The Argentine science and technology crisis

Chalela, M.[1], Charalambous, C.[1], Gonzalez, E. J.[1], Gurovich, S.[1], Luparello, H[1], Maldonado, V.[1], Mast, D.[2], Rodriguez, F.[1], Santucho, M. V.[1], Schneiter, M.[1], Sgró, M. A.[1], Sieyra, M.V.[1], Stasyszyn, F.[1], Vena Valdarenas, R.[1]

[1] Instituto de Astronomía Teórica y Experimental (IATE - CONICET), Córdoba, Argentina.

[2] Observatorio Astronómico de Córdoba (OAC – UNC), Córdoba, Argentina

Opening remarks

Argentinian history is characterized by a series of very complicated periods followed by rearrangements where the political and social actors have not enough time to reach a long-term balance. This unsteady scenario has reverberated onto the science and technology policy of the country. Persecution because of the ideas, periods of emigration because of economic crisis and discouragement of scarce investment in research have not prevented the science policy debate from reappearing as a recurrent theme. A negative feature of Argentine political culture is the lack of disposition for constructive dialogue, which is why the scene of public debate is frequently populated with interlocutors who are more interested in de-legitimizing each other than in achieving lasting basic agreements (1).

In the formulation of scientific policy four types of "typical cultures" (2) can be identified, which have also evolved over time:

- **bureaucratic culture**, represented by the state, which seeks to administer and organize science to make it available to the service of politics;
- **the academic culture**, generated in the scientific community, that seeks to preserve the traditional values and autonomy of science against other interests;
- **economic culture**, dominated by entrepreneurs and those responsible for economic policy, who are interested in the technological applications of science oriented towards profitable innovations;
- **civic culture**, embodied in social movements such as feminism, environmentalism, and human rights defenders, which pays attention to the social impact of science.

The first three are easily identifiable in Argentina and their confrontation has dominated the scene of scientific and technological politics. An idiosyncratic Argentinian trait, unlike the European one, has been the lack of knowledge demand from the entrepreneurs on any investment decisions with respect to research and development, leaving it up to the "bureaucratic culture" to decide. In recent years the "civic culture" has taken a certain lead with a more informed public opinion and with certain firm opinions. Some events, such as confrontations about the law of glaciers, forest law, soy bean mass-production, deforestation, open pit mining and shale-oil drilling (fracking) are examples in which public opinion takes a stand on issues where political conflict is mediated by scientific and technical discourses.

On the other hand, it is important to define the type of science in terms of social needs/demands and the model of the country with which it corresponds, in the development path of Latin American and particularly Argentinian scientific institutions. The lack of ideas of the local leadership on what to do with science and how to use it in terms of social benefits has been its natural counterpart.

Argentinian science in the last few years and the international context

The fraction of the National Budget (NB) assigned to MINCYT (Ministry of Science, Technology and Productive Innovation) is divided into the following entities: MINCYT, CONICET (National Scientific and Technical Research Council) and CONAE (National Commission for Space Activities). Stefani (3) analyzed the evolution of this NB in the period 2009-2016. **Figure 1A** shows the evolution of the total joint budget in USD. This budget gradually increased until 2014, from where it began to decrease, and in 2016 the reduction took this budget to the level of 2012. **Figure 1B** shows the budget of the three entities in terms of percentage of the NB. In the period 2009-2016, the fraction of the NB ranged from 0.7% to 0.8%, reaching a record low of 0.59% in 2017.

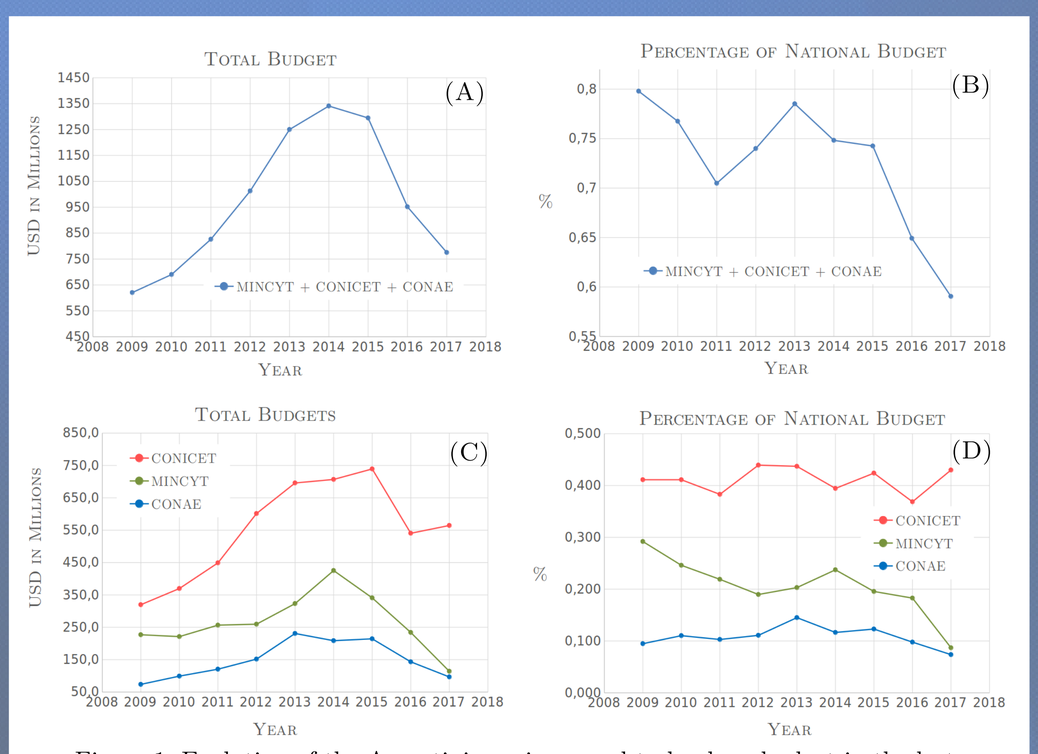

Figure 1. Evolution of the Argentinian science and technology budget in the last years (see description in text).
Source: http://users.df.uba.ar/bragas/Informe%20presupuesto%20MINCYT.pdf

Figure 1C and **1D** shows analogous graphs for the separate MINCYT, CONICET and CONAE budgets. In terms of percentage of the NB, both CONICET and CONAE have maintained their participation, while MINCYT has suffered a systematic decrease, except in 2013 and 2014. The budget of CONICET deserves a separate analysis since its personnel base increased considerably during this period, with a majority of its budget earmarked for salaries.

In the studied period, CONICET always had an operating budget (excluding salaries and stipends) of less than 12% of its total budget. In 2016 salaries and stipends represented over 92%, leaving less than 8% for operating costs. Although there has been a marked reduction in the budget for science and technology, which has jeopardized the continuity of many scientific and technological programs promoted by the MINCYT, CONICET kept its budget at the same level as in recent years with respect to the percentage of the NB. However, a considerable reduction was applied to the number of new junior-investigator positions (see next section), revealing a marked change in the scientific policy direction.

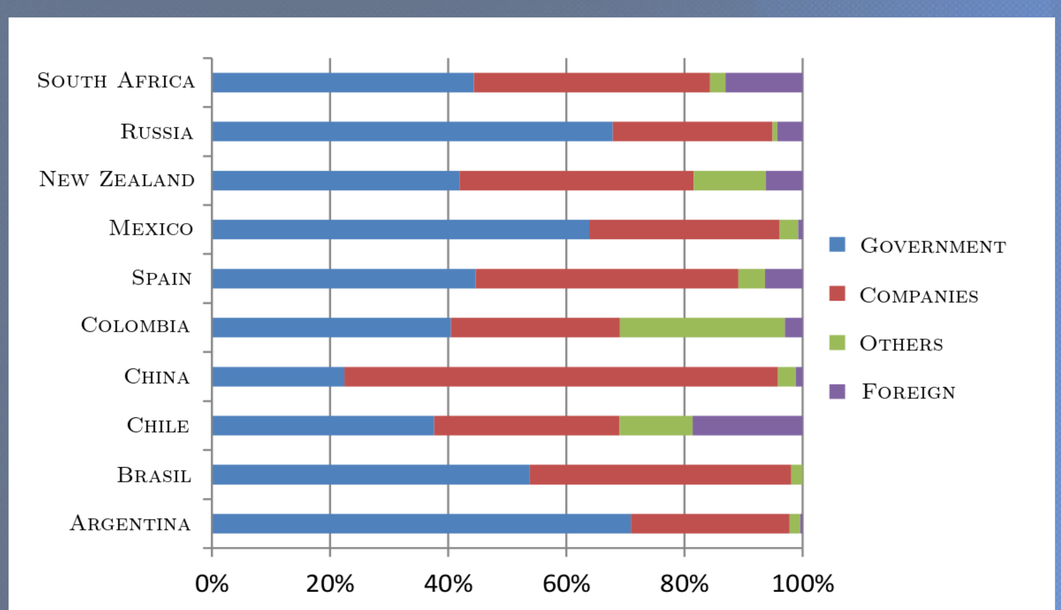

Figure 2. Estimated origin of the research and development funds of Argentina along with comparable countries (as defined in the Elsevier report).
Source: http://www.argentinainnovadora2020.mincyt.gob.ar/?p=1348

Regarding to the analysis of investment in science and technology, **Figure 2** shows the estimated origin of the research and development funds of Argentina along with comparable countries, as defined in the Elsevier report (4). As can be seen, the main funding source of science and technology in Argentina comes from the state, standing out with respect to the rest of the analyzed countries. In a wider international context, **Figure 3** shows the percentage of investment with respect to GDP and the number of researchers per 1000 inhabitants. In most countries, less than 15% of the total amount invested in science is funded by the government, ~ 70% is funded by the private sector, and the remaining percentage by universities. In Argentina, however, ~ 40% is financed by the government, ~ 25% by the private sector and the remaining amount by universities, in line with the presented in **Figure 2**.

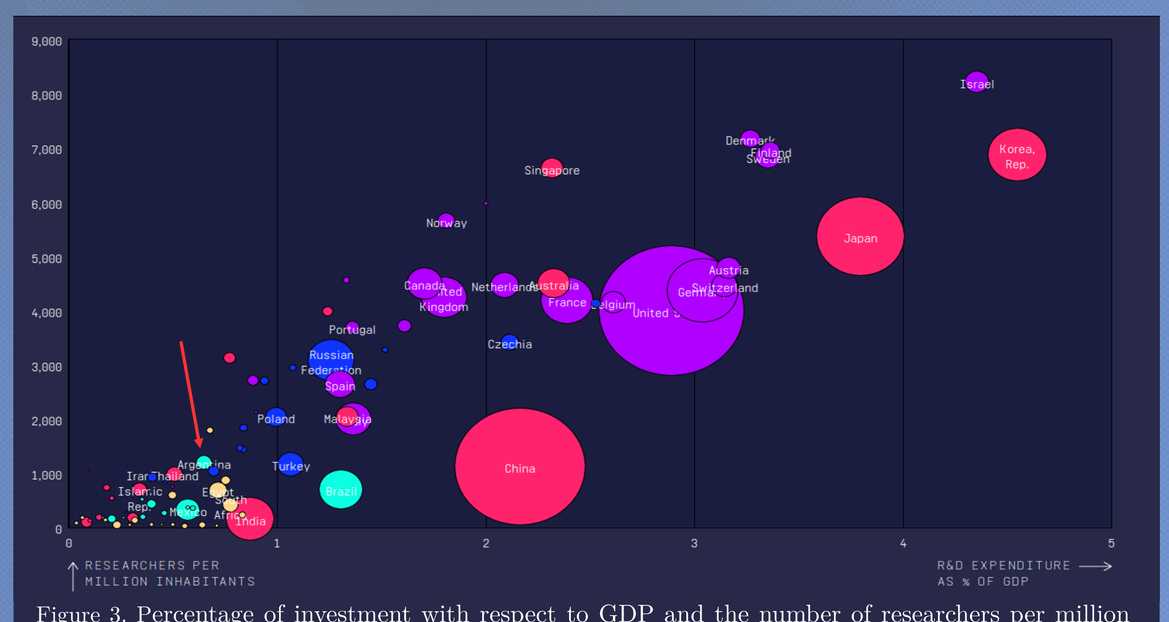

Figure 3. Percentage of investment with respect to GDP and the number of researchers per million inhabitants. The circles show the amounts countries are spending on research and development. Colors represent different world regions; Green: Latin America; Red: Asia; Purple: North America and Western Europe; Blue: Central and Eastern Europe. Red arrow shows Argentina's position.
Source: http://www.uis.unesco.org/_LAYOUTS/UNESCO/research-and-development-spending/index-en.html

Argentinian science in the present

CONICET, the country's main scientific production agency, is undergoing a profound restructuring, as discussed in the previous section. The first evidence of this restructuring was the reduction of new CONICET junior-investigator positions by ~60% with respect to the projection stipulated in the Innovative Argentina Plan 2020. It proposed an annual growth of 10% in new researchers vacancies, setting for 2017 more than 900 new positions. However, only 385 positions were approved, and the number of new vacancies is expected to remain constant at ~400/year in upcoming years reaching a workforce of 14 thousand researchers (currently there are ~9 thousand). One of the immediate consequences of this new policy is the snowball effect, in which every year the number of PhD that fail to enter the scientific system will rise (5).

Moreover, CONICET reformulated one of its basic policies to redistribute the number of vacancies to different areas. Starting in 2018, 50% of the vacancies will be allocated to “strategic areas” (agribusiness, energy and industry, health, environment, sustainable development, and technology and social development) and the remaining 50% to basic sciences. Previous years, only about 20% of vacancies were dedicated to strategic areas. This new distribution is the result of a reinterpretation of the government on the role of science in our society, increasing the influence of the bureaucratic role on science policy.

Other countries are experiencing similar dysfunctional crises, where science agencies are undergoing major restructuring and budget cuts. For example, in the USA there is a strong anti-science campaign, where the National Institutes of Health (18% budget cut) and the Environmental Protection Agency (30% budget cut) are one of the most affected (6). In Mexico, the National Council of Science and Technology (CONACyT) received a budget item decreased by 23% (7).

Too many PhD students?

In most countries a PhD is a basic requirement for a career in academia. Nevertheless, several recent articles (8, 9, 10, 11) have discussed a global tendency that the lack of academic jobs for PhD graduates may reveal that the system of PhD education is somewhat broken and unsustainable. It is sometimes even said that doing a PhD is a waste of time. This problem arose in the last decade given the growth of the number of doctorates. Between 1998 and 2006 the number of doctorates handed out in all OECD (Organisation for Economic Co-operation and Development) countries grew by 40%, compared with 22% for USA. PhD production sped up most dramatically in Mexico, Portugal, Italy and Slovakia. Even Japan, where the number of young people is shrinking, has about 46% more PhDs. This growth was encouraged by Universities and Institutes which have discovered that PhD students are cheap, highly motivated and disposable labour. With more PhD students they can do more research, and in some countries more teaching, with less money. Also, in some countries, such as Britain and USA, poor pay and job prospects are reflected in the number of foreign-born PhD students. Foreign students tend to tolerate poorer working conditions, and the supply of cheap, brilliant, foreign labour also keeps wages down. This could be understood as a corruption in the PhD meaning, instead of forming students for the pursuit of knowledge, they are used as disposable labor. There is also a growing disappointment in the PhD system itself, by the student as well as for the society. Poor supervision or bad job prospects tends to discourage students. Also, the high specialization that a PhD involves, makes them difficult to be hired out of the academia. This issue is not really been considered by universities and institutes, which do not acknowledge the role they must play in securing funding and opportunities for prospective PhD students. There is an astonishing culture of non-responsibility when it comes to ensuring that PhD graduates have academic roles to go into when they graduate.

The solutions that are proposed seems to be to restructure the PhD system or to close it down. The restructuration involves to open the research fields in order to solve more practical problems. One reason that many doctoral programmes do not adequately serve students is that they are overly specialized, with curricula fragmented and increasingly irrelevant to the world beyond academia. Expertise is essential to the advancement of knowledge and to society. But in far too many cases, specialization has led to areas of research so narrow that they are of interest only to other people working in the same fields, subfields or sub-subfields. Many researchers struggle to talk to colleagues in the same department, and communication across departments and disciplines can be impossible. This could be useful in order to prepare students for jobs outside the academic interests, nevertheless this is a tough task considering that assessors are not interested in forming students with other prospects outside the academia. There is no easy solution and is a sad reality that, as well as for many of the society interests, high level education inadvertently appears to be mass produced without considering its value and the consequences to society that this implies.

Final Comments

The presented framework leads us to discuss the continuity of the scientific technological programs. The 2017 budget represents a strong reduction, not only in value (USD) but also as percentage of the national budget. This seemingly contradicts any state science policy that purports the development of a knowledge-based economy. Specifically, this budget means discontinuing multiannual scientific and innovation programs, wasting investment already made that will cost significantly more to produce should new bureaucratic actors later decide it. The 2017 budget impacts on the quality and performance of staff and prompts a new “brain drain”. The current and expected conditions for 2017 promote a negative selection, where the younger researchers are driven to leave the country to develop their careers abroad, generating knowledge and benefits in other countries, having already being formed and hence financed by the Argentine state in the strong public university system. However, taking into account that the global academic market is also saturated, this causes a diminishing capacity, and puts in crisis the global development of science. Scientific activity requires continuity. This is essential, and even more so in tight economic situations, where knowledge generation must be deepened by fostering civic culture.

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