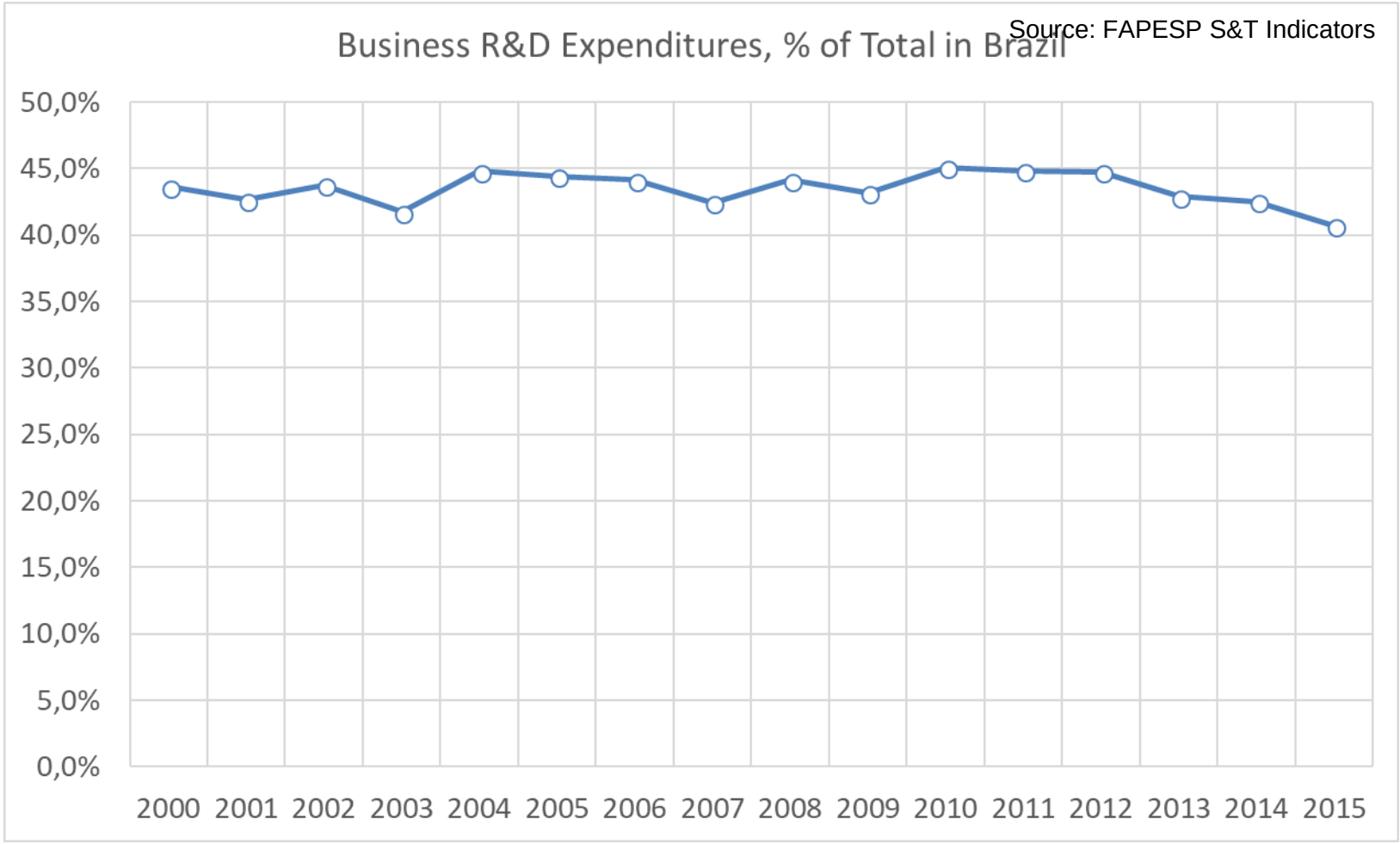
Total R&D Expenditure and Federal R&D Expenditure; Brasil, 2014



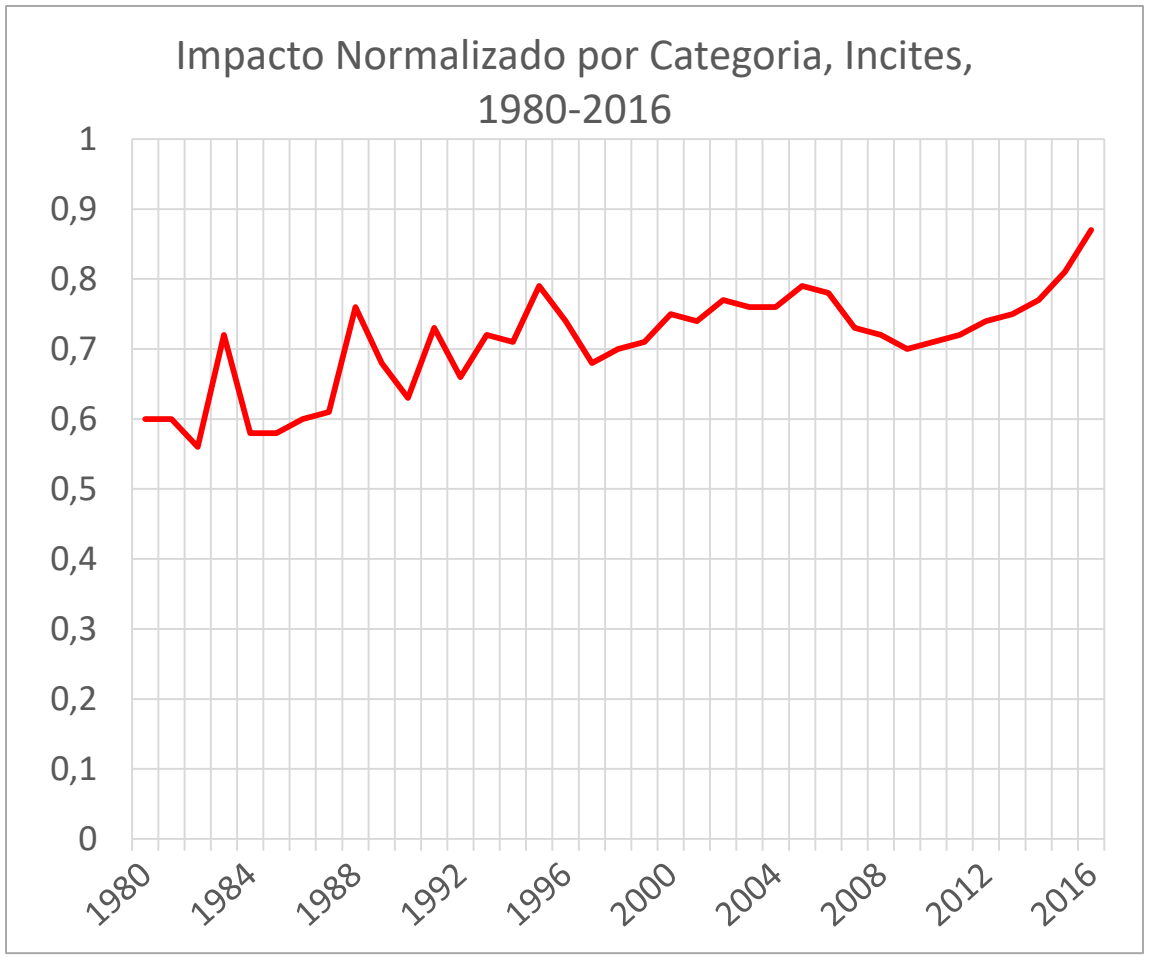
1,00% – 1,25% of GDP



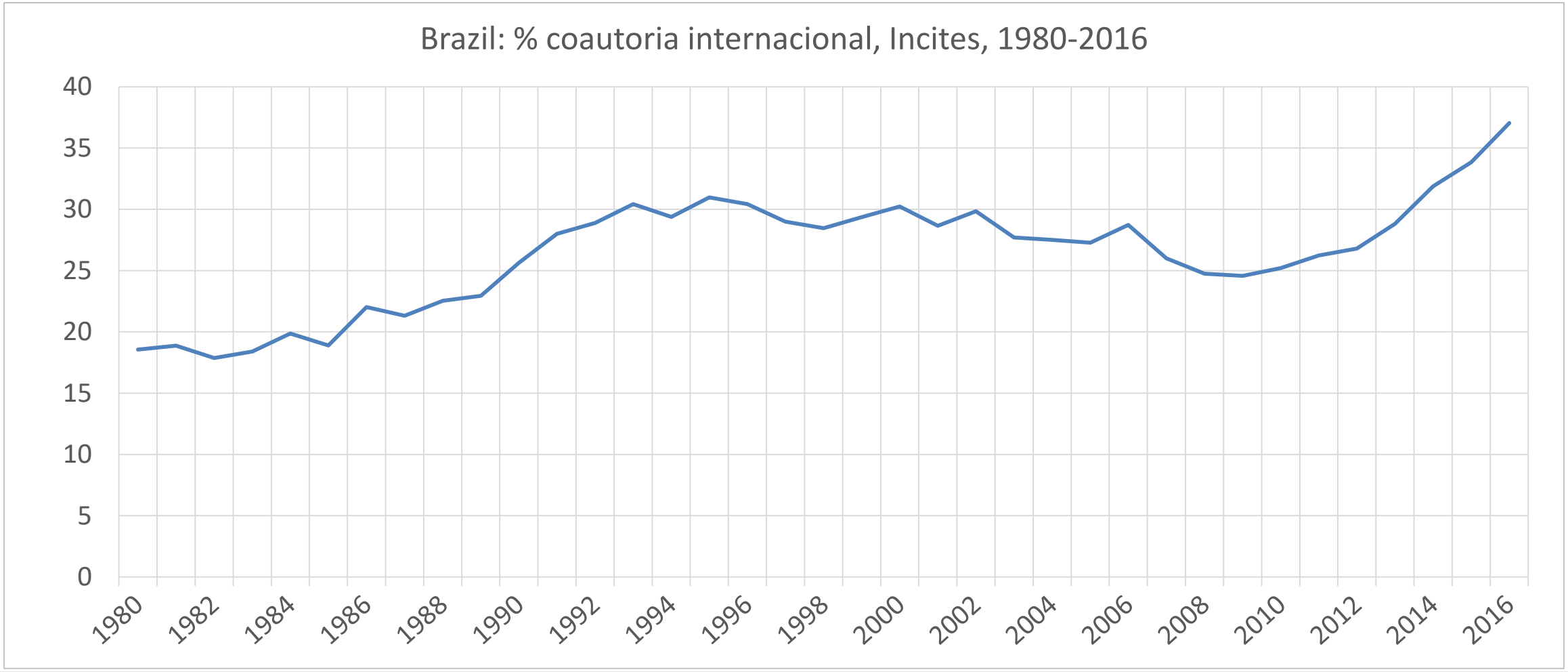
Business participation in the total R&D expenditures in Brazil, 2000-2015



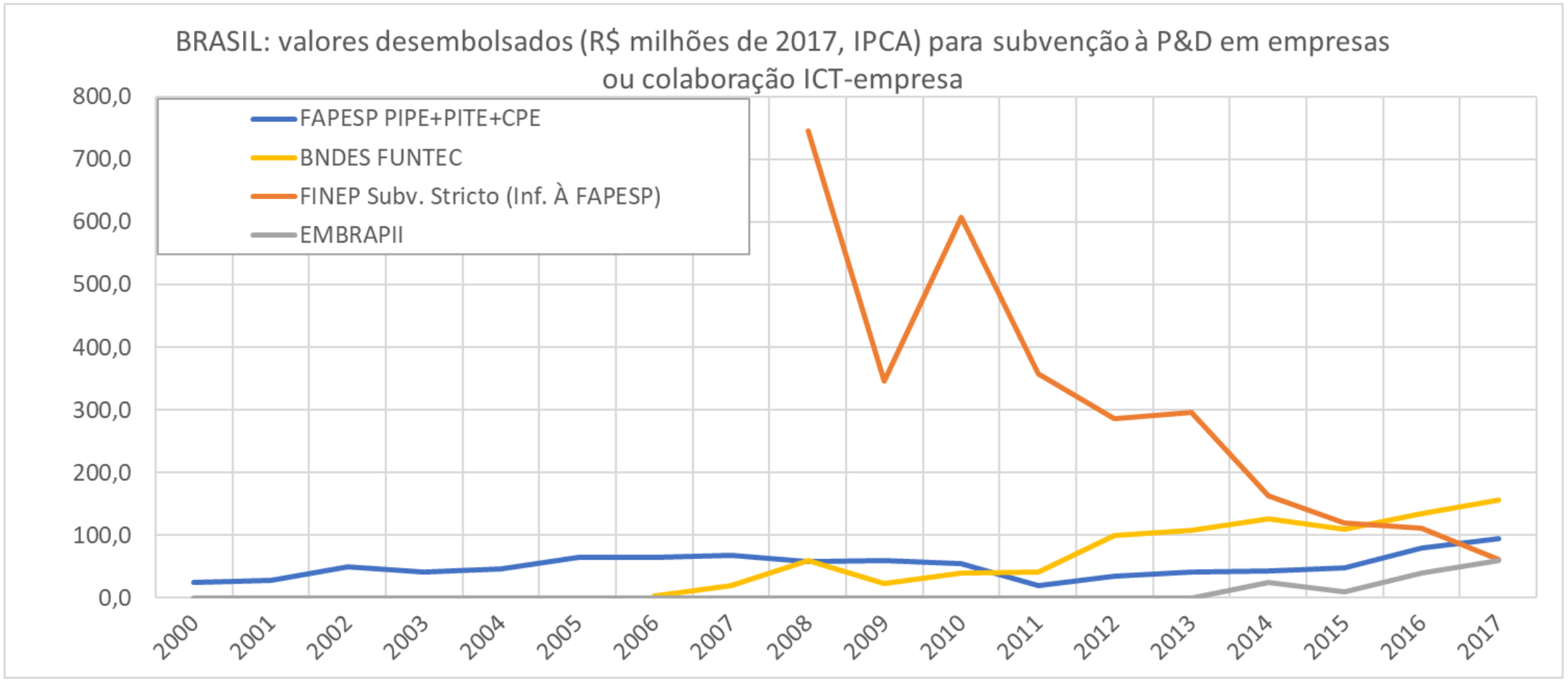
Brazil: publicações científicas e seu impacto em citações



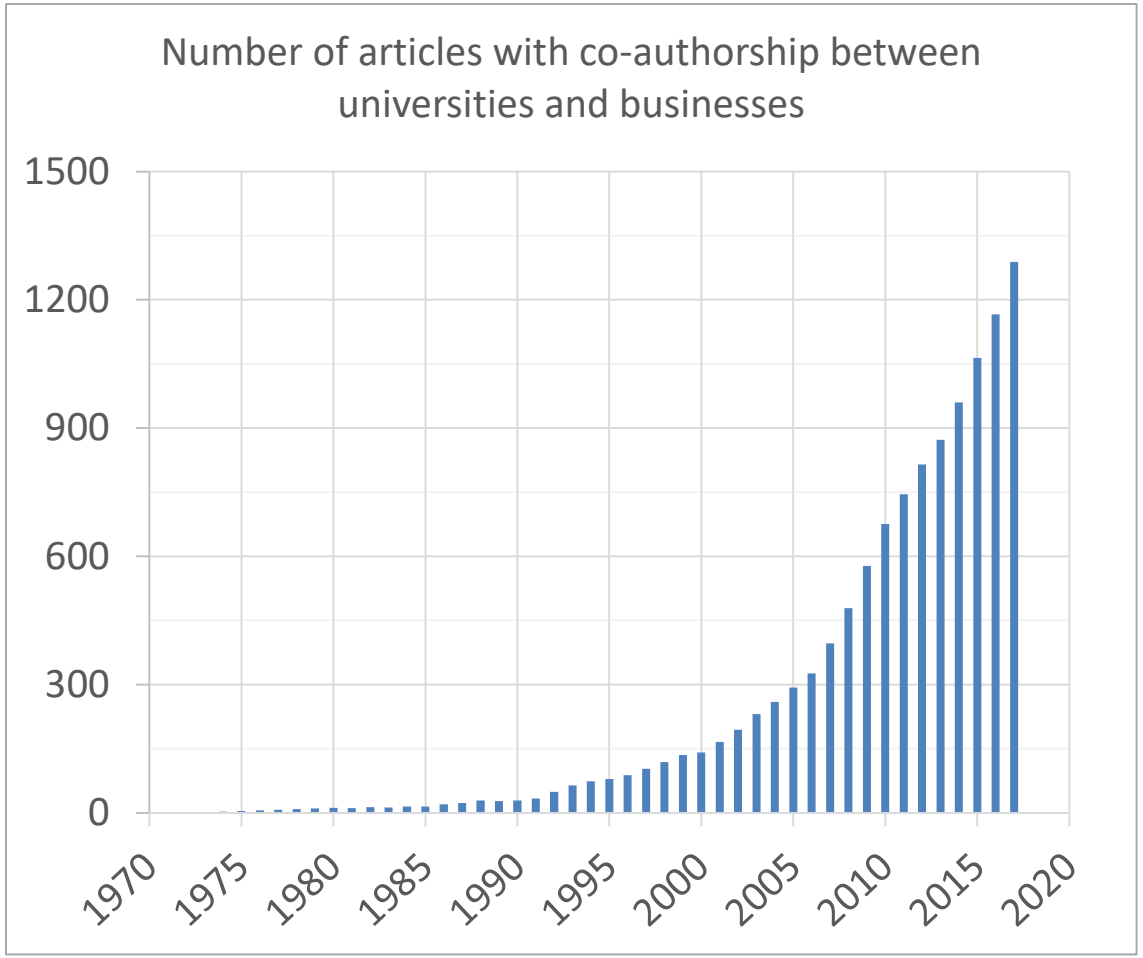
Brazil: international coautorship in scientific articles

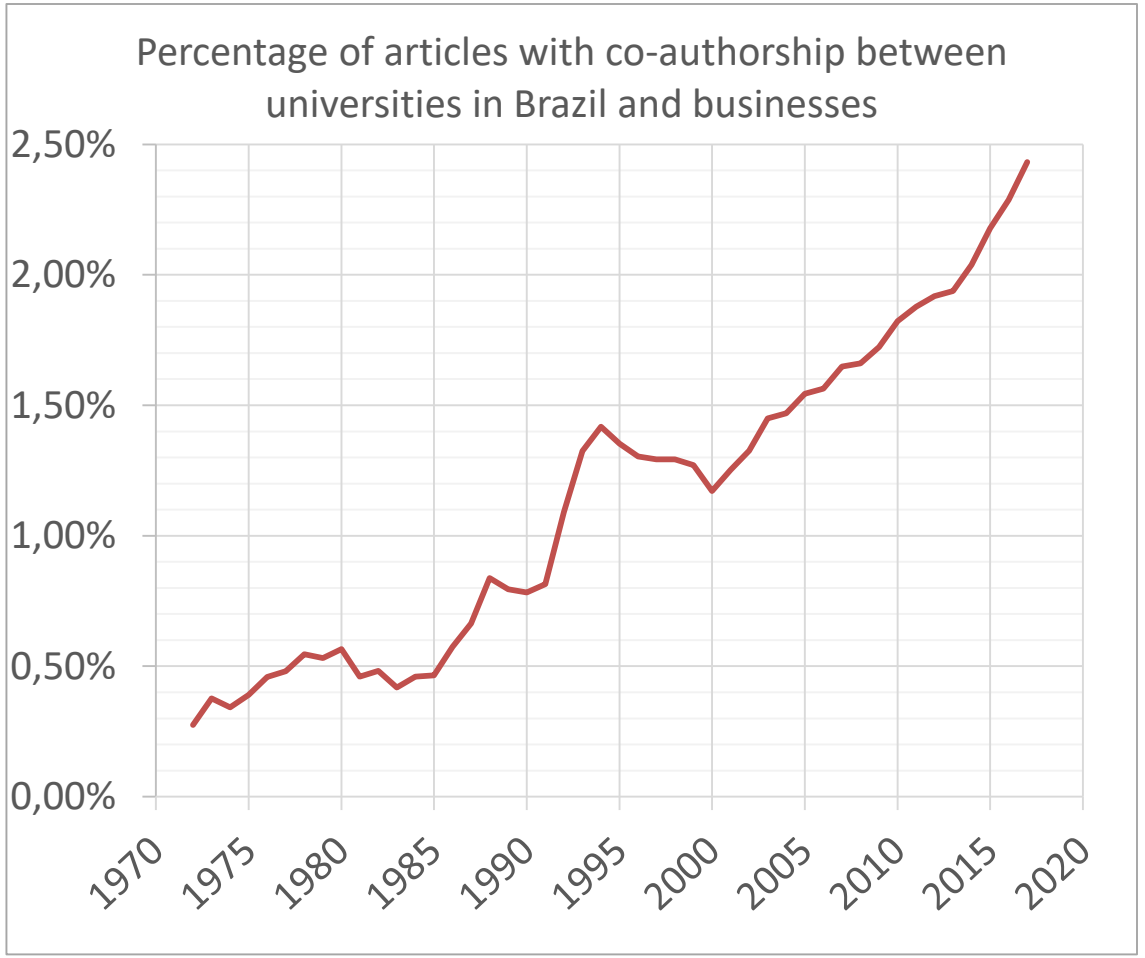


Brazil: subvention to business R&D or Business-University joint R&D (actual expenditures)



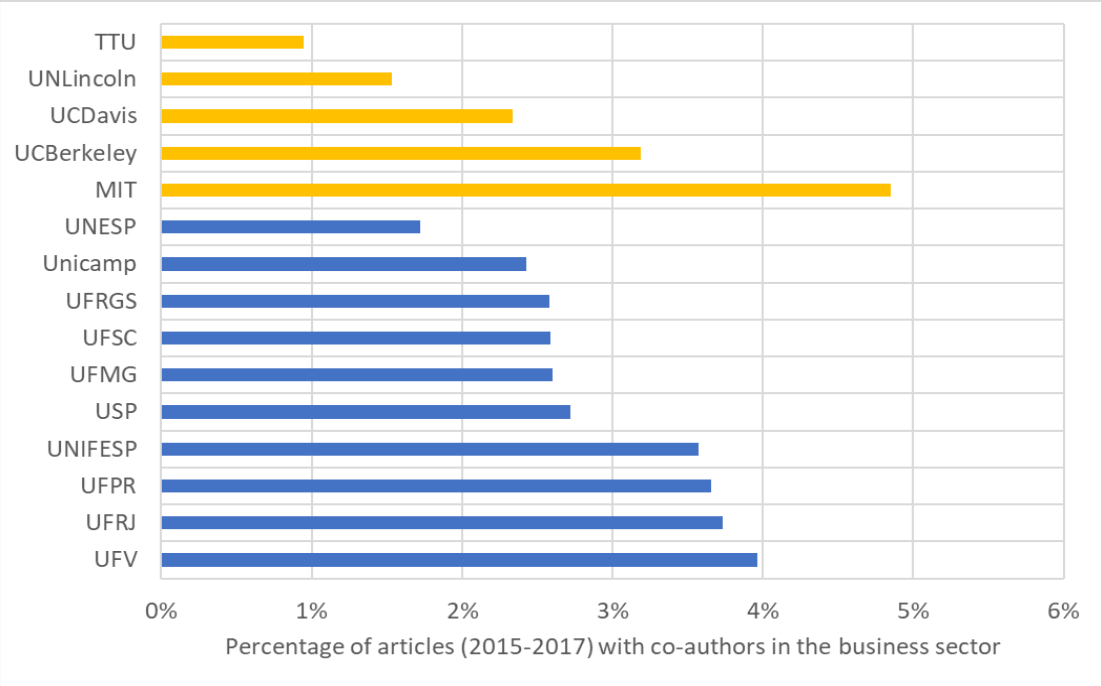
Brazil: University-Business co-authorship in scientific articles



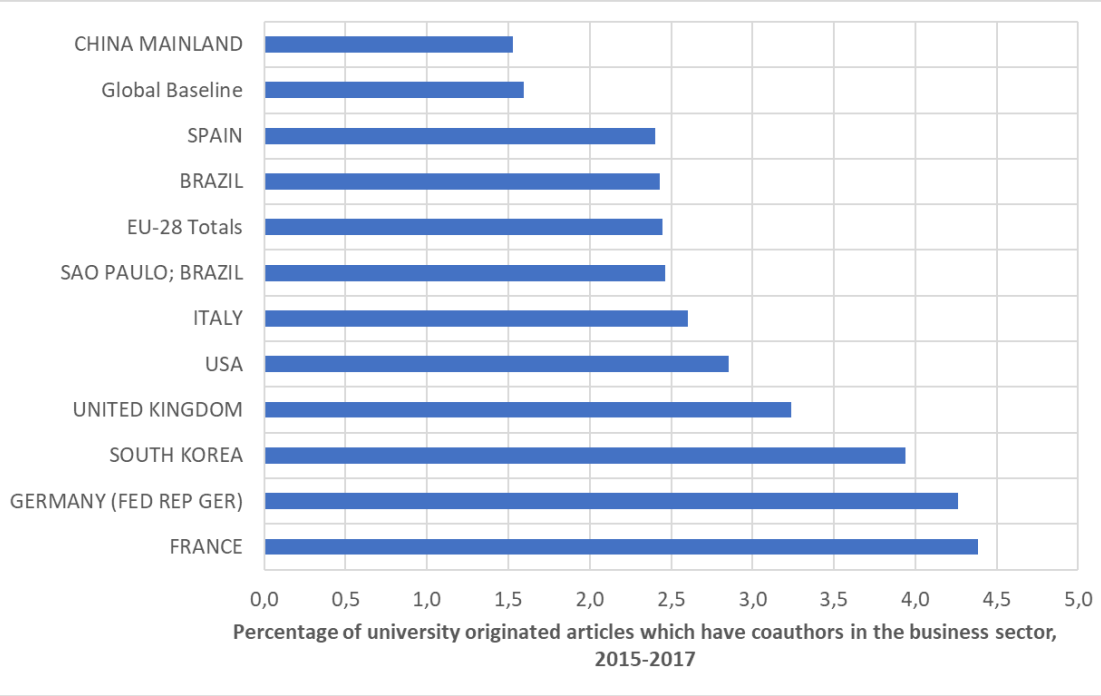


University-Business coauthorship

By university



By country



Main business entities in coauthorship, 2011-2017

Rk	Name	Qty
1	Petrobras	1050
2	Novartis	174
3	Pfizer	118
4	Roche	94
5	GSK	94
6	IBM	93
7	Vale/ITV	84
8	Merck	78
9	Eletrobras	72
10	AstraZeneca	72
11	Fibria	70
12	Westat	64
13	Janssen	57
14	Embraer	56
15	Bayer	55
16	Monsanto	54
17	Agilent	52
18	Braskem	51
19	Boehringer Ingelheim	49
20	Sanofi	49

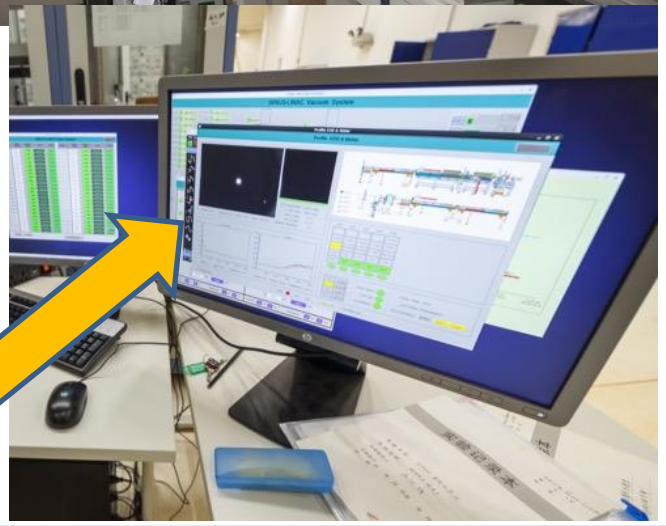
Rk	Name	Qty
21	Eli Lilly	47
22	Syngenta	47
23	Novo Nordisk	45
24	Amgen	42
25	Dow Agrosciences	42
26	Itaipu	40
27	Bristol-Myers	39
28	Genzyme	38
29	Whirlpool/Embraco	38
30	Fundecitrus	36
31	Ericsson	36
32	Genentech	34
33	IPEF	33
34	Suzano	31
35	CEMIG	31
36	AT&T	30
37	Furnas	26
38	Microsoft	26
39	Apis Flora	26
40	Votorantim	25

Unicamp 485 start-ups; 29 thousand jobs, R$ 3 billions in revenues (2016)

2012-2016:

34 start-ups/year

Sirius, mostly on-time: first LINAC beam last Saturday, May 5



ASSESSING IMPACT

Assessing Impact: Cases x Measurement

Social Rates of Return and Other Aspects of Agricultural Research: The Case of Cotton Research in São Paulo, Brazil*

HARRY W. AYER AND G. EDWARD SCHUH

Economic impacts of investments in cotton seed research and development in São Paulo, Brazil, are estimated. The internal rate of return to Brazilian society is estimated to have been approximately 90 percent. The effect on export earnings was large, and consumers benefited via a decrease in the price and an increase in the quantity of cotton cloth. Of total net benefits producers captured about 60 percent and consumers 40 percent. Landowners and managers received the largest share of producer benefits. Laborers benefited through an increase in employment, but wage rates were not raised. Policy implications are given.

Source: *American Journal of Agricultural Economics*, Vol. 54, No. 4, Part 1 (Nov., 1972), pp. 557-569

FAPESP, 2004: agricultural research impact

4. PRODUTIVIDADE TOTAL DOS FATORES E RETORNO À PESQUISA PÚBLICA NA AGRICULTURA PAULISTA

Tomando-se os coeficientes do Quadro 4.1 e multiplicando-os pelo produto físico médio do estoque de pesquisa, e pela média dos ganhos na produtividade total dos fatores, chega-se a valores que oscilaram entre R$ 10 e R$ 12. Em outras palavras, para cada real despendido em pesquisa houve um incremento no valor da produção da ordem de R$ 10 a R$ 12.

(Paulo Cidade Araújo, 2004)

Retorno do investimento em pesquisa: Citricultura em SP

Retorno Econômico dos Investimentos em P&D na Citricultura Paulista

Margarida Garcia de **Figueiredo**[1], Alexandre Lahóz Mendonça de **Barros**[2] e Junia Cristina Peres Rodrigues da **Conceição**[3]

Resumo: O presente estudo teve como principal objetivo medir o retorno econômico dos investimentos em P&D na citricultura paulista. O Brasilé o maior exportador mundial de suco de laranja, eo estado de São Paulo responde por 98% das exportações brasileiras de suco. A metodologia utilizada foi o cálculo da produtividade total dos fatores (PTF), através do Índice de Tornqüist, para posterior comparação com os gastos em pesquisa e desenvolvimento no setor. Verificou-se que, para cada R$ 1,00 investido na pesquisa citrícola, obtém-se aumento de R$ 13,67 no valor da produção de laranja no estado de São Paulo.

RESR, Piracicaba-SP, Vol. 50, Nº 3, p. 493-502, Jul/Set – Impressa em Setembro de 2012

Avaliação do Programa PIPE
Dep. Política C&T Unicamp

Evaluation of ST&I programs: a methodological approach to the Brazilian Small Business Program and some comparisons with the SBIR program

Sergio Salles-Filho, Maria Beatriz Bonacelli, Ana Maria Carneiro, Paula F Drummond de Castro and Fernando Oliveira Santos

Research Evaluation, 20(2), June 2011, pages 159–171
DOI: 10.3152/095820211X12941371876184; http://www.ingentaconnect.com/content/beech/rev

PIPE FAPESP e SBIR NSF

Table 2. Similarities between PIPE and SBIR

Indicators	PIPE	SBIR
Revenues derived from the projects	40%	40%
Revenues of the 5% biggest firms	R$20 to 5 million	US$ 25 million
Projects with patents	29%	30%
Projects that would not be developed without the support of PIPE/SBIR	1/2	2/3
Projects that get more financial resources other than PIPE/SBIR grants	52%	56%

PIPE FAPESP e SBIR NSF

Table 3. Differences between PIPE and SBIR

Indicators	PIPE	SBIR
Firms that were created to receive PIPE/SBIR funds	12%	20%
Projects that received venture capital	12%	25%
Commercial exploration of intellectual property rights	4%	16%

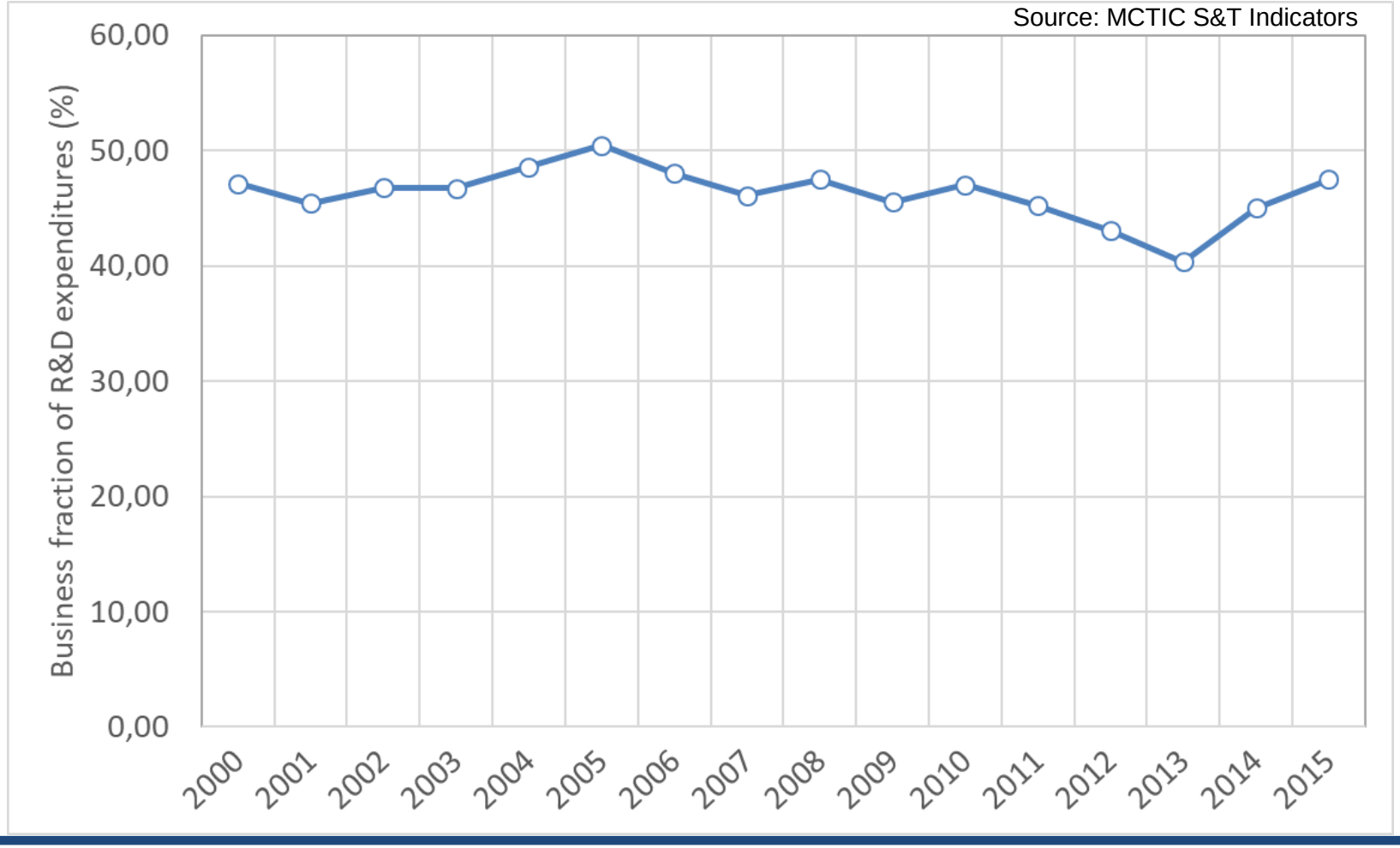
Small Business Innovative Research@FAPESP

- Economic impact
  - FAPESP = 1 / Small Business = 0,8 / Revenues = 11
- Small business failure rate was 8%
  - Well below the 70% found by SEBRAE for SB in Brasil
  - Higher failure rate for SB created in order to obtain PIPE support
- Jobs
  - Increase of 40% in the gross human resources involved (hired, fellowships, outsourced)
  - +30% in direct hires at least one year after Project ended
    - 60% for higher education level
    - >90% for graduates

Conclusion

- A complex and multidimensional S&T system exists in Brazil
  - Universities, business, institutes, funding agencies and instruments
- A multitude of high-impact results
  - 3-dimensions of impact: intellectual, social, economic
- Weak points
  - Planning, following-up programs, stability, coherence among actors
  - Balancing Excellence x Breadth
  - Economic drivers for innovation
  - Communication to society and their representatives
    - Assessing impacts, telling about them

Business participation in the total R&D expenditures in Brazil, 2000-2015



Desafios para a ciência e a tecnologia no Brasil: Três Impactos

- Impacto social
  - Ideias que afetam políticas públicas
- Impacto economico
  - Ideias que criam empresas
  - Ideias que aumentam a competitividade de empresas
  - Ideias que criam setores industriais
- Impacto intelectual
  - Ideias que criam mais ideias
  - Ideias que fazem a humanidade mais sábia
  - Ideias que são citadas na literatura

Added complication….

- Multiple agencies
  - CNPq, CAPES, FAPs, FINEP, BNDES, …..
- What was the plan anyway???
  - Training graduate students
  - More Engineers…?
  - More R&D in the business sector – innovation
  - More University/Institutes – Business research collaboration
  - Higher impact research
  - International research collaboration