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University based applied R&D: Promising results and new challenges. A regional perspective

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Abstract

This presentation is based mainly in the recent Chilean experience on joint R&D projects between universities and companies. After more than 10 years of sustained investment, very interesting results arose: new products and processes related to main economic and social sectors, technology based businesses, increasing amount of patents, momentum of cultural change at academia.

This analysis is complemented with some considerations of other Latin American experiences in the subject, concluding with a proposal for a regional framework for applied R&D

1. Introduction

The world is under transformation. Almost all human activity is facing new ways of doing Things. Globalization, knowledge creation and diffusion and more educated people are the main driving forces that are shaping new societies, very likely a global society.

Among all those activities, research and development based on universities in developing countries face a relevant challenge: how to participate in the wealth creation process that those societies urgently need.

The main universities in Latin countries usually have some amount of R&D activity that is strongly linked to objectives and patterns coming from the main universities and other entities in developed countries (mainly European Union and USA). But, rarely those R&D work is connected to the local needs for wealth creation (although it is common that researchers say they do that).

Nevertheless, in the last decade interesting seeds of change have arose. Now, it is easier to find some of those experiences in Chile, Argentina, Brasil, Mexico and other American countries.

This paper provides evidence of this emerging process. The case of Chile is presented to deepen the analysis.

2. Global perspective.

Developed countries that are entering the knowledge-based society around the world have similar characteristics and national/regional strategies. One, they heavily invest in education at all levels in order to build the human capital necessary to develop an educated and skilled population that is needed to create, share and use knowledge. Two, they create an appropriate set of economic incentives and institutional regimes to create an enabling environment, including a regulatory and economic environment that enables the free flow of knowledge, supports investment in information and communications infrastructure and alfabetization, and encourages entrepreneurship central to a knowledge economy. And three, they create a strong and effective national innovation system, promoting research and development to bring innovations to market, thus rationalizing government funding for R&D, improving support for innovation and networking, and encouraging greater cooperation and interaction of the various stakeholders: industry, university, government and private research organizations, as well as foreign entities.

In this perspective, developing countries need to accelerate the creation of policy frameworks, economic incentives, human capital, infrastructure and innovation capabilities that will make possible for them to participate regionally and globally and thus create sustainable economic growth that benefits all sectors of their society.

In the pursuit of a more prosperous, secure and sustainable world, developing countries are seeking to enhance their human, institutional and infrastructure capacity. International organizations like UNESCO, World Bank (WB) and InterAmerican Developing Bank (IDB) are mounting major efforts at technical capacity building in developing countries. Their aim is to develop a solid base of technologically prepared people that can compete internationally and will effectively improve their economies and quality of life. Such a base will facilitate the infusion of foreign capital through attraction of multinational companies to invest in the developing country, assist in making the most of foreign aid funds, and provide a basis for business development by local entrepreneurs.

3. The case of Chile: general framework

Chile is a country under a relevant transformation process. In less then 15 years, it has rebuilt the nation democratic system and more than doubled both its GDP and the number of students in universities. Huge efforts and investments have been deployed to reach those results. The country is in the transition process to be a developed country in a new context, the global economy. Creating wealth is the main challenge now, not only for government but also for industry, institutions and people as well. Improve the quality and productivity of work, improve education to prepare people to be able to create value, fight against poverty and foster social mobility and protection, are some aims of this challenge.

Chilean economy is mainly based in natural resources (mining, agribusiness, forestry, fishing, aquaculture) and services (telecommunications, energy, financial resources, transportation). In the last decade, the main Chilean companies have multiplied for more than three times their exportations to more than 160 countries, amounting about 30% of GDP, competing with world class operators. Those kinds of activities are a good opportunity for R&D and innovation in order to increase its competitiveness in the global economy. This is possible not only because the well

known international specialization of Chile in quality natural resources processing, but also for the local conditions that are appropriate for that purpose.

Companies that compete in international markets require better technologies continuously. More and more, Chilean bigger companies are demanding improvements in technologies (equipment, processes, and services) from other companies, usually smaller and technology based ones.

These technology based companies, more oriented to innovation, are the seeds in the market for the transition to a knowledge economy. These enterprises work as components of clusters linked to leader companies in each economic sector, developing competitive value chains. That entrepreneurship constitutes interesting partners for foreign companies looking for market and investment opportunities. Investment is one of the main drivers in the capacity building process.

Chilean universities and technological institutes have been the base for research and development in the country. Chile invests 0,7% GDP in R+D, about 65% of that financed with public resources and mainly executed in these institutions. About 30% of total is financed by industry and other is 5% is financed by international institutions. Hence, the challenge in the Chilean knowledge creation process is to increase the investment in R&D and innovation, particularly by the private sector.

The Chilean government, conscientiously, created some mechanisms to increase the R&D investments and to foster the links between universities and companies and to attract investment from industry. First, in the nineties, was FONDEF (Chilean fund for fostering science and technology development) and other instruments in CORFO (now ChileINNOVA), all of them supported by IDB. Then, at the beginning of this century, was the establishment of the Bicentennial Science and Technology Program for the Knowledge Society (supported by WB). And recently, one year ago, started to operate the new Fund for Innovation and Competitiveness (financed by a new tax: royalty to mining).

These mechanisms also promote the participation of institutions and companies from other countries, creating an effective opportunity for international cooperation and developing alliances to participate in competitive markets. One of the mechanisms established in these programs are the competition for technology based consortia formation among companies and universities and technological institutions, from Chile and abroad.

The main science and technology fields in which Chile is investing (both public and private) are information and communication technologies (ICT) and biotechnology (BT). ICT has been playing a relevant role in government modernization (e-government), education (ICT tools), company management systems, automation and networking. BT has been playing a relevant role in the natural resources processing in several fields in the Chilean economy: forestry, food production, agribusiness, etc. Both ICT and BT provide a realm of opportunities for advancement of country economic competitiveness and people quality of life. From that perspective, ICT and BT are the right base for value creation in a country that transits to the knowledge society.

Those seeds will grow in a new scheme under development, based on: policy framework and economic incentives to knowledge creation and transfer; human capital development mainly through education; strengthening and evolution of the Chilean innovation system; development of the information and communication infrastructure.

4. The case of Chile: FONDEF R&D experiences and results.

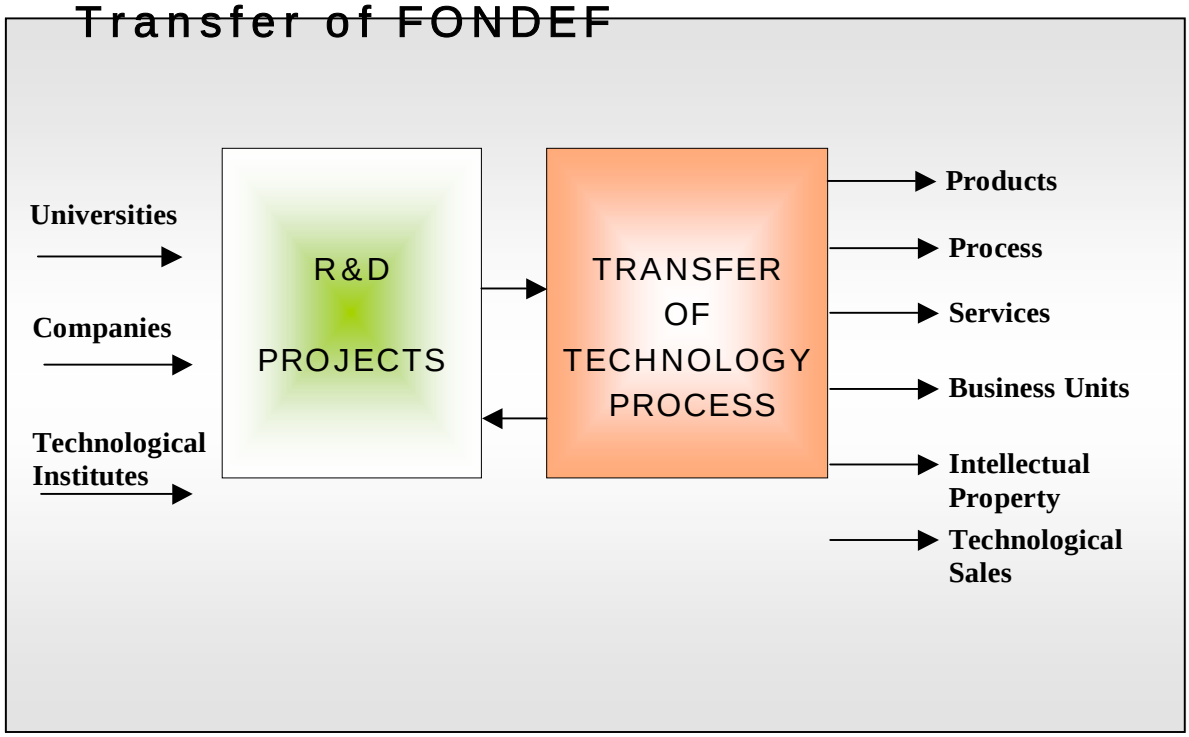
To illustrate the transformation that is occurring in university based R&D, it is shown the experience of FONDEF. This governmental instrument invests in R&D projects among universities, companies and technological institutes. It assigns resources on a competitive base in several fields: agribusiness, mining, forestry, fishery, aquaculture, industry, information and communication technologies, building, water and energy, health and education.

To participate in the contests, institutions and companies need to constitute competitive teams, usually with the participation of universities and companies from other countries that are specialized on the subject. FONDEF finance less than 60% of total project budget and companies are required to invest at least 25% of that. The projects need to be pre-competitive in order cooperation is feasible.

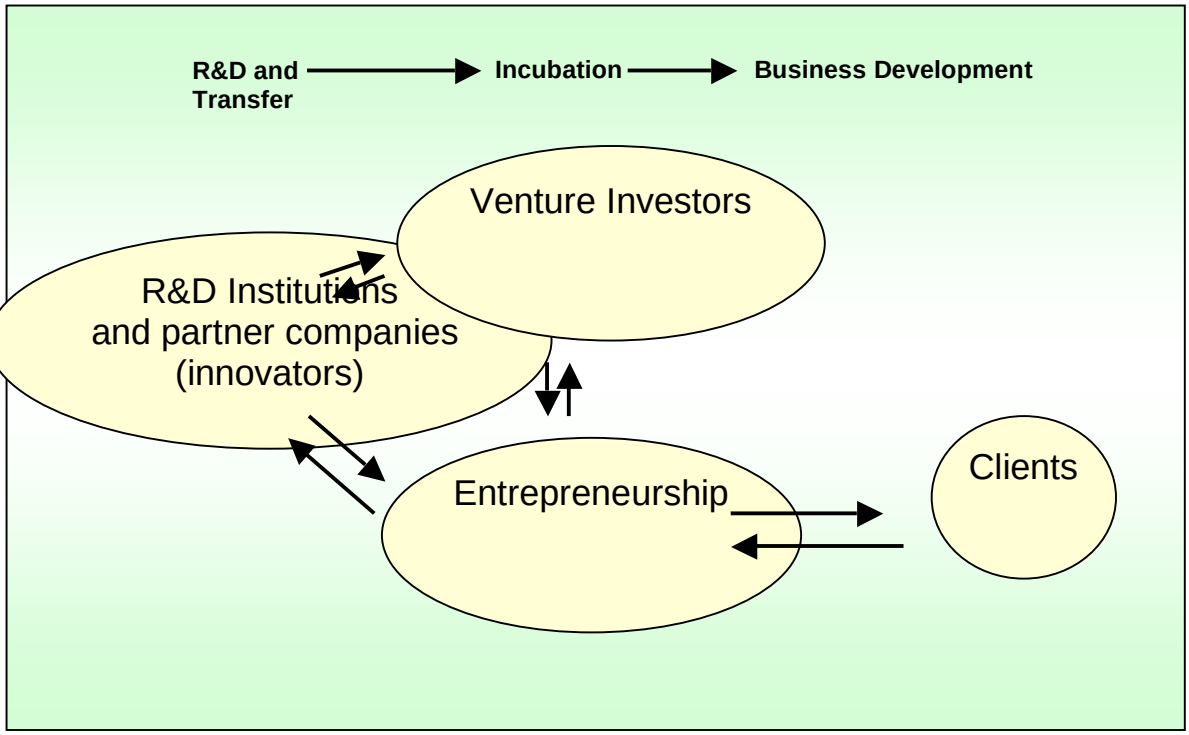
The main features of FONDEF process are: the combination of international technology transfer and local adaptation / improvement as the base to identify technology innovation and R&D opportunities; understanding of country challenges that demand science and technology contributions; building long lasting relationships among companies, universities and technological institutes; a specific environment: linkages among relevant actors; a specific task oriented to foster science and technology in order to increase the competitiveness of the economy and improve the quality of life of people; fund design to achieve linkages and impact; grants to institutions that can share de property of R&D results with researchers and others; promoting competition and open participation; focus in management efficiency and transparency; project evaluation and selection based on: science and technology peer review evaluation and socio-economic evaluation; contracts with institutions in the linkage chain (then, contracts between university, companies and other institutions, from Chile and abroad); combination of quality, relevance and pertinence; promoting leverage and co-financing; promoting good teams, best practices in R&D, particularly in project management and project follow-up and control ; implanting appropriate metrics for results and outcome

The general model of the instrument is presented in the following figures.

MODEL OF R&D / Technology Transfer of FONDEF



Technological Entrepreneurship



After less than ten years of continuous improvement of the instrument and its application to a growing base of universities and institutions (more than 40 by 2005) and companies (more than 500 by 2005), relevant results started to arose:

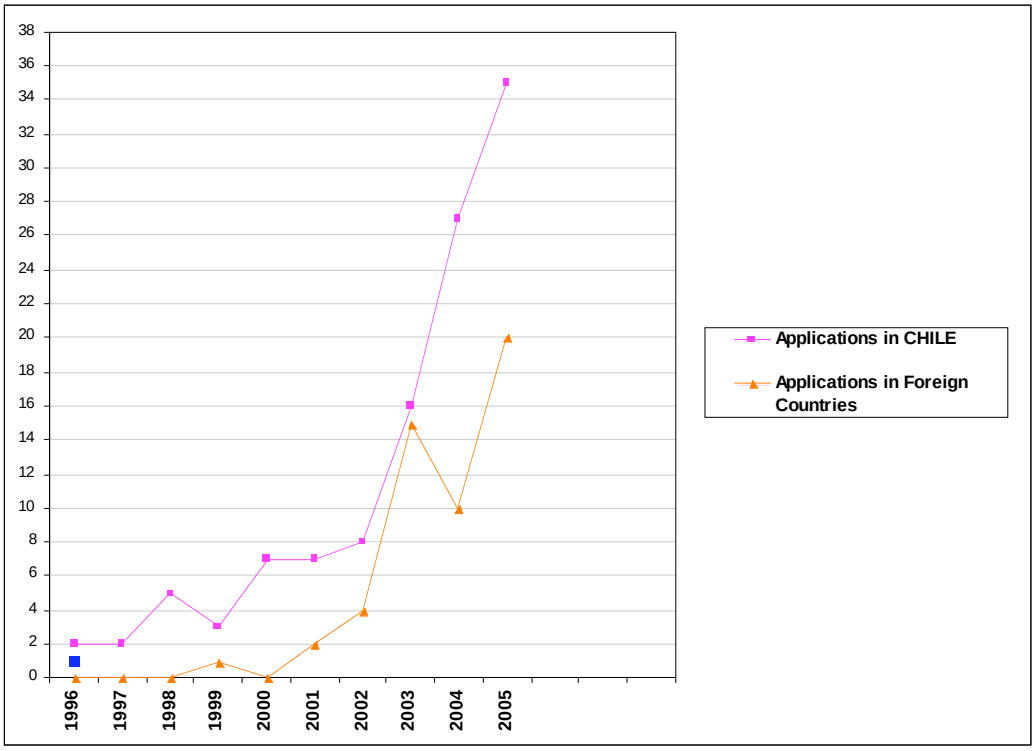
- Science and technology impact
  - Cultural change: almost 50% of the Chilean researchers have experienced this kind of R&D activity, building new ways for doing applied research and finding new goals for their projects, and trespassing these experiences to new researchers and students.
  - Building of new science and technology world class capacities, attracting and forming people and developing infrastructure.
  - Building trust and knowledge in companies to work with universities in R&D projects with mid and log term objectives
  - Increasing the science and technology assets.
- Socio - Economic impact
  - Value creation process: by 2003 more than 273 new products and processes were developed from 159 projects (about 150 million dollars of R&D busget) with a projected value of 5,1 times the amount invested; almost 60% of those results are new in the international market, the 40%

other are improvements; 56 spin off business units and new enterprises were created. These results are improving yearly. For instance, the patenting rates are improving a lot, as shown in the following figure (for the first time, the Chilean universities are patenting in USA, Europe and other countries as a regular protection of their intellectual property rights).

- "Virtuous" process development among universities, companies, technologies and other institutions and attraction of investments to the resulting transfer of technology to market and society.
- Capabilities to afford relevant country problems and opportunities: increasing the efficiency of mining and industrial processes; value added: improvement and new products and processes; development of "clean technologies"; development of "integrated production technologies"; development of new regulations for industrial production; introduction of new vegetable and animal species; genetic improvement of plants; decontamination of industrial processes**;** new treatments for animal and plant diseases; biological control for agricultural production; development of "organic" production in agriculture; mechanization and automation of industrial and mining processes**;** development of agriculture in desertic and semi-desertic zones; development of computer based networks for different applications; valuation and sustainable management of native forest; information technology solutions applied to natural resources industries; development of pedagogical instruments; new educational methodologies and instruments for science, technology, language and mathematics; preventive and clinical treatments for human health; new organization and management technologies for human health services; new mechanisms for school evaluation, certification and management; methods for teaching in specific fields: non violence education, environmental protection and others; new water resources processing and management; detection and evaluation of basic natural resources: water, minerals and energy sources; improving energy efficiency in process and products; new technologies for wood and timber industry; new technologies and designs for antiseismic devices; new catastrophe and emergence management systems; exploration and evaluation of new energy sources; active principles and new molecules for pharmaceutical industry.
- New technologies and innovations that are transforming a complete economy sector (for instance, aquaculture).

- Institutional impact: contribution to the renovation of university mission and strengthening the institutional capabilities; international cooperation and participation; increasing the employability of scientists and technologists in productive sectors.

Patenting of R&D results



As a consequence of this evolution, new programmes have been created to deepen the R&D and innovation activities. In all of them, universities are playing a relevant role:

- Fostering intellectual property (IPR), particularly patents
- Birth of thematic programmes: Genome Chile applied to vegetables and mining; information and communication technologies applied to education; red tide; word class aquaculture; science, technology and innovation information systems; ICT international center in high performance computing; R&D in health public policies.
- Technology based consortia among universities companies, from Chile and abroad, in several fields: biotechnology applied to forestry, fruitculture and agribusiness; drugs development for catastrophic deceases; unmanned airplanes.

5. Challenges to universities.

The Chilean case shows that is possible to have university based R&D activity simultaneously related to wealth creation (and linked to industry) and complying with quality standards according to international mainstream science and technology trends.

For instance, in biotechnology applied to mining (genomics applied to bioleaching bacteria to process copper mineral ores) is at the same time a R&D with relevant economic impact (it is expected to decrease the production cost to one half and increase by four the amount of exploitable mineral resources) and a science and a technology breakthrough.

As a consequence of the evolution explained, universities in Chile are facing a huge challenge at the crossroad.

For one side, R&D activity is growing and there are more opportunities for better contributions to wealth creation. But their researchers are few and it is required to increase the amount of them. Time to form them is not always available, then the attraction from other countries need to be considered. More world class researchers in universities will lead to major renovation of research universities and also to transform some of the others. In every case, academic staff needs to be renewed.

For the other side, big Chilean companies that are competing in international markets are looking for university partnerships not only in Chile but also in developed countries. Some of those relations are already in place and results are becoming in the next years Chilean universities need to strengthen the fields they want to be leaders and compete with universities from abroad (forming world class R&D teams with enough critical mass). In the other fields, they need to cooperate with universities and technological institutes from other countries to form research associations and networks.

That will lead to open innovation system, more extensive than the national ones. In this model, universities and companies and technological institutes from different countries cooperate and define the specific participation of every player.

This is the challenge for the universities in Chile and also in developing countries, like American ones.

The lasts decades have seen universities playing a more relevant role in Latin America. Both private and public universities have being paving the way for the gradual expansion of cultural elites and established the foundations for national research and development and innovation systems. Furthermore, these universities have facilitated social mobility, served as political socialization channels and, in general, fostered the development of national cultures and common markets.

University research is not a frequent practice in Latin America. According to the criteria of the Carnegie Foundation for the Advancement of Teaching, in 2003 Brazil, which is the country more populated in the region, had only 16 “extensive research universities”. Other countries like Argentina, Mexico, Colombia, Chile and others have fewer research universities that that figure.

Local governments finance most of the research carried on Latin American Universities, producing results mostly on basic research. Although these results are solid, they do not lead automatically to wealth creation, unless they become part of a larger ecosystem of knowledge creation involving the productive sector.

For that reason, the situation presented in the Chilean experience is so interesting. Of course, is not unique in the region. Every major country has its successful experience. For instance, some Brazilian universities from Rio de Janeiro are working with the Brazilian petroleum company, in developing high-level applied research. In the State of São Paulo, well-established lines of research and development are already the

results of interaction of the universities and the local industries. Other well known example is Monterrey in Mexico where research and technological development are pivotal activities. Through its research centers and national and international network of researchers in disciplines that have been defined as a priority, Monterrey Tech generates knowledge by means of patents, innovations, technological development, and social development in the different areas of the economy.

These are a few examples and not the rule in Latin America. But the new seeds of change are starting to grow. Clearly, different countries will have different experiences and results. But, capabilities will be higher and the possibility to succeed in more ambitious projects will also increase. Hence, the interconnection of those capabilities will create a new way of doing R&D in America.

Universities need to assume the challenge in a more aggressive way and the same is for technology based companies both from local countries and abroad.

The opportunity is now.