How to Set Up a Technology Transfer System in a Developing Country

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ABSTRACT

This chapter reports the results of a recent study of the current state of technology transfer in Chile, including recommendations for the development of a new technology transfer system. Currently in Chile, few commercially viable technologies are transferred from research institutions to the private sector. This means that many universities should review their role and implement innovative ways of contributing to society.

1. INTRODUCTION

In emerging economies, existing R&D capabilities tend to be highly concentrated within universities and public research institutes. In Chile, about 85% of scientists are formally linked to universities, and the Chilean government contributes an estimated 80% of funds spent on R&D.

In early 2004, the Ministry of the Economy entrusted Fundación Chile, a private, independent, nonprofit research organization located in Santiago, with studying the technology transfer units at Chile's universities.[1] The ministry's aim was to find ways to improve the mechanisms for transferring the results of R&D performed at Chile's universities and research institutes to the private sector. In order to carry out this study, Fundación Chile assembled a team of six local specialists and three foreign experts.[2]

First, Fundación Chile set out to assess the current state of university technology transfer in Chile. Interviews and surveys were conducted at seven universities that together currently conduct 51% of all university research projects in Chile. Surveys were also conducted at four technology transfer offices (TTOs) located within business incubators associated with these universities.

Second, a workshop was held involving specialists from the Ministry of the Economy, CORFO (Corporación de Fomento de la Producción),[3] CONICYT (Comisión Nacional de Investigación Científica y Tecnológica),[4] and the team of experts assembled by Fundación Chile. The first day, the workshop focused on the current condition of technology transfer at universities and research institutes in Chile (see Section 2 in this chapter). The second day, the participants discussed their experiences of technology transfer in other countries. The participants then created guidelines for technology transfer from Chile's universities and research institutes to its commercial sector.

The assessment of Chile's current conditions and the guidelines created by the workshop participants were used to develop a proposal for the creation of a new national technology transfer system (described in Section 3).

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2. THE CURRENT STATUS OF TECHNOLOGY TRANSFER IN CHILE

2.1 *The role of universities within the national R&D context*

Traditionally, universities have fulfilled two primary societal functions: educating students and conducting research. In recent years, however, universities have had to fulfill an additional function: promoting the commercialization of the results of their research. This expansion has required changes, not only in policy and allocation of resources, but also in academic culture itself.

In an ideal environment, many mechanisms link the academic and business worlds. Researchers exchange information through seminars and publications, and there are informal and formal ties between researchers in various types of institutions. Additionally, academics work as consultants and as company board members and are involved in professional training, contract research, and the spinout and incubation of new businesses. And, of course, universities educate the researchers of the future.

In Chile, however, the lack of systematic policies for technology transfer has hindered productive interaction between the academic and business worlds. This, in turn, has led to other challenges:

- There are few incentives for academic researchers to participate in technology transfer and commercialization.
- Academic culture does not see technology transfer and commercialization as "legitimate" activities.
- The academic and business worlds have different ideas about technology transfer: different short- and long-term visions, different expectations about how resources should be used, and different priorities when it comes to meeting shared targets.

For the past 20 years, Chile's growth has been sustained by industries exploiting the country's rich natural resources. Technology transfer during this period mostly occurred by importing capital and by receiving foreign investment, virtually excluding the local innovation system of Chile. As a result, both the formation of innovative companies and the development of an entrepreneurial culture in Chile were inhibited.

In Chile, around US$480 million is spent annually in R&D; only about one-fifth of this money comes from private sources. Universities carry out some 58% of ongoing R&D projects in Chile; 4,800 specialists—or three out of every five scientists and engineers in Chile—work on such projects. Only 6% of those working in R&D do so in a private company.

Furthermore, no more than 13% of the national budget for R&D goes toward commercial development activities. The rest goes to basic and applied research projects. In contrast, about 60% of the R&D expenditure in developed countries supports development activities, and only 40% goes to basic and applied research.

In a recent study, Benavente[5] suggests that joint activities between universities and the private sector should receive more financing from government and that TTOs should to be established in order to promote the commercial application of university research results.

2.2 *A survey of technology transfer units at universities in Chile*

The results of the surveys conducted by Fundación Chile of seven universities and four technology transfer offices are summarized in the following nine items:

1. **IP-protection activities in universities.** The concept of intellectual property embodies the right of ownership protected by law to intangible (that is, intellectual) works or information, or representations of information such as literary works, trademarks, logos, data, and know-how. In Chile, intellectual property can be protected by patents, copyrights, trademarks, industrial designs, or rights for plant varieties. Like any other goods or assets, intellectual property can be bought, sold, or licensed.

   The surveyed universities were asked what specific IP protection activities (such as signing confidentiality agreements or applying for IP protections) they engaged in each year. Most of these activities involved

agricultural, health, and energy technologies. The total number of such activities for all eleven institutions was fewer than 100. Signing confidentiality agreements accounted for almost half of the activities; filing applications for patents accounted for another quarter. The remaining quarter primarily involved copyright and plant-variety registrations. Only about four confidentiality agreements were signed per institution per year.

2. **Communications between universities and the private sector.** At 73% of the institutions surveyed reported that their technology transfer offices (TTOs) and/or investigators contacted private companies. Other methods of contacting companies included publications and the Internet (55%), fairs and exhibitions (36%), and technology brokers (27%).
3. **Procedures for evaluating potential technologies.** Formal evaluations (those that do not rely solely on the opinions of the research team) are the best way for universities to determine which technologies should be transferred to private companies. However, only one of the seven universities surveyed claimed to have a formal procedure for evaluating technologies. Three of the four TTOs associated with the incubators did have such a procedure.
4. **Policies regarding ownership of research results.** It is important to clearly define who owns the rights to research results. Only three of the seven universities surveyed had a formal institutional policy regarding the ownership of research results. None of the TTOs associated with the incubators had such a policy.
5. **Policies regarding conflicts of interest.** TTOs need to have the resources to manage potential conflicts of interest. Only two of the eleven offices surveyed had a specific policy regarding conflicts of interest.
6. **Distribution of income generated by technology transfers.** On average, the universities distributed revenues from technology transfers as follows:
   - 38% to the researchers
   - 15% to the research units (departments)
   - 18% to the central administration
   - 8% to the technology transfer office
   - 21% to other actors

   The offices associated with incubators distributed revenues as follows:
   - 37% to the research units and to the researchers
   - 12% to the central administration
   - 10% to its own transfer office
   - 41% to other actors
7. **Networks for collaboration.** The surveys reveal that institutions do not collaborate with each other to any appreciable extent. For example, of the universities surveyed only half of them belong to networks with other universities, and only two of them are part of networks with business organizations. Of the offices associated with incubators, only one participates in a network of research centers.
8. **The influence of technology transfer on university researchers' careers.** Four of the seven universities stated that technology transfer has no influence on their researchers' academic careers. Two of the seven noted that successful technology transfer may raise researchers' salaries, and one of the seven reported that it influences promotion decisions. The technology transfer experience of potential candidates for academic jobs has no influence on hiring at any of the seven universities surveyed. Therefore, it is not surprising that 78% of the university investigators participating in Fondef projects consider this fund only as a source of financing for their own projects and Institutions.[6]
9. **Spinouts and startups.** Over the last 19 years, the 11 surveyed technology transfer units have created a total of 28 companies using the results of their institutions' R&D. Of these new companies, two-thirds are spinouts and the rest are start-ups.

   Over 13 years, from 1991 to 2003, Fondef. has financed a total of 159 R&D projects:

- Agriculture 37 projects
- Fisheries and Aquaculture 35 projects
- Forestry 34 projects
- Mining 17 projects
- Education 13 projects
- Other 23 projects

A total of US$126 million was invested in these projects, of which only 28% was contributed, in money or in kind, by companies or other institutions interested in using the technologies produced by these projects.

These 159 projects led to the creation of 33 companies, 13 business units, and 12 new lines of business in existing companies. Two-thirds of these institutions are still operating today. By the end of 2002, these projects had generated an accumulated sales total of US$8.9 million.

These results show that technologies developed by Chilean universities lead to very few start-ups or spinouts.

2.3 *The current state of university technology transfer in Chile*

The existence of TTOs in Chilean universities is a recent phenomenon. The capabilities of these offices are still limited. Generally, they have small staffs. Many have yet to establish essential policies regarding the formal disclosure and evaluation of technologies, the ownership of intellectual property, and conflicts of interest. Most have little experience in such areas as technology management, IP protection, and commercial agreement negotiation.

Academics are not encouraged to engage in or initiate technology transfer to the productive sector. Moreover, very few university projects result in commercially viable innovations, so few technologies leave the universities, and few spinouts or start-ups are created. Therefore, many universities see little reason to set up technology transfer offices.

3. A PROPOSAL FOR A NATIONAL SYSTEM OF TTOS

The participants in the cross-disciplinary workshop proposed the creation of an institutional consortium, the members of which would share a central TTO. Each institution in the consortium would also have a local TTO to assist in relationships between researchers and private companies, as well as with technology marketing. The consortium would represent the interests of the member institutions and operate with the double aim of improving Chile's technological capabilities and developing a national entrepreneurial culture.

The consortium would be a private, nonprofit organization, governed by a board of directors made up of representatives from the member institutions. These offices would be established using public funds; once they are operational, they would support themselves with fees they earn for the services they provide.

3.1 *A business model for the TTO system*

The central TTO would need to have the capacity to manage 20 to 30 technology transfer projects annually. The TTO system would be involved in these projects from gestation to final commercialization. The system would also be required to participate in the analysis of about a dozen completed Fondef and FDI projects, in order to identify opportunities for the commercialization of the technologies they have developed.

The central TTO system would require an annual budget of approximately US$650,000. The member institutions would make annual contributions based on the volume of research that each has conducted. The TTO would also charge member institutions an *ex ante* fee for each project based on its size and complexity. Furthermore, the TTO system would receive fees from companies that it assists, as well as from other users of its professional services. The institutions belonging to the consortium also would be expected to pay annual dues for the right to participate in the consortium. During the system's first three to five years of operation, any additional financing needed would come from public sources; however, this public subsidy would be granted only if the TTO system continued to receive positive annual performance evaluations. The consortium's board of directors would be responsible for securing outside financing for the TTO system.

The TTO system's financial management would be based on annual accounting (an

examination of the system's total income and expenses) and separate accounting (an examination of the income and expenses relating to each individual project). The following formula for the distribution of royalties is recommended: the university distributes one third of net income to the inventor and another third to the inventor's department or research unit; this formula is aligned with international practices. The remaining third typically goes to the university's general fund, but may go to other specified funds, including the TTO system's own fund. Royalties would be distributed after the end of each fiscal year. General expenses such as salaries, rent, office equipment, and general travel would be paid for by the TTO system's fund. Any project-specific expenses (such as the legal fees involved in a patent prosecution) would be paid for by royalties that accrue from the licensing of the corresponding technology. The board of directors would review this distribution of funds annually and modify it as necessary.

3.2 *Central and Local TTOs*

3.2.1 *Contracts between central and local TTOs*

The central TTO would supervise and work together with each of the local TTOs to protect and market the technologies resulting from R&D conducted at member universities and institutes. The contracts between the central and local TTOs would need to include the following information:

- Policies outlining:
  - the legal supervision of the consortium by consortium members
  - the ownership of intellectual property
  - the distribution of income from the development of intellectual property
  - conflict of interest resolution and what obligations each party has to the others
- terms and conditions for the formal evaluation of inventions with commercial potential
- plans for marketing and licensing the inventions, both domestically and internationally
- plans for a follow-up system to track the success of inventions
- plans to disseminate and communicate the results of the TTO system
- plans to establish national and international strategic alliances in technology development and commercialization

3.2.2 *Function of the central and local TTOs*

The main functions of the *central TTO* would be to:

- evaluate the results of R&D projects expected to have commercial potential
- apply for patents and other forms of IP protection
- market technologies
- provide expertise and technical assistance to the local TTOs
- establish national and international strategic alliances in areas important for successful technology transfer

The main functions of the *local TTOs* would be to:

- facilitate interactions between their institutions and industry (duties would include developing research contracts, identifying collaborative research projects, and consulting)
- educate academic investigators about opportunities and techniques for marketing research results
- stay abreast of new technologies developed at their institutions and identify marketing opportunities for these technologies
- serve as a contact point between the central TTO and the institution
- help researchers gain funding for R&D projects

As the local TTO gains experience and becomes more effective, it may take on other functions, such as offering its services to other institutions (for example, local business incubators) that are not part of the national consortium.

3.3 *Human resources and infrastructure*

A fully functioning TTO system would have the following personnel needs, some of which could be fulfilled by outsourcing, either for the long

term (as would be appropriate for the office's legal experts) or on a short-term basis (as would be appropriate for consultants hired to conduct market studies, for example).

3.3.1 *Central TTO personnel*

The central TTO would need to employ skilled individuals to fill key roles:

Director. The director would need proven leadership skills; excellent ability to create networks and establish alliances; business vision; experience in technology management; knowledge about national and local laws and regulations; and an understanding of the national university system, the national innovation system, and the status of local industry. In addition, the director would need a minimum of ten years' experience in a relevant field, and good written and spoken English.

Program managers. International experts recommend that the central TTO initially be staffed by program managers. This encourages specialization and focused searching. It also takes advantage of the synergies that can be generated via networks. Program managers would need to have within their ranks:

- a Ph.D. in biological sciences and/or biotechnology with both laboratory experience and experience in product development, a minimum of ten years of professional experience, and good written and spoken English
- a Ph.D. in the engineering sciences with broad knowledge of the product development process, at least ten years of professional experience, and good written and spoken English

Project analysts. The central TTO would need at least two economists and/or engineers. They would need to have completed at least some graduate studies, with a minimum of five years of experience in the profession, and good written and spoken English.

3.3.2 *Local TTO personnel*

The local TTOs would need a staff composed of:

- a director or manager
- two or three professionals with graduate degrees, preferably Ph.D.s, with at least five years of professional experience in either biological sciences/biotechnology or engineering
- project analysts

The volume and type of R&D being carried out at each university or institute would determine the size of the office and the discipline(s) in which its staff members would need to specialize.

3.3.3 *Office support staff and infrastructure*

The central and local TTOs would need an administrative and support staff. At minimum, each office would need a computer for each professional, a printer, local and international communications networks, filing space for documents, and the space and equipment to make formal presentations.

3.4 *Policies*

The TTO consortium would design collectively the key policies regarding the technology transfer process, and these policies would form an integral part of the consortium's charter or proposal. They should clearly establish the terms of IP ownership, the distribution of income, and the resolving of conflicts of interest:

Ownership of IP rights. The universities or institutes participating in the technology transfer consortium would need to have uniform guidelines for assigning IP ownership. Uniform practices help to reduce transaction costs, increase transparency, and facilitate utilization of intellectual property protected by third parties. Government agencies could encourage members to agree on common guidelines through "codes of practice" or by making adherence to certain guidelines a requirement for receiving funds from the state.

Distribution of income. Fair distribution of income generated from technology commercialization is common practice around the world, and it is a powerful incentive for the various players in the technology transfer process. There are many options for how to distribute such income, and the options taken would have to depend on institutional and national context.

Resolving conflicts of interest. The consortium members would need to include clear policies and procedures for resolving potential conflicts of interest in the initial proposal for the creation of the technology transfer system.

3.5 *Early phase*

Planners/developers of the TTO consortium would need to consider a few issues early on in the creation of the national system:

- Skills at different levels would need to be developed.
- The concept of the national TTO system would need public support so that the central TTO could assume a leading role by establishing its own trademark.
- Initially, the TTOs could help address their institutions' weakness through training and educational efforts that would provide them with the necessary skills.

4. CONCLUSION

A foundation of innovative technology companies and the development of an entrepreneurial culture will drive the development of new industry and enhance the global competitiveness of Chile's economy. The author believes these goals can be best achieved through a TTO system such as the one proposed in this chapter. Such a system could provide a full range of technology transfer functions for the main universities and research institutes in Chile in the most economically efficient manner. ■

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1 Fundación Chile. 2004. Design of a Model for Technology Transfer Applicable to Chile. The Ministry of Economy sponsored this study.

2 The selection of foreign experts began with a request to the Association of University Technology Managers (AUTM) of which Fundación Chile is a member. AUTM is the leading professional association in technology transfer, with about 3,200 members worldwide. The foreign experts who were chosen have been actively involved in the design and implementation of different transfer offices—in their home countries and abroad: Alan Bennett, Executive Director of the University of California system's Office of Technology Transfer; Niels Reimers, an international consultant and formerly the Director of Stanford University's Office of Technology Licensing; and Pedro Palominos, Director of Spain's Consultoría Tecnológica de Instituto Robotiker. The local team consisted of Eduardo Bitrán, Director General of Fundación Chile; Sergio Burdiles, Project Head in Information Technologies at Fundación Chile; Joaquín Cordua, Manager of Fundación Chile's Human Capital and Information Technologies Area; Carlos Fernández, Head of Regulations for Fundación Chile's Agribusiness Area; Michael Moynihan, Director of Research for Biogenetic S.A.; and Gabriela Paiva, from the law firm Paiva Associates.

3 CORFO is a government organization that promotes the productivity and competitiveness of the Chilean economy. www.corfo.cl/.

4 CONICYT is a government organization that promotes science and technology development. www.conicyt.cl/.

5 www.expansiva.cl.

6 Santibáñez E. 2003. *Intellectual Property, University and Business*. Presentation at the WIPO-ECLAC Regional Expert Meeting on the National System of Innovation: Intellectual Property, Universities and Enterprises. Santiago: Chile.