

CHAPTER

19

Challenges and Opportunities for Public Research Universities in Brazil

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Federal and State-level support for higher education and research played a fundamental role for Brazil to develop a graduate schools system that awarded 13,912 doctoral level titles in 2012. The number of scientific articles authored by scientists working in Brazilian higher education institutions and published in international journals grew from 2,000 in 1980 to 38,000 in 2012 (TR Web of Science data, 2013).

In the Brazilian higher education system, research-intensive universities exist because higher education and research are supported by public funding provided through two complementary streams, plus a smaller fraction sourced from business. One is the institutional funding to universities that covers salaries for faculty and staff, plus the basic operation costs of the institutions. By law, public universities cannot charge any tuition for both undergraduate and graduate courses. The second funding stream is the competitive peer-review processes, operated by (public) research funding agencies at the national and state level. Business funding for university research contributes a small fraction of the total research funding in most Brazilian universities, with a few notable exceptions.

Of the 190 universities in Brazil in 2011 (INEP, 2011), 102 were public. Among the private universities, on average, only 24% of the faculty has a PhD degree, and practically none of them qualifies as being research intensive. Among the public universities, on average, 54% of the faculty has a PhD degree, and for only 14 (11 federal and 3 state universities) of those more than 75% of the faculty has that title.

Besides having faculty qualified to lead research, it is expected that research-intensive universities offer a broad range of graduate courses, which are instrumental in defining the connection between education and research that underlies these institutions. Applying this additional criterion, the estimated number of 14 research-intensive universities mentioned above reduces to the 10 universities shown in Table 1.

Having 21% of the faculty among the public universities in Brazil, these 10 universities responded, in 2012, for 55% of the doctoral titles awarded in Brazil, for 68% of the number of scientific articles published by authors from Brazil in Web of Science journals, and for 88% of the citations received in the scientific literature.

Presently, one of the most important challenges for these universities is that of obtaining higher impact. By “impact” we mean two main dimensions: (1) intellectual impact, measured for example in the number of citations received in the international literature; and (2) societal impact, measured for example in terms of assisting the competitiveness of business and the effectiveness of public policy. This does not mean they do not already have a strong impact in the development of Brazil. They do, e.g. in terms of qualified personnel they graduate and get positions in business or in other universities in Brazil. Most of them also have intense ties with business, and their scientific articles receive a good fraction of the citations to Brazilian-authored articles. The point is that there is room to grow, and the taxpayer and their representatives expect that. In the following we describe some of the initiatives that were put in place to this end, focused mainly in (1) developing university-industry research collaborations; (2) developing international research collaborations; and (3) developing long-term, high-impact research.

Of course, the list shown in Table 1 is only indicative and it is dynamic. Younger universities (the case of the Federal University of ABC comes to mind) are climbing the ladder quickly and will soon have the breadth of fields and graduate doctoral programs to be considered research-intensive. A small number of private universities, such as the Pontifical University of Rio de Janeiro and the Pontifical University of São Paulo might also be included.

DEVELOPING UNIVERSITY-INDUSTRY/GOVERNMENT RESEARCH CONNECTIONS

In addition to a steady flow of graduates to industry, research-intensive universities in Brazil have been working to intensify their research connections to business through two main mechanisms: (1) joint university-industry research projects; and (2) start-up company generation, mostly led by former students.

Table 1: Size of faculty, percentage with a Doctoral degree, number of Doctoral thesis approved in 2012, and number of Web of Science documents for Brazil and for the ten universities in Brazil qualified as research-intensive universities.

Region/University	Faculty	%DR	DR Thesis approved	Web of Science Documents
Brazil	129.716	54%	13.912	34.393
Sum for the ten universities below	27.854		7.597	23.549
University of São Paulo	5.860	99%	2.439	7.712
State University of Campinas	1.739	99%	853	2.534
Federal University of São Paulo	1.216	95%	308	1.561
University of the State of São Paulo	3.625	95%	852	2.716
Federal University of Minas Gerais	3.027	83%	626	1.903
Federal University of Rio Grande do Sul	2.570	82%	767	2.068
Federal University of Rio de Janeiro	3.791	81%	773	2.310
Federal University of São Carlos	1.226	79%	220	820
University of Brasília	2.513	77%	365	843
Federal University of Santa Catarina	2.287	77%	394	1.082

Sources:

Faculty and percentage with Dr degree: for federal universities, INEP's Statistical Summary, 2011; for state universities the respective Statistical Yearbooks, 2012

Number of Dr Thesis approved: CAPES database, 2012

Number of Web of Science Documents: Thomson Reuters InCites, 2012

Most, if not all, of the universities listed in Table 1 have offices directed at developing opportunities for joint research. They look for partnerships with industry and, to a lesser but still relevant extent, with government. For the universities listed for which there is data available on the value of the research contracts with industry, the percentage of the total research expenditures falls between 5% and 8%, which is comparable to the average value for universities in the U.S. (NSB, 2012).

The number of opportunities for joint university-industry research has been growing, and research funding agencies like the National Funder of Studies and Projects (FINEP) and the São Paulo Research Foundation (FAPESP) offer special programs to match funds to those of companies looking to contract research at universities.

FAPESP operates a program through which the foundation enters in an agreement with partner companies to jointly announce calls for proposals to

select the projects to be co-funded. The portfolio of companies using this program has been growing and includes Microsoft, Agilent, Braskem, Oxiteno, SABESP, VALE, Natura, Petrobrás, Embraer, Padtec, Biolab, Cristalia, Whirlpool, Boeing, GSK, BP, BG and PSA (Peugeot-Citröen). The calls invite proposals that might be for two-year research projects up to 10-year research plans for a joint Engineering Research Center (ERC) hosted in a university.

In some cases the partner is a governmental organization, a Secretary or Ministry. To mention an example, the researchers of the FAPESP-BIOTA program, who lead several research grants to study the biodiversity in the State of São Paulo, developed a longstanding interaction with the State of São Paulo Secretary for the Environment and assisted them in creating more than 20 pieces of legislation for environmental conservation (Joly *et al.*, 2010). In Bioenergy, researchers from the FAPESP BIOEN Research Program are working with UNESCO in a SCOPE assessment of the impacts of large scale bioenergy production.

Start-up creation is also a target for the research-intensive universities in Brazil. The State University of Campinas describes on its website a list of more than 200 start-ups originating in the last 20 years, generating thousands of jobs and opportunities for young students. Again, FINEP and FAPESP offer programs to fund small business R&D that are similar to the SBIR program in the U.S.

DEVELOPING INTERNATIONAL RESEARCH COLLABORATIONS

Increasing international research collaboration can help to increase the intellectual impact of the research. Most of the universities listed in Table 1 have been developing programs for international collaboration. The University of São Paulo (USP) is one of the most effective in this endeavour, and, besides having a good number of active exchange agreements, has recently organized a joint graduate course with Ohio State University and Rutgers University, in topics related to plant sciences.

In 2012 the Ministry for Science and Technology of Brazil announced an ample program to send students from Brazilian universities for stays up to 12 months in universities abroad. The program, named Science without Borders, offers opportunities for students in fields of study considered strategic by the Brazilian government and invites collaboration with industry. The announced target is to send 100,000 students in four years. Most of these are undergraduate students who will attend classes that will contribute to their courses. A smaller fraction is composed of graduate students who will either do a full PhD abroad or spend 12 months working in research related to the thesis they are doing in Brazil. As of August, 2013, 35,138 students had been supported. Of these, 26,682 were undergraduates, 3,718 were doctoral stu-

dents enrolled in Brazil who went for a 12-months stay, 746 were doctoral students enrolled in a full doctorate abroad, and 1,989 were post-doctoral fellows (CNPq, 2013). The sheer magnitude of the program will bring important results for the education of the students involved and also for the establishment of international networks in research.

In the state of São Paulo FAPESP has been developing an important strategy for creating opportunities for research collaboration for researchers in the state. FAPESP maintains cooperation agreements with research funding agencies, higher educational and research institutions and business enterprises. The international cooperation covers a broad range of countries and agencies (FAPESP, n.d.-a), including the U.K. Research Councils, the Agence Nationale de Recherche in France, the Deutsche Forschungsgemeinschaft (DFG) in Germany, the National Science Foundation and the Department of Energy in the U.S., the Danish Council for Strategic Research (Dk), the Fundação para Ciência e Tecnologia (Portugal), the Academy of Finland, the Consejo Nacional de Ciencia e Tecnologia (Argentina) and other funding agencies.

To foster the preparation of joint proposals, FAPESP has agreements with universities in most of these countries, through which seed funds are offered for teams of researchers to work together and prepare full proposals to be jointly submitted.

In addition to this, FAPESP has been organizing a number of scientific events (FAPESP Week Symposia) in key hubs like Washington DC, Toronto, Boston, Tokyo, Madrid and London. In each of the FAPESP Week Symposia, researchers from São Paulo, Brazil, and invited colleagues from the region present their recent results and discuss the ongoing collaborations, creating opportunities for the funding agencies to interact directly with the collaborating researchers and assess the progress of the collaborations. FAPESP's strategy and instruments for international collaborations are described online (FAPESP, n.d.-a) The number of joint research projects supported by FAPESP grew 20-fold, from eight in 2005 to 150 in 2012.

The strategy for international collaboration also includes bringing foreign scientists to São Paulo. FAPESP's program of post-doctoral fellowships is open to foreigners willing to come to Brazil. In the Natural Sciences the percentage of foreign post-docs supported by the foundation grew from 15% in 2007 to 34% in 2012. In the Life Sciences the change was from 4% to 11%. In 2012 FAPESP awarded more than 920 post-doctoral fellowships. All proposals are selected through peer-reviewing and applications can be submitted in English.

Additionally, the Young Investigator program selects scientists with a few years of post-doctoral experience, demonstrating outstanding research leadership capabilities (FAPESP, n.d.-b). Funding includes a fellowship, plus a research grant. In 2012, 88 young investigator awards were granted for researchers to start their careers in São Paulo, in the Natural Sciences and Engineering.

For outstanding, experienced researchers who have a permanent position outside Brazil, FAPESP offers the São Paulo Excellence Chairs (SPEC). The candidate must commit to spend not less than 12 weeks per year for five years, leading a research project hosted in a university in the State of São Paulo. The 12 weeks do not need to be continuous. The grant covers funds for equipment, consumables, trips, fellowships for students and post-docs, as well as expenses to travel to Brazil. The host institution in São Paulo will pay a salary for the weeks spent there leading the research.

In order to foster international research experience by the recipients of its fellowships, FAPESP offers for the 3,000 undergraduate, the 6,500 graduate students and the 2,000 post-doctoral fellows who have FAPESP fellowships in universities in São Paulo an additional fellowship for a stay of up to one year to work in a research laboratory of their choice abroad.

Finally, to enhance the visibility of the research environment in São Paulo and to facilitate interactions with prospective candidates, FAPESP created the São Paulo Schools of Advanced Science. Each School runs from one to three weeks and is led by a researcher in São Paulo, who invites colleagues from Brazil and from abroad to be lecturers. Around 100 doctoral students can attend, at least half of those coming from other countries, all fully supported by FAPESP funding. Started in 2010, the program has supported the organization of 38 Schools so far (ESPCA, 2013).

DEVELOPING LONG-TERM, HIGH-IMPACT RESEARCH

FAPESP created the Research, Innovation and Diffusion Centers (RIDC) Program in 1998 with the objective to offer outstanding research groups in São Paulo the opportunity to pursue a long-term research plan, breaking away from the two- or four-year cycle of grant duration. The expectation was that with a long-term contract the group would be able to pursue higher-risk research objectives. Following international experience, FAPESP requested, in return for the longer term and higher than average value of the funding, that each centre have a core of world-class research, and use it to exploit two additional objectives. One is to create opportunities for innovation through university-industry and/or university-government interactions to assess and/or assist in the creation of public policies; the other is to use the advanced research experience to assist science education, impacting the public awareness about science and the quality of science education in basic schools. By adding these two objectives to the core research mission of each centre, FAPESP seeks to maximize the social benefits created by the research done.

A first round of the program supported 11 centres from 2001 to 2013. The centres were selected in a competitive call for proposals which had a 10% success rate, using international peer-review. The results were excellent in all

three fronts: high-impact research, technology-transfer and innovation, and public awareness and science education.

In May 2011 FAPESP announced the call for proposals for the second round of the program. 90 pre-proposals were received and 150 reviewers contributed to the Phase 1 selection process preparing 207 reviews. Of the 90 initial pre-proposals, 44 were selected and invited to submit full proposals for Phase 2 of the selection process. The invited full proposals were submitted by 6 February 2012.

In May 2013, FAPESP announced the 17 new Research, Innovation and Dissemination Centers (RIDCs) selected for funding for a period of up to 11 years, subject to continuation reviews on years 2, 4 and 7.

Funding for the 17 RIDCs will come from FAPESP and the host institutions (funding faculty salaries, technicians, support personnel and infrastructure). It is estimated that for the 11-year duration of the program, the total funding for the 17 centres will be above US\$680 million, with US\$370 million coming from FAPESP and US\$310 million in salaries from the host institutions. Additional funding will be obtained by each centre from industry and government organizations.

The 17 RIDCs bring together 499 scientists from the State of São Paulo and 68 scientists from other countries. The research topics covered by the centres include the following: food and nutrition; glasses and glass-ceramics; functional materials; neuroscience and neurotechnology; inflammatory diseases; biodiversity and drug discovery; toxins, immune-response and cell signalling; neuromathematics; mathematical sciences applied to industry; obesity and associated diseases; cellular therapy; metropolitan studies; human genome and stem-cells; computational engineering; redox processes in biomedicine; violence; and optics, photonics and atomic and molecular physics.

The 17 centres started in 2013 are:

- Food Research Center — FoRC, University of São Paulo;
- Center for Research, Teaching, and Innovation in Glass — CEPIV, Federal University of São Carlos;
- Center for Research and Development of Functional Materials — CDFM; University of the State of São Paulo;
- Brazilian Research Institute for Neuroscience and Neurotechnology — BRAINN; University of Campinas;
- Center for Research on Inflammatory Diseases — CRID, University of São Paulo;
- Center for Research and Innovation in Biodiversity and Drug Discovery — CIBFar, University of São Paulo;
- Center for Research on Toxins, Immune-Response and Cell Signaling — CeTICS, Butantan Institute

- Research, Innovation and Dissemination Center for Neuromathematics — NEUROMAT, University of São Paulo;
- Center for Research in Mathematical Sciences Applied to Industry — CeMEAI; University of São Paulo;
- Obesity and Comorbidities Research Center — OCRC, University of Campinas;
- Center for Research in Cell Therapy — CTC; University of São Paulo;
- Center for Metropolitan Studies — CEM; Brazilian Center for Analysis and Planning (CEBRAP) and University of São Paulo;
- Human Genome and Stem-Cell Research Center — HUG-CELL, University of São Paulo;
- Center for Computational Science and Engineering — CECC, University of Campinas;
- Center for Research on Redox Processes in Biomedicine — REDOX-OME; University of São Paulo;
- Center for the Study of Violence — NEV, University of São Paulo;
- Optics and Photonics Research Center — CEPOF, University of São Paulo.

CONCLUSION

Public support for research-intensive universities has been decisive in Brazil. In addition to federal funds, some other states appropriate substantial funding for higher education and research.

In the state of São Paulo, which responds for 33% of Brazil's GDP, three public universities have their budget appropriations set at 9.57% of the state VAT revenues, through a Governor's Decree from 1989. Additionally, the Constitution of the state guarantees for the São Paulo Research Foundation 1% of all state fiscal revenues. Federally funded universities do not have the same kind of autonomy, but have seen climbing budgets in recent years.

Universities and funding agencies have been fostering university-industry/government interactions, the internationalization of higher education and academic research, and the search for high-impact research. Several programs exist in Brazil for sending students and researchers for short stays abroad and for bringing foreign scientists to Brazil. There are substantial challenges, such as the language barrier. Even so, the number of international joint research projects has grown intensely in the last seven years, and the same has happened to the number of young foreign post-doctoral fellows coming to Brazil, especially to the state of São Paulo where there is an aggressive program of fellowships.

Public research universities face growing demands from society to display more direct relevance in social and economic development. This happens

especially in relation to university-business relations, but also with respect to the social impacts of higher education and academic research. Universities are more and more pressed to focus on research that either helps business competitiveness or heals the sick or makes poor people richer. While trying to answer these calls, it remains essential for research-intensive universities to remember that their commitment to that research that makes mankind wiser and to its connections to education is what makes them singular to society.

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