Scientific cooperation between Italy and Israel: A perspective looking to the future

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Scientific cooperation between Italy and Israel: A perspective looking to the future

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Abstract

From renewable energy through neuroscience, from chemistry to nanotechnology, the scientific cooperation between Italy and Israel touches many fields and involves hundreds of scholars and students in both countries. We identify the main research policy factors that led to this successful outcome, and those that might drive forthcoming cooperation between these two Mediterranean countries whose science linkages have a long and significant history.

Keywords: collaboration; Israel; Italy; R&D; innovation

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Introduction

The story of scientific cooperation between Italy and Israel goes back to the early days of the Israeli State. The Casali Institute of the Hebrew University of Jerusalem, for example, is named after Alberto Casali, an Italian industrialist who, along with Zvi Enrico Jolles, formerly a chemistry professor at Florence University, conceived the idea of founding an institute for applied chemistry in Israel, eventually built on the Givat Ram campus of the Hebrew University of Jerusalem.[1] The example is far from being unique as several Italian scholars played an important role in shaping Israel's research and academic system. Physicist Giulio Racah in 1939 moved to Jerusalem from Italy, where he was extraordinary professor at the University of Pisa, and created the country's school in theoretical physics.[2] Eventually he will become rector and acting president of the Hebrew University (1961-1965). Today, hundreds of Israeli and Italian scholars benefit from the intergovernmental science and technology cooperation agreement signed in mid 2000, and enacted in 2002.[3] Since then, the agreement has resulted in the funding of 115 industrial and 58 fundamental research projects, 9 joint laboratories, and 145 bilateral initiatives attended by over 1000 Italian scholars.[4]

Cooperation is not limited to the natural sciences but extends to history, art, classics, Mediterranean studies, archaeology and numerous other scholarly domains. In this study we offer a perspective overview aimed to identify the main factors that in our view will drive forthcoming cooperation between these two Mediterranean countries whose science linkages have a long and significant history.

International collaboration as a basic need

Increasing share of internationally co-authored articles is one of the many outcomes of globalization with its ease of communication and travel and rapidly rising scientific production in China, India, Brazil, Iran, South Africa and other large and rapidly developing countries. Indeed, following a trend that mirrors both western Europe and USA, Israel percent of global scientific output relative to the world between 1996 and 2014 has declined,[5] though retaining its traditional excellence with 6 Nobel Prizes awarded to Israeli scientists between 2004 and 2013 (4 in chemistry and 2 in economics).

Asked to explain the reasons of such excellence in scientific research, Mandler, a chemistry professor at the Hebrew University of Jerusalem, held a seminar at Italy's Research Council in 2007.[6] Beyond significant funding (about 4% of the domestic gross product) and advanced scientific infrastructures, he suggested, the high quality of science in Israel would be due to three basic research policy options.

First, Israeli scholars are asked to compete internationally. Textbooks are written in English and Israeli universities do not support research, forcing scholars to look for funding in highly competitive calls in which research projects written in English are peer reviewed mainly by foreign scholars. Second, though being led by full professors, research in Israel is mostly conducted by students (Master of Science and PhD) and temporary post-doctoral graduates, who are highly motivated to do their best by the need to apply for tenure before or shortly after the end of their grant. Third, in Israel about 10% of the salary of every scholar feeds a special fund supporting travel

to meet scientists at international scientific meetings and establish scientific collaboration.

Another important factor, emphasized by the scientific *attaché* at Italy's Embassy (2007-current),[7] is that Israel has built a truly effective innovation system in which every university or public research center operates a technology park hosting the "start-up" companies and small laboratories in which young researchers develop for the market the solutions based on the basic findings conceived at that specific research center.

Getting back to international collaborations, their relevance was clearly identified by Arunachalam and co-workers studying the outcomes of Israeli research in biology in three years (1992, 1995 and 1998).[8] Israel, they found, was "using collaboration with overseas laboratories to great advantage", with over 42% of the papers published involving international collaboration (half with laboratories in the USA, followed by Germany, France, the UK and Canada). Since then, however, the traditional pattern of international scientific collaboration in Israel, showing a preference towards collaboration with American scholars, has changed.[9] In detail, in the period 1991-2005 the overall number of internationally co-authored papers of Israeli scholars has more than doubled, with the share going from 31.8% in 1991 to 41.9% in 2005, and the percent of articles published with European scholars increased by 80%.

In 1996, indeed, Israel was the first non-European country to be associated to the European Union Framework Programme for Research and Technological Development. In the subsequent 20 years of partnership, Israel

invested €1.375 billion and received €1.7 billion from the European Commission in the form of grants to over 3,000 projects (2,450 from academic, 1,270 from industrial, and 715 from other sector researchers).[10]

Israeli scholars, furthermore, won a significant percent of European Research Council (ERC) grants supporting ground-breaking research. Similarly, young Italian scientists have been widely successful in obtaining ERC grants awarded on selective criteria of scientific excellence and creativity. For example, Italy in 2016 was third (following Germany and France) with 22 "starting grants" for researchers in the early phase of their career (Figure 1). Unfortunately, most grants were awarded to Italians working abroad.[11]

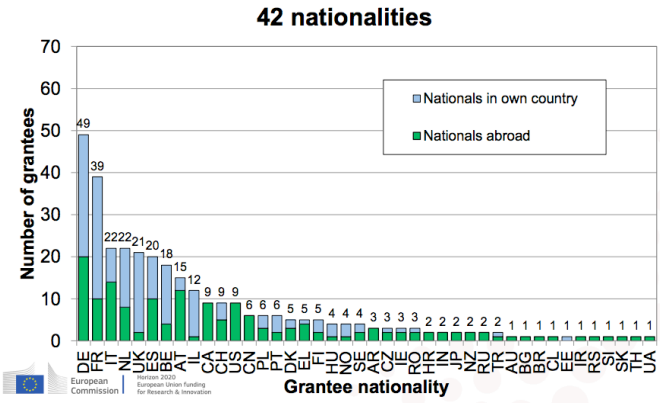

Figure 1. Outcomes of ERC Starting Grant 2016 Call. Nationals in own country and abroad. [Reproduced from Ref.11, with kind permission].

Italy indeed allocates the lowest share of gross domestic product to annual R&D spending among all countries part of the OECD, whose statistics show that Italy counts an average on just 4.83 research workers per 1000 employed, versus 9.87 in France and 17.38 in Israel.[12]

However, giving place to a debated paradox,[13] between 1996 and 2015 Italian scholars based in Italy published 1,318,466 research papers in indexed journals,[14] with the country retaining its eighth position worldwide and fourth in Europe (behind France, Germany and the UK) despite the dramatic growth in scientific production of the large emerging countries briefly mentioned above. In almost all fields, with the exception of computer science and economics, the citations per paper average produced by Italian researchers between 2008 and 2012 exceeded the world average for the field,[15] with main areas of strength being clinical medicine (44% above the world average), agricultural sciences (+37%), space science (+33%), physics (+30%), and chemistry (+16%).

From scattered to unified collaboration pattern

Prior to the signature of the intergovernmental agreement on industrial, science and technology collaboration signed on June 13, 2000, scientific collaboration between Italy and Israel relied on direct interaction between research centers and universities which exchanged PhD students or applied jointly to calls issued by public agencies and private foundations, and on bilateral agreement between Governments mostly enabling researcher exchange (in Italy the program was managed by the Research Council).

Figure 2. A commercial catalyst developed in Canada, originating in the context of Italy and Israel cooperation [Image courtesy of SiliCycle].

From archaeology through agricultural studies and chemistry, the outcomes of these collaborations, started decades ago, were generally satisfying and even led to commercialization of new technologies (Figure 2).[16]

The intergovernmental agreement brought unity to these scattered initiatives and gave a significant input to the overall collaboration in basic and applied research, promoting the exchange of hundreds of scholars from medicine to "any other area of mutual interest", as specified in Article 2 of the agreement defining the broad areas of cooperation. Until 2016, Italy alone invested over €15 million in the context of the bilateral agreement.[4] Every year, two calls are published aimed at supporting joint research projects in basic and applied (industrial) science.

For the scientific call two research topics are selected by the joint committee managing the agreement. For example, in 2016 the scientific call was aimed at supporting joint research in the field of motor-neurovegetative diseases and migration (new technologies applied to demographic and cultural changes). The project lasts 18 or 24 months, and the selected partners in Italy and in Israel are funded by the respective Ministries with €100,000. The industrial call, in its turn, is open in terms of topic and budget. In Israel the partner must be a company. In Italy, it can also be an academic institution providing that a company is included in the consortium submitting the proposal.

A joint committee with representatives of the two countries is responsible for the implementation of the agreement. For example, the committee held its 15th session in Israel on September 2016, when it was agreed to co-finance 16 new research and innovation projects proposed by companies, universities and research centers, and approve the creation of two new Joint Laboratories in Italy (in nanoelectronics and in optics) funded with

€175,000 per year. Indeed, among the most important achievements of the agreement there are nine Joint Laboratories, 6 based in Israel and 3 in Italy (Table 1).

Table 1. Italy-Israel Joint Laboratories financed in the context of the intergovernmental agreement [adapted from Ref.4, with kind permission].

Laboratory	**Partners**	**Headquarter**
Physics of cold atoms	European Laboratory for Non-linear Spectroscopy (LENS) and Weizmann Institute	Rehovot, Israel
Neuroscience	CNR (Institute on complex systems) and Tel Aviv University	Tel Aviv, Israel
Space research for peaceful purposes	Agenzia Spaziale Italiana and Israel Space Agency	Israel
Management of large scale threats to public health	Istituto Superiore Sanità and Ben Gurion University	Beer Sheva, Israel
Solar and alternative energies	ENEA and Ben Gurion University	Beer Sheva, Israel
Neurostimulation	Hospital San Raffaele Milan and Weizmann Institute	Rehovot, Israel
Cyber-security	Università degli Studi di Modena e Reggio Emilia and Tel Aviv University	Modena, Italy
Nanoelectronics	Scuola Normale Superiore di Pisa and Weizmann Institute	Pisa, Italy
Non linear optics	CNR (Institute of optics) and Tel Aviv University	Pozzuoli, Italy

Finally, between 2012 and 2016, mobility of young researchers was financed with grants to Italian post-doc and medical trainees (16 young researchers funded) to work in one of the 4 Centers of Research Excellence in Israel benefiting from advanced training, while contributing to research and innovation.[17]

Along with collaboration based on the bilateral agreement, scientists in the two countries co-operate also in EU-funded research projects. In the

context of the 7th EU Framework Programme only Tel Aviv University was involved in 12 research consortia including Italian partners.

"What most people might not know", was reporting a newspaper in 2008, "is the fact that Italy has probably become Israel's second most important scientific and technological partner in Europe".[18] Almost a decade later, hundreds of conferences may have dispelled this ignorance, at least in Israel where 145 bilateral conferences where held, attended by over 1000 Italian experts, using funding from the intergovernmental agreement (starting in 2017 bilateral meetings will be held also in Italy).

Forthcoming cooperation

Forthcoming scientific cooperation between Israel and Italy will be driven by scientific progress itself, and thus from unforeseeable creativity of scholars worldwide, as well as by economic and social factors, often going well beyond the borders of these two Mediterranean countries. A major driving force, we argue, will be sustainability and the associated global need to exit the fossil energy era to enter the solar economy.

In its early days Israel was a pioneer in solar energy utilization, and today most of the country's homes are equipped with solar water boilers (the *dude shemesh*) using solar collectors in which heat losses from the surface are minimized thanks to the selective surface invented by Tabor in Israel in 1955.[19] Fifty years later, however, the country was not amongst those taking part in the photovoltaic (PV) boom that is now changing the energy landscape across the world.[20] In late 2016, the share of renewable energy produced covered 2% of the Israeli electricity demand, when in Italy the same share exceeded 34%.

In brief, Israel could meet all its electricity needs through solar energy by installing utility scale PV plants in a tiny fraction of the Negev desert (where the average annual global horizontal radiation is above 2000 kWh m^{-2} $year^{-1}$),[21] and even less when all buildings will be retrofitted with solar PV modules connected to new generation batteries, a field of research that is ideally suited to be advanced along with Italy, the country with the world's highest stake of PV energy in the energy mix (7.3% of 310 TWh demand in 2016).

Cooperation in biotechnology between Italy and Israel has been particularly successful, especially amongst companies.[22] Another field that holds great promise for joint progress is the closely related bioeconomy in which agriculture by-products become the raw material for a variety of highly valued functional products ranging from pectin and fragrances from citrus,[23] lycopene from tomato,[24] omega-3 from blue fish leftovers,[25] polymers from bioglycerol,[26] and so on. New successful green technologies will create new opportunities for farmers and rural workers in both countries which host vibrant agricultural activities, and will likely be exported to large countries such as India, Brazil and South Africa with which both Italy and Israel enjoy prosperous commercial relations.

Finally, one eminent field in which Israel and Italy might actively cooperate in the future is advanced education based on achievements in the two countries. For example, Blonder at Weizmann Institute has significantly advanced the teaching of nanoscale science by developing a model providing chemistry educators with opportunities to enhance their knowledge of contemporary scientific areas and supports them in adapting it for use with their students.[27] Similar education building cross-disciplinary knowledge and competences in energy management[28] or solar energy[29] aimed at researchers, managers and professionals from countries across the world might become an important contribution of the two countries in the common progress of the world towards clean and renewable energy and wise energy utilization.

Outlook and Conclusions

The overview of scientific cooperation between Italy and Israel presented in this study shows how cooperation, historically going back to the early days of Israel, has evolved from a collection of scattered initiatives relying on direct interaction between research and academic centers, to the point that Italy became Israel's second main scientific partner in Europe. Sustainability, we have argued, will drive forthcoming collaboration efforts to encompass distributed generation of renewable energy from water, sun and wind to get rid of pollution and dependency on fossil fuels; and the use of agricultural and forestry by-products as raw material for the production of chemicals, polymers and functional materials. The very transformation of the energy system, which cuts across all sectors of society, inevitably leads to cross-disciplinary action as previously separate scientific and technology domains start to interact serving new societal sustainability needs.[30] At this crossroad, both Israel and Italy whose educational systems are known for their versatility and inclusiveness, might evolve to the point that the two countries might become able to jointly offer new educational services of direct interest to industrialized and emerging countries entering the bioeconomy and solar energy era.

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