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Policy Considerations on EU-Brazil Future Scientific Cooperation

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Abstract

The global financial crisis 2007-2008, considered by many economists to have been the worstfinancial crisis since the Great Depression of the 1930's, resulted in investment instability worldwide. This reflected differently in education and research implementation policies in different countries; in some there was a reduction of funding, in others there was a boost in investment to relaunch competitiveness. Such competitiveness is in terms of sources, capacity building, costs, and importantly, technology. Investments in R&D can have a significant impact on a nation's GDP, nevertheless policies and opportunities may not reflect it, especially when it comes to unions of states, such in the case of European Union and Brazilian Federation. Challenges and expectations of those sub-continental areas are different; the EU' member states belong mainly to the category of "developed countries" that are facing increasing of competitiveness from new emerging economies. Brazil, labeled as emerging country of the BRICS group in early 2000, is a federation facing the double challenge of reducing its social inequality and increasing its competitiveness in the global market place. This paper provides a perspective view from the EU and from Brazil and from member states, about the role that science policies could have on nation development and how internationalization may support science development and society.

Keywords

Brazil, EU, Economic Crisis, Research, Science, Technology, Education, Cooperation

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1. Introduction

1.1. Setting the Scene: Europe and Brazil Science Cooperation Governance and Funds Supporting Shared R&D

There are several opportunities for scientific and technological collaboration between Brazil and the EU. In recent years (2007-2013), Brazil significantly increased international cooperation with the EU by participating to the "Seventh Framework Programme for Research" (FP7) [1]. From 2014, the EU has launched a new financial instrument implementing the "Europe 2020 strategy" [2], named Horizon 2020 (H2020) open also to Brazil, although with different rules of participation compared to the past Framework Programme. As other Emerging Economies,

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Brazil participates according to the non-automatic funding rule, which leads to the need for complementary matching co-funding from the Brazilian side. This is the biggest EU R&D programme, with nearly €80 billion (approximately $102 billion) of funding available over seven years (2014-2020), in addition to the private investments and co-financing which such EU funding can attract. H2020 is open to international cooperation [3] and rewards research, innovation, excellence and pushes ideas to the marketplace.

Other modalities enable scientific participation of Brazil to EU programmes [4], EU-Brazil Coordinated Calls, mobility of scientists, (Marie Skłodowska-Curie actions – MSCA) [5, 6], but most importantly, Brazil and the EU have a policy dialogue to define priorities within the roadmaps for international cooperation [7] and the Strategic Forum for International Science and Technology Cooperation (SFIC) initiative on Brazil [8].

1.2. New Areas for EU-Brazilian Cooperation

As recently defined, shared EU-Brazil strategic areas should be: Marine Research and bio-economy, food security, sustainable agriculture, Energy, Nanotechnology, Information and Communication Technologies (ICT). In such areas, cooperation shall be mostly fostered within H2020, although such priorities might change, or becoming highly focused, given that roadmaps shall be updated along the way to 2020.

From the Brazilian side, it must be clear that the global economic crisis has not spared Latin America, but in a trend of development [9] has found this region more reactive than others. Brazil has had important advances to reduce social and economic inequalities [10] and in the development of science and technology; the country alone bears a budget to these areas and seeks to recover the backlog for many decades. The federation has diversified its areas of operations research, and there has been significant increase in the resources allocated for this purpose, expanded the infrastructure of R&D and strengthened institutionally the S&T system of federal and state universities.

A programme launched in 2014, and which resembled in many ways H2020 was the *Plataformas do Conhecimento* [11] which had the goal to promote the development of sectors that can potentiate Brazil's global competitiveness in areas linked to R&D. Such knowledge platforms, planned to be created in the next ten years are in areas such as agriculture, health, energy, aerospace, ICT, and naval equipment.

Another significant context for Brazilian international cooperation is within science mobility. To this end a considerable investment has been made through the "Science Without Borders" Program (*Ciência sem Fronteiras* –CsF [12] foresees over 100.000 international fellowships, including hosting visiting scientists), aiming to internationalize the Brazilian S&T system and to promote an accelerated pace of technological development and innovation by qualifying Brazilian students and researchers.

2. Cooperation Schemes

2.1. EU Member States: Italian and Brazilian Cooperation

The global financial crisis 2008-2009, considered by many economists the worst financial crisis since the Great Depression of the 1930's [13], resulted in investment instability worldwide. Funding research was affected as well by the crisis and different countries reacted in opposite ways. On average, most of the OECD countries increased their investments in education [14, 15], with the rationale of improving their technological knowledge and therefore increasing, or at least maintaining, their competitiveness. Italy is among those few that decreased their investments. This is not surprising, as Italian strategic choices often mortified education and research public investments. Nevertheless science in Italy fairly improved over the years, keeping the pace with other EU countries with richer and more stable research and education programs. This lead to a sort of "Italian paradox" [16, 17], in which with a constant neglect of investment of research leads in any case to an improvement of the scientific national system. Yet, to date, Italy still displays a fair excellence in science and technology, ranking 8th worldwide in terms of volume of produced research [18]. If we look at the data (Table 1, A) we can appreciate how in the last decade, among the BRICS [19] countries, China improved its ranking from 9th to 2nd and India entered into the top ten, while Brazil (not shown) rose to 13th from 19th.

Despite the growth of those "giants", Italy still remains in this top ten rank and in terms of scientific production, Italians are leading global performer [20]. Moreover, if we aggregate the performance of EU member states in the top ten rank (UK, DE, FR, IT, ES, Table 1, B) we would find EU together with USA.

All together, these considerations give a picture of Italy as a country with a scientific community extremely competitive and able to produce relevant science despite the objective difficulties, and part of a European Union that overall is scientifically excellent.

Cooperation between Brazil and Italy in science and technology could be a positive factor to improve and maintain a high technological standard, as well as (improve) standards of social and economic life. At the governmental level, in 2010 Brazil and Italy signed a "strategic partnership

action plan" [21], foreseeing among other points, creation of a special industrial collaboration relationship, strengthening of scientific-technological collaboration in various sectors, increasing cultural and university collaboration. Yet, Italian-Brazilian relations date far earlier than that, and beside public/governmental initiatives, major private companies with high tech profiles invested in Brazil over the years in terms of capacity building and human resources; to name a few, the automotive industry FIAT (now FCA), Pirelli since 1929 and investing in Brazil with Italian-derived R&D [22,23,24,25]. Also Telecom Italia invests in TIM Brazil in terms of education and training.

However, before configuring how those two countries could collaborate, we should frame them in terms of size and role at a global level (Table2); Brazil is a Federation of 26 states, and Italy is a founding member state of the European Union, consisting of 28 states, implementing a collaborative foreign policy toward Brazil [26,27]. The comparison of Italy or any other state of the Union should be done with a member state of the Federation and not with the whole of Brazil, to get the right proportions of capacity, challenges and needs. Sovereignty of EU member states, however, still allows independent foreign policy, and despite their differences, bilateral relations between Italy and Brazil have always been very intense, for sharing commercial and technological interests and for a natural cultural affinity.

Table 1. (A) Top ten world countries in terms of scientific production in 1996 and 2014 (from SJR — SCImago Journal & Country Rank, ref. 18). Over the decades Italy's rank moved down from 7th to 8th, while the entry of India in the top ten and the rise of China is significant. Among the BRICS, with respect to 1996, in 2014 Brazil ranks +8 positions (up to 13th), the Russian federation -7 (15th), and South Africa +3 (30th), (not shown). (B) Comparison between the sum top ten EU members states only (UK,DE,FR,IT,ES) and the USA

A	**1996**		**2014**	
	Country	**Documents**	**Country**	**Documents**
1	United States	330949	United States	552690
2	Japan	84906	China	452877
3	United Kingdom	83480	United Kingdom	160935
4	Germany	72808	Germany	149595
5	France	54427	Japan	114999
6	Canada	41167	India	114449
7	Italy	37726	France	104739
8	Russian Federation	31482	Italy	93064
9	China	28704	Canada	88117
10	Spain	23597	Spain	78817
B	**1996**		**2014**	
	Country	**Documents**	**Country**	**Documents**
	United States	330949	EU top 10	587150
	EU top 10	272038	United States	552690

Table 2. Facts and figures of Brazil, Italy and European Union.

	Brazil	**Italy**	**European Union**
Population	190.000.000	60.000.000	500.000.000
Surface Km^2	8.514.876,599	301.338	4.423.147
Population density p/ Km^2	23.7	201.7	116.2
Government	Federation of 26 states	Republic, EU founder Member state	Political and Economic Union of 28 member states
Language	Portuguese	Italian	24 official languages
Currency	Real	Euro	EURO zone (18 member states) and Other currencies

2.2. The Role of the States of the Brazilian Federation, Not Always the Usual Ones

Brazil has a network of public agencies of federal and state support for science, technology and innovation. These bodies are represented by various ministries and state secretariats and within the Brazilian federation, individual states also have their own research support foundations (*Fundações de Amparo à Pesquisa*, FAPs), as the main instrument to promote STI development.The body which gathers together all the FAPs is CONFAP, the Brazilian National Council for the State Funding Agencies, a non-profit organization created in 2006 to articulate the interests of Brazilian State Funding Agencies. CONFAP is very active on the international scene both at bilateral level with single European Countries (i.e. with the UK partnering within the Newton Fund) and with the EU in general, supporting Horizon 2020. Brazil's largest and oldest FAP is FAPESP, Research Foundation of the state of São Paulo, linked to the Department of Economic Development, Science and Technology (*Secretaria de Desenvolvimento Econômico, Ciência, Tecnologia e Inovação*). With an annual budget of 1% of the state's total tax revenue, which reached US $560 million, it fosters São Paulo's scientific and technological advancement by supporting research projects of institutions of higher education and research in all fields of knowledge [28].

Beside São Paulo and some more states relevant for their GDP [29] such as *e.g.* Rio de Janeiro and Minas Gerais, others states of the federation may be attractive to establish R&D collaborations, although they display lower figures; is this the case of the states of Amazonas and Parà, that have the unique feature to constitute a portal to the Amazon region. Bearing the world treasure of the Amazon rainforest

[30], Amazonas and Parà sum together more that half the land size of the EU and are essential actors to collaborate with when tackling global challenges, such as water security, energy, agriculture, and biodiversity. Both states implement a policy to incentivize investments that aim to innovate and promote industrialization also support research, education and sustainability. Financial incentives are available, mainly to facilitate productive investments both domestically and internationally, nevertheless they should also effect R&D by augmenting the capacity building potential. State research support bodies include the Foundation for Research Support of the State of Pará (*Fundação de Amparo à Pesquisa do Estado do Pará* FAPESPA) and the Foundation for Research Support of the State of Amazonas (*Fundação de Amparo à Pesquisa do Estado do* Amazonas FAPEAM), while sources of investment come from revenues for taxation, and incentives for investments [31]. Table 3 lists some relevant research funding and support at federal and regional levels for the state of Parà and Amazonas. Only in the state of Amazonas the estimated resources for R&D in 2014 alone were about US $200 million [32].

Table 3. Brazilian Federal (A) and regional (B) funding and support bodies with relevance to R&D for the States of Amazonas and Parà.

A		
Funding/Support Body	**Governing Body**	**Mission/ Action**
Conselho Nacional de Desenvolvimento Científico e Tecnológico National Research Council CNPq	Ministry of Science Technology and Innovation	to promote scientific and technological research and encourage the formation of Brazilian researchers
Financiadora de Estudos e Projetos Funding Agency for studies and projects FINEP	Ministry of Science Technology and Innovation	Funding STI activities of companies, universities, technology institutes and other public or private institutions.
Coordenação de Aperfeiçoamento de Pessoal de Nível Superior Coordination of Improvement of Higher Education Personnel Capes	Ministry of Education	The expansion and consolidation of postgraduates (master and doctorate) in all states of the Federation.
Fundo Nacional do MeioAmbiente National Environment Fund FNMA	Ministry of Environment	to contribute, as financial agent, through social participation, for the implementation of the National Environmental Policy Act
Banco Nacional de Desenvolvimento Econômico e Social National Bank for Economic and Social Development BNDES	Ministry of Development Industry and Foreign Trade	to support projects that contribute to the country's development
B		
Funding/Support Body	**Governing Body**	**Mission/Action**
Fundação de Amparo à Pesquisa do Estado do Amazonas, FAPEAM	Secretaria de Estado de Ciência, Tecnologia e Inovação, SECTI	with the specific purpose of support to basic and applied scientific research and experimental technological development in the State of Amazonas.
ConselhoEstadual de MeioAmbiente Environment State Council Fund CEMAAM	Secretaria de Estado do Meio Ambiente e Desenvolvimento Sustentável State Secretariat for Environment and Sustainable Development SDS Instituto de ProteçãoAmbiental do Amazonas Amazonia Environmental Protecion Institute IPAAM	The Implementation of projects for conservation of natural resources come from environmental fines imposed by the IPAAM
Fundo Amazônia Amazon Fund	BNDES	to raise donations for non-reimbursable investments in prevention, monitoring and combating deforestation and promoting conservation and sustainable use of forests in the Amazon Biome
Economic Development Fund FDE	Bank of the State of Pará	funding equivalent to 75% of the state sales tax (ImpostosobreCirculação de Mercadorias e Serviços -ICMS-), for a period of up to 15 years worth, in order to strengthen the working capital and expand the capacity of investment in the productive sectors
Superintendência do Desenvolvimento da Amazônia Superintendence of	Amazonia Development Fund FDA	Tax and financial incentives Credit operations for productive investment, including a grace period for early payment, repayment plan long-term and special

Development for the Amazon SUDAM		interest rates.
Banco da Amazônia	Constitutional Fund of the North FNO	Financial incentives Credit operations for productive investment including a grace period for early payment, repayment plan long-term and special interest rates.

2.3. The Impact of R&D on GDP, Productivity, and Economic Growth in Brazil and the EU

Investment in R&D can have a significant impact on a nation's GDP. It is estimated that for every ½ percent (%) of GDP investment in R&D, a nation's GDP increases by 9.5% [33]. However, the industrial nations only spend between 1.5 to 3% of GDP on R&D [34]. The average rate of return on R&D investment in countries such as the United States amounts to double the return on capital equipment investment and in some countries far exceeds that amount [35].Thus, an increase in R&D can have a substantial impact on economic growth.Moreover, studies have also shown that the social rates of return to R&D to be significantly higher [36].

A key figure used for measuring R&D expenditures is the Gross Domestic Expenditure on Research and Development (GERD). The GERD is designed to show the total expenditure on R&D performed in a country during a given period. The amount of GERD relative to a nation's GDP size is an often used as an indicator of innovation performance. The GERD / GDP ratio for Italy between 1995 and 2005 has shown a 12% increase while for the EU, as a whole, it is only a 2% rise for the same time period [37]. However, for Brazil the GERD / GDP ratio has been roughly 1.3% for the time period of 2012 to 2014 [38].

Another key area in which R&D has a substantial impact is on productivity. Advances and break throughs in technological advancements are the foundation of increased productivity that the economies of advanced industrial nations have experienced over time. But these advances and breakthroughs can only come about by R&D. In one study of Italian companies, it was found that there is a positive relationship between R&D and market performance in which a firm employing a significant amount of resources for R&D was more innovative than others and becoming more successful in the marketplace ultimately resulting in higher profits [39].

3. Discussion

3.1. The past and Future Economic Crises, the Complementarity Between Europe and Brazil and the (Lost?) Opportunities

Today science is more distributed than before. The growth of the BRICS, the technological advances of many Asian countries, and the consistency of EU R&D over the decades generate a different scenario than the mid-1990's. American analysts acknowledge that trend as well [40], and suggest ways to create novel and beneficial shared opportunities for collaboration, while keeping a grip on paramount challenges such as economy, health, security and environment. Scientific networks, exchange of scientists, and collaboration between institutions should be solutions for this new scenario.

In these terms, the Brazil Federation and European Union could reciprocally partner with great potential using an established policy dialogue and the necessary tools and tuning and synchronizing their initiatives, to result in a smart and strategic growth plan based on knowledge, research, and innovation.

Yet, to date, such potential risks does not appear to be synchronized; while Europe seems to be getting out of the economical crisis [41, 42], Brazil's GDP is on on a opposite pace and the country entered a track for recession, that together with the uncertainties of a political crisis [43, 44], resulted in the suspension of several initiative; *e.g.* both the above mentioned comparable scientific platform *Plataformas* as for the EU H2020 and the mobility programme CsF as for the EU MSCA, that remained stalled for the time being [45].

This economical situation, somehow opposite to the early years of the century, may lead to a deviation of goals, with detrimental effect on the cooperation ones [46]. In any case, Latin America has become an indispensable interlocutor and partner in facing all major international challenges, such as security, common rules for global finance, the resumption of the Doha negotiations, and the issues related to the environment. The participation of a large negotiation table such as the G20, which includes Brazil, Argentina, and Mexico, and the LAC-EU summits [47, 48], definitely legitimizes the global role of the subcontinent. Thus, a sudden exclusion of Brazil form the global picture is unlikely to happen. Trade between the EU and Brazil will represent an important factor too: the EU is Brazil's first trading partner, while Brazil is the EU's 9th, accounting for 2.1% of total EU trade (2013-2014) [49], with a fair margin of increase from Brazil's side.

R&D has profound long term benefits also for a nation' economy, as a foundation for future economic growth and progress that will drive creation, application, and increase of new knowledge and technologies. Thus, R&D programs,

whether oriented toward basic or applied research, should still be fueled in order to assist both EU and Brazil in long term economic growth, improved productivity, and increased GDP as well as education and equality.

3.2. Still an Opportunity for EU-Brazilian Joint Achievements

Today the relationship between the EU and Latin America works along different guidelines: the European Union policy, the bilateral state-to-area policy, *e.g.* Italy to Latin America [50], and the bilateral state-to-state policy. Paradoxically, it is this latest type of interaction that may lead to best immediate results in term of cooperation (not just scientific); single states may have a better focus on short and medium term results and may succeed where larger and slower aggregations such as the Federation and the Union, do not. In this perspective, a relevant advance in cooperation mechanisms in the field of S&T between the EU and Brazil, which is currently experiencing a growing trend are the dialogues and agreements between the EU and Brazilian single States, through their representation within the Brazilian Council of State Funding Agencies – CONFAP. Given the new cooperation schemes under Horizon 2020, which require in the majority of cases a co-funding mechanism from the Brazilian side, CONFAP and the Delegation of the European Union in Brazil have signed a Letter of intent to support such process [51]. Following this, CONFAP has promoted and elaborated Guidelines for the preparation of research proposals in collaboration with proposals submitted to Horizon 2020. Under such framework, researchers eligible for funding by the Brazilian Funding Agencies (FAPs) can use the normal modes of funding offered by each Funding Agency which adopted the Guidelines to support their participation in H2020 proposals. Many Brazilian States such as São Paulo, Santa Catarina, Goias, Minas Gerais and Distrito Federal have already launched their own Guidelines, thus defining mechanisms which allow their research and innovation actors to participate in collaborative and mobility projects within Horizon 2020. Other States and the respective Funding Agencies are on their way to follow the same direction. This new framework overcomes the significant obstacles which have modified and limited EU-Brazil cooperation schemes within R&D projects under the European Framework Program. To summarise; as the dialogue trough CONFAP and the different Ministry at Federal level is still possible, but single states are active toward the Union as the EU member states has always been towards Brazil as a whole.

Thus, despite several economic and policy difficulties that may hamper future scientific collaborations, the availability of different modalities of collaboration available between the Union and the Federation provide to be resilient to the political and economical crises that occur periodically form both sides. Still the risk of having too heterogeneous initiatives is present, and to avoid that, data mining for scientific networks platforms and matchmaking of institutions should be achieved using the most common tools (institutional or independent searches) but also using dedicated tools such as the Brazilian *Lattes* Platform [52], or the EU CORDIS [53], and also regional sources, *e.g.* in Italy the CINECA database [54]. More informatics tools may also be welcome, given that they will be built to enable wide inclusion and broad access.

3.3. A Forward Look to EU-Brazil Cooperation

In the complex global system of environmental, economic, and social interdependencies, sustainable development can only be addressed when global and national efforts are coordinated on an equitable basis. Synergistic partnerships and shared policies for science and technology development should aim to share results and innovations and produce cooperation between markets and countries [55, 56, 57].

Thus, both the EU and Brazil may find in these years a common ground of both goals and policies for achievement, and Italy could play a pivoting role in this process as it represent for Brazil a hub for their relation with the EU, based also on the capacity of research and networking ability with the other members of the Union [58]. The same role could have the Brazilian research institutions have access to joint research at the federal or regional level. Surely, the great ongoing commitment goes beyond official diplomacy, and should come from the business world, the scientific community and civil society. This should take the form of investments, knowledge exchanges, and common projects which behooves Brazil and EU to consolidate their relationship.

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