Doing science in dire straits: the role of internationalization to boost R&D

This paper gives a view on the future research plans and funding opportunities between Europe, Japan, and Italy, as a member State of the Union, but also as a country with a strong tradition of bilateral collaborations with Japan. The policies chosen to support research and technological innovation are discussed in the light of the global economical crisis and the natural events of the earthquake and tsunami that struck Japan in 2011. The policy decisions taken in Japan and Italy, as well as the future research program of the EU, show evidence that investing in research is broadly considered a priority. Yet, there are many uncertainties to the future implementation of research programs in a period of economic crisis and strategic uncertainties for dramatically important issues, such as, e.g., the energy sources, that may eventually result in a conservative approach, rather than in investing in long-term initiatives as research. The paper concludes with some considerations on the importance of the internationalization, to manage the way out of the crisis and achieve research and technological development

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Research and technological development (R&D) are essential factors to pursue in any country worldwide, either for a developing country that needs to improve the know-how of the population and create new tools for industry and market growth, or for the highly developed ones that need to maintain international competitiveness and are facing the challenge of sustainability. Even countries and areas traditionally benefiting from natural sources for their wealth are in the modern age recognizing the importance of having a strong scientific and technological background. Developing "giants" such as the so called BRICS countries (Brazil, Russia, India, China, South Africa) do not only have an important academic tradition, but are strongly boosting their research capabilities, leading in some cases to the so called "displacement effect", as produced by the exponential increase of China and other scientifically emerging countries such as India and Brazil on the main European producers[1], namely Germany, France and UK. The derived innovation resulting from the research effort is therefore broadly considered essential to guarantee, or improve the quality of life, increase security of sources (e.g., energy, food), achieve sustainability, and ensure education and employment of the populations.

There is no governance or policy program that would deny the importance of R&D, yet when it goes to (public) funding and (national) budget allocation, practice may prove to be different from theory.

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Usually R&D implies long-term planning of resources and harvesting of results, and the deriving innovation and technological transfer to industry may lag behind. Therefore, although the results generated are not only long-term but may produce spillovers with short- and medium-term effects on industrial innovation, when it comes to budget allocation, the potential risks of investing in research are often prevailing the potential benefits. This is especially happening in those years of economic crisis; high expectations for the creation of a green economy and the investment expected to be done worldwide – e.g., in the innovative creation of smart grids and the smooth conversion to the use of renewable energies – has been hampered not only by the lack of funding but also by the political uncertainties in oil-producing countries (the "Arab Spring"), and also in the strong emotional impact of the Fukushima Daiichi nuclear disaster following the Tōhoku earthquake and tsunami on 11th March 2011.

As a consequence, when it comes to a situation of emergency and uncertainties, like it happened especially in 2011, policy chooses to redirect sources to safe investments and solid technologies, putting aside long-term planning.

It is within this background scenario that we consulted in a trialogue Italian and Japanese scientific institutions together with the Italian Ministry of Foreign Affairs and the European Commission delegation in Japan, to discuss existing scientific collaborations between Italy/Europe and Japan, and compare ideas and sources for future challenges.

The trialogue enabled an analysis of different disciplines (energy, earthquake engineering, new materials, ICT, cultural heritage, life sciences) and of the approaches to science funding proper to Italy and Japan.

The bilateral Japan-Italy Science & Technology: state of the art

Italy and Japan established a strong and high level of collaboration over the years. As a matter of fact, Italy has a science and technology agreement with Japan dating back to 1988, and the 10th Executive Program was signed in Tokyo on March 29th 2010[2]. The Italian Ministry of Foreign Affairs (MAE) assigned 16 mobility grants and 27 relevant scientific projects in 2010-2011.

The Italian National Research Council (CNR), one of the major Italian stakeholder in R&D, has a collaboration with the Japan Society for the Promotion of Science (JSPS), established in 2007, and the scientific output from this collaboration can be "weighted" in 14.400 peer reviewed joint publications and 1780 joint patents.

ENEA is an important partner in science with Japan too, being recipient of grants, *e.g.*, in the area of biotechnologies[3], renewable[4] and nuclear energies; within the framework of the EURATOM fusion program agreement, the European Union and Japan launched an R&D program, called Broader Approach (BA)[5], to sustain and complement the international effort to build the International Thermonuclear Experimental Reactor (ITER). Italy contribution to the EU Fusion programs and to the BA is coordinated by ENEA, also committed to the design, manufacture and testing of components for the superconducting tokamak JT-60SA that will be built in Naka, Japan[6].

Taken together, these facts and figures indicate that on the Italian side research and the related grants with Japan are still supported despite the economic crisis and the political uncertainties mentioned above. This is resulting in knowledge and innovation on a short-, medium-term period (publications-patents) and long-term period (the broader approach). Notably, in a scenario of shrinking research financing, the commitment of MAE in the science and technology executive programs is forward-looking.

The Japanese Science & Technology Plan

In Japan, several funding agencies are under the ministries. The Japan Science and Technology agency (JST, www.jst.go.jp) and the Japan Society for the Promotion of Science (JSPS, http://www.jsps.go.jp) are under the same umbrella of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Both are sister funding agencies for basic research under the same ministry, but their objective and methodology of grant are totally different. In fact, while JSPS takes a "bottom-up approach" which promotes basic research depending on the freedom and originality of researchers, JST takes a "top-down approach", which pursues the goals and targets strategically set by the government. JSPS promotes various fields from humanities and social sciences to natural sciences and fellowship programs as well, while JST covers a more concentrated research area, basically natural sciences and engineering.

JST expenditures estimated for 2011 accounted for $ 1.383,7 million USD (roughly 1,1 billion euros), mainly devoted to the creation of advanced technology (51%) but also promotion of dissemination, communication and technological transfer, as well as international cooperation. This is a fair amount for a single country, if we consider that the EU is allocating for the seven-year-long framework program 7(FP7)[7], approximately € 50,5 billion, an average of € 7 billion per year to be competitively shared among the 27 States of the Union. It is interesting to note that the budget JST allocated to International cooperation increased almost 40 times in the last 8 years, *i.e*, from $ 3,36 million to approximately $ 38 million USD.

Besides the budget allocation, it is the policy of research that demonstrates an extraordinary dynamism in Japan's society. In 2011, the Japanese government approved a plan that shows its intention to focus on firstly reconstruction and revival from disaster, and promoting "green innovation" and "life innovation" (see table 1 for details). Moreover, the Japanese government did set a target to increase the R&D investment to over 4% of GDP. In 2009, the Japanese investment was already 3.62% of GDP, nearly 80% of it coming from the private sector[9]. In the EU27, in 2007 the same indicator resulted to be 1,85% and 40%, respectively[10].

This financial effort is implemented by providing appropriate tools to exploit the investments. JSPS outlook from 2011 is to reform grants in the aid system, by making them easier to use, increasing opportunities for young scientists, strengthening research, and pioneering new research domains[11]. Very innovative is the highly flexible grant usage that would enable a research group to shift funding to new unanticipated findings, accelerating

BASIC POLICY
Japan will strategically promote S&T innovation aiming at rebuilding after the earthquake, achieving renewal, and sustainable growth and societal development into the future
RECONSTRUCTION AND REVIVAL FROM THE DISASTER
i) Rebuilding and revival of industries in affected areas
ii) Restoration and renewal of social infrastructure
iii) Realization of safe living environments in affected areas
PROMOTING GREEN INNOVATION
i) Realization of a stable energy supply and low-carbon energy sources
ii) Realization of more efficient and smarter energy use
iii) Development of low-carbon social infrastructure
PROMOTING LIFE INNOVATION
i) Development of revolutionary methods of prevention
ii) Development of new early diagnostic methods
iii) Realization of safe and highly effective medical treatment
iv) Improvements of Quality of life (QOL) for the sick, elderly and disabled

TABLE 1 Key topics of reconstruction, Green Innovation and Life Innovation as defined by the Japanese Government. These topics will be promoted strategically and strongly in Japan in coming 5 years.

towards research lines of interest and leaving those that are likely to be closed-end. This is expectedly an approach that would vitalize research activity and, most important in this historical moment, would enable a more efficient and effective use of limited research budget. Research policy also considers the internationalization of Japanese research; starting in 2012, two new "core-to-core" programs will be implemented to create world-class research hubs and fostering new generations of new scientists. The programs, providing co-funding from the non-Japanese counterpart, are dedicated to internationally advanced research networks and the creation of an Asian and African science platform, respectively. JSPS also implements a "Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation". Such program seeks to advance science in Japan and vitalize international brain circulation by supporting overseas visits for young researchers to be engaged in international joint research initiatives. The scientist flow between Japan and Italy has been constant in the last five years, with an exchange of 490 Italians to Japan and 415 Japanese to Italy, that is 98 person/year to Japan and 83 in the opposite direction. This is a small number compared to the rest of Europe, as in the same time window 6,786 scientists from the EU27 moved to Japan and 8,197 in the opposite direction. That means that the average flow in other EU27 countries is much higher, presumably to the most technological and industrialized ones, but even when the person/year is averaged over all member States.

The bilateral Japan-EU S&T collaboration perspectives

Since the beginning of its research-dedicated "Framework Programme" (FP), the European Union has been fostering innovation, has created opportunities for young scientists and supported international collaboration. The FP budget has been increasing constantly up to € 7 billion per year of the ongoing one (FP7). Program activities have been extended in new scientific domains and different types of grants have been utilized, both for consortia and individual research proposals. The EU did achieve important collaborations with Japan; one example is the EU-Japan Broader Approach (BA) already mentioned. Moreover, *on March 2011, in the middle of the "Fukushima crisis", the EU-Japan science and technology (S&T) agreement*[12] *entered into force.* With that S&T agreement, EU and Japan express their wish to collaborate more effectively in the field of Science and Technology. The implementation of this agreement will result in new fields of collaboration, co-funded by EU and Japan; energy research (photovoltaic), aeronautics, materials (rare earths, superconductivity), ICT, healthy aging are in the pipeline.

Conclusions

From the initiatives and programs described, it appears that the potential and the political will for scientific collaboration between Japan and Italy is significant, even in a period of economic crisis and strategic uncertainties for the dramatically important issue of energy sources; *the crisis at Fukushima had effects not only on Japan's overall energy policy, but affected the governments energy choices globally*[13,14]. Moreover, the umbrella of the EU research framework program allows to go beyond bilateral collaborations and achieve significant R&D in harmony with all member States, enabling a better bridging with Japan. Achieving International cooperation in Science and Technologies is of the utmost importance, as not only does it save funds but, by merging sources, it accelerates the creation of foresight technologies, influences global standardisation and prepares for more robust and efficient industrial alliances to the benefit of the end users, the citizens. Yet, despite these encouraging perspectives, the difficult situation cannot be ignored or underestimated: budget cuts in most of the EU member States made the grant program of the second half of the FP7 the most attractive source of funding for many research groups, with the consequence that even the large budget dedicated by the EU now appears undersized for the needs of the scientific community. *Co-funding and sharing resources appear to be a good solution to continue research and guarantee human resources flow and creation of a future generation of scientists,* but the budget availability to these activities is dramatically decreasing worldwide in the last few years. In the forthcoming EU program HORIZON 2020[15] the budget still increases, reaching the outstanding figure of € 80 billion, but this program, dedicated to research and innovation, should not be considered the only source of financing for the EU member States, that should put their national programs side by side to harmonize and complement the EU policy.

Entire industrial sectors worldwide must often manage and survive economic crises maintaining international competitiveness and, at the same time, facing the challenge of sustainability. *Recent cases in Asia, Eastern Europe, and South America offer examples of best practices,* as economic weaknesses are afforded by means of organizational capabilities that may help firms to manage their way out of the incumbent crises. Research and innovation (both system and process innovation) should play an important, but not exclusive role. Some authors[16] affirm that market orientation has an adverse effect, in contrast, strategic flexibility has a positive influence on firm performance after a crisis, which is enhanced by competitive intensity. Market orientation, strategic flexibility and RTDI (Research, Technological Development and Innovation) complement each other in their efficacy to help firms manage varying environmental conditions, which is a common problem for Italy and Japan economies in this very difficult opening 2012. From bilateral and multilateral cooperation and common efforts, some possible solutions might arise.

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References

1. Daraio, C., Moed, H.F., (2011) *"Is Italian science declining?"*. Research Policy, 40 (10), 1380-1392
2. Japanese International Cooperation on Science and Technology http://www.mofa.go.jp/policy/other/bluebook/1988/1988-2-4.htm
3. Life sciences - progetto MAE di grande rilevanza per il triennio 2010-2013: *"Sfide globali per la salute. Biofarmaceutici da pianta"* Bilaterale Italia-Giappone
4. NGCPV: A new generation of concentrator photovoltaic cells, modules and systems. Joint Technology Development Project EU-Japan, (http://www.ngcpv.org)
5. Euratom Nuclear Research – Fusion. The Boroader Approach. http://ec.europa.eu/research/energy/euratom/fusion/coop/broader/index_en.htm
6. Coccoluto, G., Cucchiaro, A. *"A broader approach on the thermonuclear fusion development path".* http://www.enea.it/it/internazionali/enea-in-japan-2011/energy/coccoluto.pdf
7. 7th Framework Programme of the European Union. http://ec.europa.eu/research/fp7/understanding/fp7inbrief/structure_en.html
8. The 4th Japanese Science and Technology Basic Plan is available at: http://www8.cao.go.jp/cstp/english/index.html
9. The Survey of Research and Development by Statistics Bureau, MIC(Ministry of Internal Affairs and Communications). http://www.stat.go.jp/data/kagaku/2010/pdf/22ke_gai.pdf (Japanese only)
10. EUROSTAT newsrelease: "R&D expenditure in the EU27 stable at 1.85% of GDP in 2007". http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/9-08092009-AP/EN/9-08092009-AP-EN.PDF
11. The Japan Society for the Promotion of Science outline: http://www.jsps.go.jp/english/e-zunoujunkan2/outline.html
12. On the EU-Japan S&T agreement signed on November 2009: http://www.deljpn.ec.europa.eu/modules/media/news/2011/110427.html?ml_lang=en
13. The New York Times special on Nuclear Energy: http://topics.nytimes.com/top/news/business/energy-environment/atomic-energy/index.html?scp=1-spot&sq=nuclear&st=cse
14. BBC news Nuclear Power: a Country Guide: http://news.bbc.co.uk/2/hi/europe/4713398.stm
15. On the incoming research and technology programme of the European Union *"Horizon 2020":* http://ec.europa.eu/research/horizon2020/pdf/press/horizon_2020_budget_constant_2011.pdf
16. Rajdeep G., Patriya T., (2001). *"Building Organizational Capabilities for Managing Economic Crisis: The Role of Market Orientation and Strategic Flexibility"* The Journal of Marketing, Vol. 65, No. 2, pp. 67-80