Research Centers of Excellence in Chile

Research centers of excellence have been under development in Chile since the late 1990s, originally through the World Bank’s Millennium Science Initiative (MSI) and subsequently funded by the Chilean government. The centers are chosen through a competitive peer-reviewed process to support research and development projects, advanced training, collaborative work by selected scientific groups and outreach schemes.

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Introduction

Until the 1990s, the Chilean scientific and technological system was beset by a number of problems (World Bank 1999, pg. 5–6):

- A lack of a critical mass of research and development (R&D)
- Fragmentation of the existing R&D
- An insufficient supply of human resources for R&D
- Inefficient coordination between research and training
- Inadequate public funding and implementation procedures
- Inefficient collaboration among research groups and with the private sector
- Insufficient international linkages

As part of a broader innovation and competitiveness strategy, the Chilean government committed to building research centers of excellence to attract world-class scientists to perform cutting-edge research, train other scientists and engineers, and increase awareness of the country’s science and technology (S&T) enterprise.

The idea of establishing such a program dates back to the concluding recommendations of an international conference on science and technology hosted in Chile by former Chilean president Eduardo Frei in June 1998. Following this event, the government requested financial support from the World Bank for the startup phase of the Millennium Science Initiative (MSI), which was approved in April 1999. For this project, the World Bank partnered with the Institute of Advanced
Study (IAS), a private, independent, U.S.-based academic institution located in Princeton, New Jersey. IAS hosts the Science Initiative Group, an international team of scientific leaders and supporters dedicated to fostering science in developing countries and facilitating MSI.

**Program design**

The program design was based on the conference recommendations and extensive consultations with the main stakeholders in the S&T sector. Selected stakeholder groups interviewed by the official delegation of experts from the World Bank and the Chilean Presidential Commission on Scientific Matters included, among others, deans of Chile’s main universities; the president of the Association of Regional Universities; the president of the National Commission for Scientific and Technological Research (CONICYT); and the presidents of Fundación Andes and Fundación Chile.

CONICYT is a government agency established in 1967 to distribute funding to strengthen Chile’s scientific and technological base and promote the training of related human capital. Fundación Chile is a private, nonprofit organization founded in 1976 by the government of Chile and the mining company BHP Billiton, which is concerned with promoting business innovation and entrepreneurship. Fundación Andes, created in 1984 to provide competitive funding for research projects, is no longer active today.

Through these initial consultations, the project team identified the specific constraints facing Chilean scientists. The following were the major ones:

- Insufficient long-term planning for and commitment to high-quality scientific research
- Inadequate support for graduate students, leading to understaffed laboratories
- A lack of understanding of outreach practices by scientific research groups
- A lack of awareness of the context and relevance of scientific and technological R&D by society at large
- A scarcity of funds for equipment necessary to perform cutting-edge research
- Excessively slow and bureaucratic funding procedures
- Fragmentation of existing resources
- Unevenly applied funding criteria

The MSI program was seen as an efficient means to tackle these constraints. The Presidential Commission on Scientific Matters advised the Chilean president to create a new model for scientific centers of excellence. The program was designed within 12 months as a tripartite collaboration among the World Bank, Chilean research teams with a potential for international excellence, and a network of world-class international scientists (see Figure 1). It was formulated as a pilot to put into place the necessary conditions for larger future investments.
The aim was to provide the best groups of scientists with opportunities to reach their full potential within a flexible, independent, transparent, and efficient system.

The World Bank helped design selection and administration procedures, guided by examples from around the world. Its involvement and the involvement of other international experts ensured the consistency of the design with international best practices, which included the following:

- Transparent, fair, and merit-based competition for resources
- Resource allocation based on independent review of proposals by scientific peers of international standing
- Concentration of resources for the most qualified researchers
- Autonomy over the use of resources by principal investigators

The program focused on improving the nation’s science base in several areas:

- Amount and quality of scientific and technological research
- Quality of the research project selection and funding allocation processes
- Efficiency in the allocation of resources
- Training opportunities for scientists and engineers
- Quality of the monitoring and evaluation process
- International collaboration among researchers
- Promotion of the advances made in research

The program was to create training opportunities for young people, in particular, reduce “brain drain,” promote the return of Chilean scientists currently working in other countries, and attract international talent to Chile.

Program designers offered several rationales for the program they presented:

- Cutting-edge research is an essential part of an effective national innovation system.
- The availability of trained human capital is the most effective mechanism for transferring and adapting knowledge.
- Education, R&D, and technology diffusion are intertwined activities.
- A transparent, merit-based model to allocate research funds based on anonymous peer review and competitive funding increases quality and productivity in science and technology.
• Science is international, and, to avoid obsolescence and insularity, policy makers need to support regional and global connections to other researchers.

**Figure 1. MSI Program Structure**

**World Bank**
S&T for development
financing expertise

**Chilean**
research teams
with high potential for
international excellence

**International**
scientists
science initiative group
(SIG)

Courtesy of Phillip Griffiths,
SIG

**Implementation**

The first phase of the MSI program was executed from 1999 to 2002, funded by $5 million received from the World Bank through *Learning and Innovation Loan* (LIL) and $10 million from the Chilean national budget. This pilot program was relatively small (the funding was to be spread over two and a half years). Financing it through a LIL was an experimental approach by the World Bank which has since proved successful.
The early phase involved three project components: (1) establishing a management structure; (2) establishing a competitive fund for scientific excellence (the centers); and (3) establishing a network for promoting scientific excellence among the centers. The activities of each of these three components are presented in Table 1.

Table 1. Components of the First Phase of the MSI Program in Chile, $15 Million (1999–2001)

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<th>Project component</th>
<th>Activities</th>
<th>Percentage of total budget</th>
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| Management structure                        | ● Establishment and operation of a board of directors, program committee, and implementation unit  
● Technical assistance for selecting the centers of excellence  
● Proposal to scale up and institutionalize the project  
● Monitoring of the remuneration of the program's personnel and administrative costs | 7.3%                       |
| Competitive fund for scientific excellence  | ● Funding of research projects at approximately 10 centers of excellence  
● Expansion of doctoral and postdoctoral training programs  
● Networking, outreach, and special activities to promote scientific excellence | 84.0%                      |
| Network for the promotion of scientific excellence | ● Visits to top centers and institutions to establish formal and informal connections  
● Coordination of appropriate initiative-wide activities with directors of centers of excellence and principal investigators  
● Programs for exchange of researchers and postgraduate and graduate students  
● Design and delivery of international advanced courses  
● Dissemination of lessons learned | 8.7%                       |


The first step was to establish an adequate institutional framework for implementation by building a management and implementation team. Correctly estimating how long it would take to set up the program management structure necessary to put the research projects in place was challenging. The government was committed to implementing the MSI program and to forming an appropriate administrative structure, management system, and panel of international scientists to act as peer reviewers. The program was launched quickly and was broadly
perceived as fair, open, and transparent. To stimulate immediate and innovative changes and to encourage, where appropriate, a fresh set of institutional relationships, the project implementation and control function was located within the Ministry of Planning (MIDEPLAN) rather than CONICYT, the traditional government agency for science funding.

Once the program’s management structure was formed within MIDEPLAN, the first call for proposals was launched in July 1999 to provide competitive funding to Chilean centers of excellence (called science institutes and science nuclei). The centers would perform advanced scientific research and train young researchers in collaboration with other national and international institutions. Review of the preliminary proposals produced a short list of candidates who were invited to submit more detailed, full proposals before the final projects were selected and awarded.

Three science institutes (SIs) and five science nuclei (SNs) were ultimately selected in the initial competitive call for proposals. Each SI is composed of around 60 doctoral and postdoctoral researchers. They are funded for ten years and subject to evaluation during their fifth year. The SNs are smaller in scope, with around 15 researchers each, and are funded for three years. At the end of the third year, they can apply in an open competition for an additional three-year phase.

The initial call was followed by ten other bidding opportunities in the natural and exact sciences. Most Chilean research centers focus on areas like immunology, neuroscience, biotechnology, biodiversity, and electronics. In 2007, the program was extended to include two bidding opportunities in the social sciences. Nine SNs were selected in these fields, which included economics, education, sociology, psychology, and political sciences.

The awarded grants could be used to finance the following activities:

- Scientific and technological research
- Purchase of new, modern laboratory equipment
- Cooperative international scientific projects with research teams abroad
- Stipends for doctoral, postdoctoral, masters, and undergraduate scholars to conduct research at the centers
- Grants to attract visiting professors from leading international research organizations to teach and conduct research at the centers
- Organization of and participation in international conferences and workshops
- Design, organization, and implementation of outreach activities

The initial challenge for the program was determining how to have a real impact in a short time and with a relatively small budget. It introduced several new features into Chile’s S&T system:
A program committee comprising distinguished foreign experts in different specialties to evaluate and select proposals

Delivery of funds directly to researchers rather than to universities

A compulsory outreach component for the funded centers

A formal “collaboration network” component for the funded centers

The creation of independent centers not necessarily associated with universities

A new proposal bidding process in Chile, comprising preliminary proposals followed by full proposals and final interviews. The merit-based selection method for allocating research funding was based on international best practices and was well accepted by the national S&T community.

The full impact of this type of initiative does not accrue in the short term, so gaining government commitment to support the program in the longer term as part of its national science policy was important. That commitment was achieved, but the program is still relatively small, and more resources are needed to have a wider impact. In the last call, the program received eighty-some proposals and the evaluators selected about a dozen; funds were available to finance only five of them, however. Claudio Wernli, executive director of MSI Chile, stated in an interview that “the other seven proposals were excellent, and more funds should be available to fund them as well. In developed countries, proposals of similar quality would be receiving funding.”

Its design provided for frequent and rigorous monitoring and evaluation of the new program. Between 2000 and 2012, it was subjected to five international and two national evaluations by independent panels of experts, plus a number of regularly scheduled evaluations of the individual institutes and nuclei. All of this was useful for ongoing policy improvement and for maintaining the support of the higher levels of government.

According to one independent evaluation, an anticipated risk that the program’s focus on excellence would provoke resistance to change from the existing S&T community or result in an unfair distribution of funds toward the elite did not materialize. On the contrary, after some initial resistance, the reaction of both senior management at universities and the overall S&T community was positive as well as the reaction of younger researchers (World Bank 2002, sec. 5, 8–9).

Although only the early phase of the MSI program was initiated and supported by World Bank funds, the program evolved over time through continued support from the Chilean government and the synergy of closely related projects supported by the World Bank. Following its initial success, the centers of excellence program was scaled up and it remains active in Chile today (see http://www.iniciativamilenio.cl/). As of September 2012, 6 institutes and 25 nuclei had been established, and the program’s budget had expanded accordingly (see Figure 2).
Results

The most recent evaluation of the results of Chile’s research centers of excellence program was published in 2010, covering the period 2000–08. The plan was to conduct a general program evaluation every five years, with the next one scheduled for 2014.

Although the program designers recognized early on that the impact of this type of program would only become fully visible in the long term, the 2010 evaluation indicated a substantial increase in scientific productivity and quality from 2000 to 2008, due in part to the improved working conditions and synergies afforded to top researchers by the program’s grants (MIDEPLAN 2010).

Outputs

The following data from the latest evaluation compare the program’s outputs to research outputs in Chile during a baseline period of five years before the centers were established.

- **Increased scientific output:** Between 2003 and 2008, investigation was started in 220 new research areas in Chile. Around 90 scientific advances were reported, with several considered world class. By 2008, the number of articles and book chapters per researcher...
increased by 19 percent and 78 percent, respectively, compared to the baseline period. The quality as well as the volume of the publications improved. Publications within the top 10 percent and 50 percent of the ISI (Institute for Scientific Information) impact factors increased by an average of 15 percent and 34 percent, respectively. Presentations at scientific events increased by 20 percent. Patents and technological innovations also increased significantly, although the absolute values remained at low levels.

- **Increased training:** In 2008, a total of 290 researchers (excluding PhD students and postdocs) were hosted by centers of excellence; 25 percent were less than 35 years of age. Their numbers increased substantially compared to the baseline period, totaling 714 students and 96 postdocs in 2008. The number of students per associate researcher increased by 66 percent, reaching 4.7 students per researcher, and half of these were doctoral students. The centers had more PhD students on average per associate researcher than the comparable foreign centers considered in a benchmarking exercise, in countries like Australia, Brazil, Finland, and New Zealand. With 2 percent of the national budget allocated for S&T, the program contributed approximately 12 percent of the masters and 29 percent of the PhD recipients in the country from 2000 to 2008.

- **Increased participation in networks:** From 2005 to 2008, the program directly supported 28 international collaboration networks, and the research centers played a role of organizational and/or scientific leadership in many of them. Participation in these networks increased by 245 percent by the end of 2008, compared to the baseline period. Also notable is that the program managed to set up—in a very short time—a network of international scientists to act as peer reviewers for the selection process.

- **Increased links (projects) between the research centers and industry:** While early evaluations suggested insufficient linkages between the research centers and the private sector, this was addressed in subsequent phases by programs such as the Science for the Knowledge Economy (SKE) project supported by the World Bank. From 2002 to 2008 the number of research projects involving partnerships with industry, academia, and the public sector reached more than 90, 85 and 40, respectively. Future evaluations should include new measures of the nature of center collaborations and the benefits derived from them beyond simply the number of joint research projects undertaken.

- **Increased outreach:** Outreach products and activities increased by 136 percent, compared to the baseline period.

**Outcomes**

So far, the evaluation reports have focused on output results, such as numbers of articles and patents and the indicators of human resources and training described above, which are relatively easy to measure. Although the project’s broader outcomes in terms of social returns are less tangible and thus harder to measure, program evaluations also included a couple of impact indicators that must rely on qualitative assessments:
• **Global competitiveness and economic diversification:** The ultimate objective of the program is to stimulate economic growth by improving the country’s global competitiveness and economic diversification. These effects are hard to measure, partly because isolating the program’s impact from other socioeconomic factors is difficult. According to a World Bank press release (2003), however, the effort has been successful: "By fostering Chile’s development of a National Innovation System, the MSI has helped Chile diversify its economic base and provide a new foundation for sustainable, long-term growth."

• **Decreased “brain drain”**: By creating opportunities for world-class researchers, and specifically for young researchers, the research centers program has reduced the risk of brain drain from Chile. A considerable number of foreign researchers—mainly from Europe, Asia, and Latin America—have been hired by the centers.

In sum, Chile’s program to develop centers of excellence has been successful for a number of reasons. First, Chile is one of the most developed countries in Latin America, and its science and technology system is also one of the most developed. Before the start of the program the country already had a critical mass of world-class researchers with the potential to contribute high-quality proposals. Many did, indeed, come from Chile’s S&T community, demonstrating that—although Chile’s national innovation system still lags behind those of the most advanced countries—it had pockets of excellence upon which the program could build.

In addition, the program was strongly supported by the higher spheres of government. The government put into place a highly competent team to manage it and engage international scientists of the highest caliber in the peer review process. To allocate research grants to the most qualified researchers, the program established a fair, open, and merit-based selection process that was well-organized, flexible, and praised by the national S&T community.

The program also provided a useful demonstration that excellence is possible with the right policies, and a successful demonstration of good practice in science funding. This was later imitated by other R&D funding agencies in the country, effectively catalyzing institutional change in other spheres of the national innovation system. The program was internationally recognized and its managers invited to make presentations overseas on 11 occasions between 2006 and 2012, and they helped implement it in other countries.

Finally, the World Bank contributed approximately one-third of the budget to the MSI program for its first stage and helped the Chilean government design, implement, and monitor and evaluate it. Since the initial funding, the Bank’s support for improving the national innovation system in Chile has evolved. Once the Chilean government took full ownership of the centers program following the first phase, the Bank’s support broadened in scope through a new loan approved in 2003 to finance a “Science for the Knowledge Economy” (SKE) project. The first phase of SKE program from 2003 to 2007 supported the establishment of a coherent policy strategy and strong policy framework. It provided funding for centers of excellence but was more focused on developing public–private linkages and enhancing the R&D capacity of private firms, including small and medium-sized enterprises (SMEs). The second phase of the SKE project,
from 2007 to 2010, continued the activities to strengthen Chile’s science base and scaled up funding for initiatives launched during the first phase, especially with a view toward enhancing private sector R&D activities (World Bank 2007).

Since the early pilot in Chile, the World Bank extended the MSI program to other countries in more recent years. Countries that have obtained Bank loans to improve their scientific and technological capacity include Mexico, Uganda, Venezuela, and Kazakhstan.

**Lessons learned**

The lessons learned from the implementation of Chile’s centers of excellence program can be summarized as follows:

- Autonomy in use of funds and reduced bureaucracy are key factors for developing science effectively.
- A well-managed investment, even if small, can lift a national system of science and technology. Coherence in overall government innovation policies and actions are crucial, however. The program needs to be well anchored within a broader innovation policy and should seek to promote linkages with the private sector.
- Centers of excellence can be virtual institutions, encompassing networks of scientists from different institutions in the same country or even from different countries. The important point is that scientists can join forces to work on a common set of problems.
- Programs to build centers of excellence should focus on the interconnection between scientific research and advanced training, recognizing that advanced training needs to be grounded in an active research environment at an international standard.
- Strong support from the higher levels of government and the quality of the program’s management team are important drivers of success. Since the returns of this type of program depend on sustained efforts and will only accrue in the medium to long term, a strong commitment by the government to maintain it for at least 10 years is important.
- Appropriate monitoring and evaluation mechanisms must be set in place to achieve the right balance between flexibility and autonomy on the one hand and transparency and control on the other.
- Coordination of such a program with other existing instruments so the programs complement each other rather than overlap is important. Initially, concern arose in the MSI program because researchers selected for the centers were also receiving grants from other agencies like CONICYT, possibly leading to a duplication of financing.
- Building research centers of excellence will be more challenging in lower-income countries because they lack a critical mass of S&T efforts. The program components will need to be adapted to the local context—perhaps with a higher focus on training rather than on basic research, for instance. Visible results in terms of scientific productivity will
take longer to emerge. The intermediate results, in terms of training and knowledge diffusion, are difficult to measure in a reliable manner.

Currently, the World Bank’s MSI Centers of Excellence Program is open to any client country and is adaptable to specific contexts, organized around these common features:

- Scientific excellence, international peer review, and quality control
- A transparent, merit-based selection and evaluation process
- Linkages to other institutions, the private sector, government, and one another
- Opportunities for scientists to collaborate with colleagues around the world
- Adequate research budgets
- Ownership of the program by stakeholders who have a role in program design and implementation
- Integration with the country’s education system and development priorities

**Acknowledgement**

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**References**


Suggested Links about the Program

Program website: [http://www.iniciativamilenio.cl/](http://www.iniciativamilenio.cl/)


Institute for Advanced Study ([http://www.ias.edu](http://www.ias.edu)); Institute for Advanced Study MSI ([http://sig.ias.edu/msi](http://sig.ias.edu/msi))

Republic of Chile, Ministry of Economy ([http://www.gobiernodechile.cl](http://www.gobiernodechile.cl))