

Chile

Fostering Technology Transfer and Commercialization

2009



THE WORLD BANK

Chile

**Fostering Technology Transfer
and Commercialization**

Abbreviations and Acronyms

ASEXMA	Asociación de Exportadores de Chile	IDA	Industrial Development Authority
CIMM	Mining and Metallurgic Research Center	IIRS	Industrial Research and Standards
CNIC	National Innovation Council for Competitiveness (<i>Consejo Nacional de Innovación para la Competitividad</i>)	INECON	<i>Ingenieros y Economistas Consultores</i>
		INIA	Agriculture and Livestock Institute
CODELCO	<i>Corporación Nacional del Cobre</i>	IP	Intellectual Property
CORFO	Chilean Development Agency (<i>Corporación de Fomento de la Producción</i>)	ISI	Information Sciences Institute
		MECESUP	<i>Mejoramiento de la Calidad de la Educación Superior</i>
CPC	<i>Confederación de la Producción y del Comercio</i>	NIIP	National Institute of Industrial Property
CRUCH	<i>Consejo de Rectores de las Universidades Chilenas</i>	NIS	National Innovation System
DICTUC	<i>Dirección de Investigaciones Científicas y Tecnológicas de la Pontificia Universidad Católica de Chile</i>	OECD	Organization for Economic Cooperation and Development
FIC	National Innovation Fund For Competitiveness (<i>Fondo de Innovación para la Competitividad</i>)	OTRI	Oficina de Transferencia de Resultados de Investigación
FONDEF	Fund for the Promotion of Scientific and Technological Development (<i>Fondo de Fomento al Desarrollo Científico y Tecnológico</i>)	PCT	Patent Cooperation Treaty
GEM	Global Entrepreneurship Monitor	PRO	Public Research Organization
HEIF	Higher Education Innovation Fund	PSU	<i>Pruebas de Selección Universitaria</i>
ICI	Inter-ministerial Committee on Innovation	R&D	Research and Development
		SAG	<i>Servicio Agrícola y Ganadero</i>
		SIMFONEC	Science Ideas to Market, Focused on Enterprise and Commercialization
		SMEs	Small and medium enterprises
		TTO	Technology Transfer Offices
		UDT	<i>Unidad de Desarrollo Tecnológico</i>
		UTEN	University Technology Enterprise Network
		WEF	World Economic Forum
		WIPO	World Intellectual Property Organization

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Executive Summary

Chile is an economy rich in natural resources and their efficient exploitation has proved the right strategy to grow successfully over the last few decades. More recently, in the broader context of increasing globalization and competitive pressures, it has chosen as its main development driver the contribution that arises from innovation and the adoption of higher levels of technology to enhance productivity growth and to add to national competitiveness. Following extensive technical analysis this effort has focused on priority clusters of economic activity that offer increasing opportunities for Chile's exports in competitive global markets.

In this context, the President of Chile established the National Innovation Council for Competitiveness (*Consejo Nacional de Innovación para la Competitividad, CNIC*) to provide the vision and lead the thinking on these issues. The CNIC has charted a broad strategy that proposes new directions in the national research and development effort, to improve the relevance and quality of the supply of innovative ideas. Concurrently, efforts are being made in the industry system to encourage the private sector to increase its investment in research and development, which has historically been low, to generate a strong practice of innovation on the demand side and so improve productivity and competitiveness. In line with modern theories on innovation systems, the strategy is also concerned with the stimulation and enhancement of the intermediaries who are working to link the research system and the industrial system and to facilitate information flows in both directions. This for short hand has been referred to as *technology transfer*

and commercialization or technology brokering and constitutes the focus of this report.

The report responds to a request by the CNIC, through its Technical Secretariat, to review Chile's technology transfer and commercialization system and identify practical steps to accelerate the development of an effective and dynamic system. The findings and conclusions expressed herein do not necessarily reflect the view of the CNIC members or its Secretariat. A summary of the main findings and conclusions follows.

A Diagnostic of Technology Transfer and Commercialization in Chile

Empirical evidence suggests that Chile not only underperforms on innovation inputs such as R&D expenditures, but there are also inefficiencies in the way in which innovation resources are utilized within the national innovation system. Patenting by Chileans in the United States, which is the most advanced market for research based innovations and is used as an international reference point, is almost negligible despite some increases during the last decade. An econometric analysis based on data from 1963 through 2000 and covering a wide range of OECD and non-OECD countries also confirmed that the relative efficiency of transforming Chilean R&D investments into commercial patents stands below the OECD average.

While many factors and incentives have affected Chile's capacity for technology transfer and commercialization and the efficient application of its innovation-related

resources, the main ones can be classified into four key areas: *insufficient articulation between the productive sector and knowledge centers, underdevelopment of the institutional and incentive framework for intellectual property management, weak public technology institutes, and inadequate institutional and financing mechanisms to encourage the formation of new technology firms.*

The relationship between industry and knowledge centers, i.e., universities and research centers, lies at the heart of many innovation networks, but despite some encouraging recent developments, these alliances are at an incipient stage in Chile. Differences in culture between industry and universities, which have been common in many OECD countries, are also present in the Chilean context but in a more acute form. Existing incentives in Chilean universities have not favored collaboration either. In addition, until recently, public initiatives in support of innovation had not recognized the importance of these linkages so public funding for these efforts had been quite limited.

In Chile, there is little appreciation and inadequate understanding of the value of the intellectual property (IP) system by universities and businesses to the detriment of technology transfer and its potential economic impact. Use of the IP system is a central and ever growing aspect of the knowledge economy in advanced OECD countries and almost all research performing groups pay careful attention to the potential of their results for commercialization. The present practice in Chile differs markedly. Broadly speaking, the IP incentive framework of most universities falls short of prevailing policies in OECD countries, and where an adequate framework is available, there is a permissive attitude towards IP management but it is not actively encouraged. Public policy towards universities did not encourage it either. Consequently, necessary competences have not been developed with technology transfer offices (TTO) in universities running on minimal budgets and staff.

Public technology institutes can make valuable contributions to the technology transfer process as well. The performance of Chile's public technology institutes, however, is uneven. For the most part, they have not evolved with the needs of the productive sector and have not responded to the challenges of Chile's priority

clusters. In addition, they face the challenge of an aging staff and retention of young qualified staff.

The formation of new knowledge-based firms has received considerable attention in Chile over the last few years, but efforts have not been successful on a broad enough scale to achieve impact. This process is notoriously challenging worldwide, even more so in emerging markets such as Chile. The difficulties concern the articulation of funding from the research idea to the various development phases that a new enterprise undergoes as well as the provision of incubation support during the early stages of the new venture. In Chile, the attention has been focused on incubators based at universities rather than on the broader incubation process that revolves around the entrepreneur and the business idea, explaining the weak impact to date. Articulation of funding to support these new ventures has also proved difficult.

Fostering Technology Transfer and Commercialization in Chile: Options for Consideration

Considering Chile's current endowments and drawing on other international experiences, the report proposes several strategic directions and recommendations to create a milieu in Chile that will be more prone to technology transfer and commercialization (Figure 1). Changing the culture and incentives of key actors in the innovation system and building the necessary institutions and competences will be a long-term effort. As the Association of University Technology Managers (AUTM 2002) noted

*"commercialization of activities can take a significant amount of time...because of the time needed to develop a portfolio of intellectual property to license, build up a body of expertise and develop a **culture of technology transfer** within the institution—as well as giving licenses the time needed to develop and market products."*

The above also applies to other intermediaries in the system such as public technology institutes and private specialist providers and to the need to change the innovation culture of the business community.

That said, progress can be made with strong public commitment and consistency in public policies. Changes can start now. Market failures in innovation in general,

and technology markets in particular, justify public interventions. Within about 10 to 12 years, Chile cannot only increase its R&D and human capital for innovation levels, as committed in the national innovation strategy, it can also narrow its gap (relative to OECD countries) on the efficiency of R&D use relative to technology transfer and commercialization outcomes such as patenting and licensing and increase the number of knowledge-based firms that emerge locally (see Annex I for a set of indicative performance indicators).

There is strong public commitment to increase funding to stimulate innovation, but improvements in the technology transfer and commercialization system will not only involve an increase in funding but also changes in incentives, funding reallocations and institutional building. It would be desirable for funding allocations to help stimulate changes in institutional incentives and to be more closely linked to performance. Constant communication on the importance of technology transfer and commercialization to Chile's competitiveness and celebration of successes will also be important to foster a change in culture at universities and the business community. The CNIC can play a leading role in helping define a long-term strategy for technology transfer and commercialization and the Inter-ministerial Committee of Innovation in helping secure its implementation.

Increased funding will need to go hand in hand with a strong evaluation framework, especially since policies and programs to foster technology commercialization will entail learning and experimentation. Adjustments in some of the programs are likely to be necessary, and others should come to an end as market gaps are closed. Thus, the monitoring and evaluation framework will be crucial in guiding the policy-making process.

The report proposes complementary interventions in seven areas to stimulate the development of a more dynamic technology transfer and commercialization system. A brief summary of them follows (see Annex I with matrix summarizing recommendations).

- Improving the institutions, regulations and practices to foster an efficient and more dynamic *IP management system*;
- Developing strategic partnerships for applications oriented research and enhancing the potential of

technology institutes;

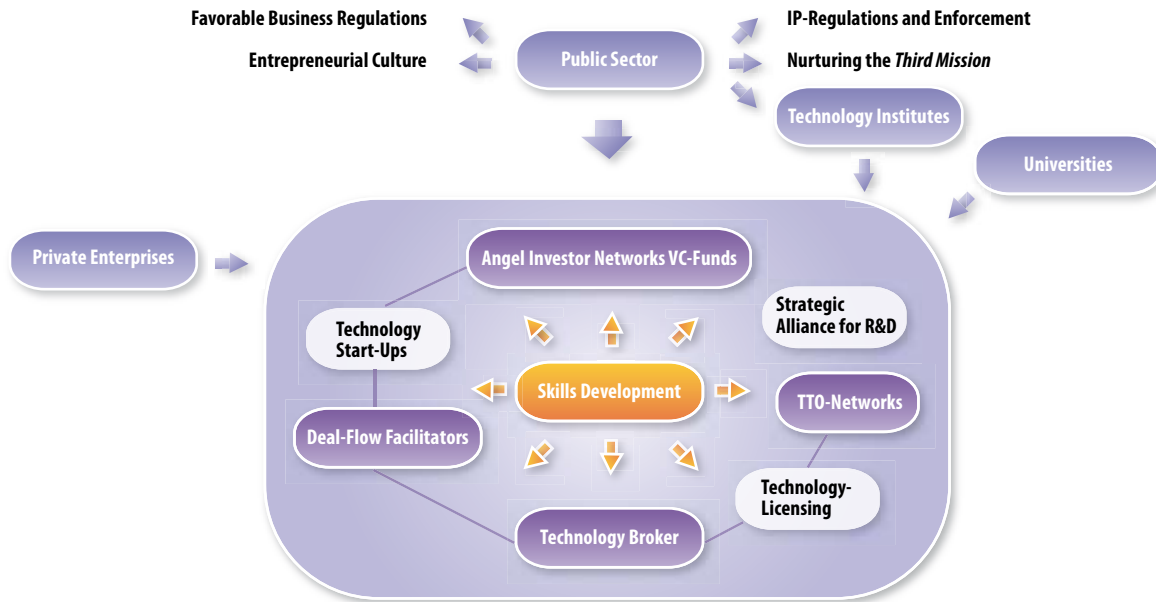
- Accelerating the formation rate of *new technology firms*;
- Developing the necessary *skills and competences* to support the above;
- Strengthening technology extension services and stimulating its demand;
- Nurturing '*universities*' "*third mission*" of contributing to economic growth; and
- Fostering an *innovative and entrepreneurial culture*.

Improving IP management system. Intellectual property is the bedrock on which licensing can take place and new technologies can be developed and benefits captured by Chileans firms. Without it, the appropriation of innovations is limited and so are the benefits of commercialization, all of which leads to a reduced rate of innovation effort. All forms of intellectual property (patents, copyrights, designs, trademarks, and plant breeders' rights) can be licensed. IP management, however, is a complex process that can only thrive if there is a strong institutional, regulatory and incentive framework, and current IP incentives and competences in Chile are not in line with practices prevailing in more advanced knowledge economies.

Closing this gap involves (i) promoting the development of a strong network of TTOs at universities and other private intermediaries, (ii) generating awareness and demand for IP services, (iii) improving the efficiency of public institutions responsible for approving, registering and enforcing IP rights, and (iv) signing of critical IP international agreements. It also requires the nurturing of a new culture in universities as further discussed below.

Developing strategic partnerships for applications oriented research between the business community and knowledge centers. Strategic partnerships that pursue a medium- to long-term research agenda relevant to priority economic clusters are necessary to sustaining an internationally competitive position. There is a need to nurture and expand the best of the existing strategic partnership experiences in Chile and foster new ones in other key cluster areas. Public funding for the first large scale public-private strategic alliances will come to an end within about one-two years, and thus to provide continuity, the next public funding program for

Figure 1: Key Elements of a Technology Commercialization and Transfer Model



Source: Authors' elaboration.

strategic partnerships could be launched within that period or shortly thereafter.

The experiences of existing strategic partnerships in Chile and similar international initiatives have provided valuable lessons that would need to be incorporated in the design of the next public funding program. Special attention will need to be paid *inter alia* to linking the objectives of such partnerships to the needs of the productive sector, fostering the formation of a critical mass of researchers to secure impact, moving from a project oriented culture to a sustained longer-term effort, and inviting international peer reviewers to the selection process. To avoid duplication, it would be desirable that efforts to promote strategic partnerships for applied oriented research be led by a single public funding agency but implemented in collaboration with other relevant agencies. InnovaChile might be suited to lead these efforts given the commercial orientation that needs to underpin such initiatives.

Enhancing the capacity of public technology institutes. The performance and impact of Chile's public technology

institutes can be improved. Prior to devising a strategy for them, it is important to distinguish between (i) those whose primary public mission is to contribute to technology transfer and (ii) those whose primary public mission is to generate information on issues of national strategic interest and/or develop standards for producers and consumers. The report is focused on the former.

Greater collaboration with the productive sector would help the public technology institutes to identify sectoral priorities and increase their relevancy and impact on technology transfer. The institutions could enhance their "intelligence services", quality and relevancy of research, commercialization of research outcomes, and provision of new technology packages. Improvements in these areas would imply changes in their governance and incentive framework (including funding incentives) and the formulation of a new medium-term strategic plan with clear performance targets linked to their core mission.

Accelerating the formation rate of new technology firms. The formation of new firms based on the findings

of R&D work constitutes an important pillar of Chile's commitment to advance as a knowledge economy. *Born global* firms or those with an export focus merit special attention. Assistance packages to these fast growth companies are needed in the area of incubation and early stage finance and venture capital (VC) capital along with greater efforts to promote an active deal flow from research ideas. The greatest financing gaps for new technology ventures are in the early stages. CORFO could consider sponsoring a pilot private-public technology venture fund, primarily focused on early stage finance, to provide a demonstrative effect. Current global conditions, however, suggest that such an initiative could be postponed for a few years until financial conditions improve. Continuing to seed the development of angel investors will also be important.

Improving incubation services and promoting a more active deal flow from the research base is also critical. As a first step, InnovaChile is starting to formulate a program to benchmark incubators in terms of capacity and outcomes to encourage performance improvements. It would be desirable for the benchmarking process to distinguish among incubators with a focus on *born global* ventures and those with a national or regional focus due to differences in services required, but seek to promote excellence in both. This initiative could be taken a step further in the medium term. InnovaChile could seed the development of a market of deal flow promoters that would actively seek ideas from the research base with commercial potential and prepare them to the stage where they can be presented to early-stage VC funds or other financial agents.

Developing the necessary skills and competences. The expansion of activities in the three aforementioned areas will require a deepening of skills and competences related to technology management and brokering as well as more specialists in patent law. A two-pronged approach can be followed to accelerate the development of such critical skills. First, there is a need to fill the most immediate gaps in competences through a pragmatic approach such as (i) attracting diaspora and contracting international specialists in the field, (ii) building alliances with equivalent agencies/intermediaries overseas, and (iii) offering internships for Chilean staff in overseas agencies. In parallel, there is a need to create a professional cadre of specialists or technology managers,

which implies both specialist degrees in universities to train those entering the profession and professional associations to organize accreditation and continuous professional development. InnovaChile can seed the development of these initiatives.

Nurturing universities' "third mission" of contributing to economic growth. Changes in the culture and practices in universities need to underpin Chile's innovation focused development strategy. Chilean universities today are timidly engaged with the *third mission*, meaning activities related to the needs of society in general and the productive sector in particular. Progress achieved in highly recognized research universities (for example in the United Kingdom and Finland) over the last two decades suggests that such change of culture is possible and the public sector can help catalyze the process.

Similarly, the CNIC and the Government of Chile can put in place an awareness campaign and series of incentives to encourage Chilean universities to engage more actively with the business community as a way of contributing to the country's economic development and thus to social progress and standard of living of its population. The CNIC, for example, could convene a special Committee with the participation of the Ministries of Education and Economy, university rectors, and private sector representatives to discuss issues related to the *third mission* and propose initiatives to address them. Vice-chancellors of internationally recognized universities could be invited as senior advisors to the Committee. Over time, budgetary transfers to universities would need to include incentives linked to the *third mission*.

Stimulating firms' demand for technology and innovation. Working on the demand side of technology transfer and commercialization is as important to the effectiveness of the innovation system as is the efficiency of the linkage with the supply side. The overall objective is to expand the number of firms in Chile that use knowledge as the main competitive strategy. Addressing this need has to be tailored at two levels. The first is for leading clusters whose orientation is predominantly the competitive international market. Here, the aforementioned tools to promote strategic alliances for applications oriented research are the most relevant. At this stage, however, some firms around leading clusters are still far from the technology frontier, which points to the need for

combining these strategic alliances with technology extension services in some of the clusters. The second is for other firms who lie outside the priority clusters. The most frequent response to this challenge is to combine shared-cost grant schemes to stimulate the demand side and to link this effort to accredited suppliers who have been vetted for the quality of services they offer. InnovaChile has a grant scheme of this type that could be further promoted and is planning to complement it with the further development of suppliers of technology extension services.

Fostering an innovative and entrepreneurial culture. Initiatives to stimulate technology transfer and commercialization will be more effective if rooted in a broader entrepreneurial culture. While some individuals are born with a higher propensity toward entrepreneurship, students are more likely to undertake an entrepreneurial career the more exposure and learning they have to entrepreneurship and entry-level entrepreneurial skills. International experts on entrepreneurial education point out that the primary and secondary levels can start to teach entrepreneurial attitudes, while post-secondary education can further nurture these attitudes and substantially improve the skills for entrepreneurship. It would be desirable for Chile to develop a plan on entrepreneurship education, starting with the tertiary level and expanding it to other levels over time. Universities in Chile, for example, could start teaching entrepreneurship throughout various disciplines and across the campus, not only in business schools. Entrepreneurship teaching could subsequently be gradually expanded to secondary levels. Initiatives to enhance entrepreneurship skills will need to go hand in hand with other efforts to enhance science education from the primary level on.

1

Chapter 1: Introduction

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Chile is an economy rich in natural resources and their efficient exploitation has proved the right strategy to grow successfully over the last few decades. More recently, in the broader context of increasing globalization and competitive pressures, it has chosen as its main development driver the contribution that arises from innovation and the adoption of higher levels of technology to enhance productivity growth and to add to national competitiveness. Following extensive technical analysis this effort has focused on priority clusters of economic activity that offer increasing opportunities for Chile's exports in competitive global markets.

In this context, the President of Chile established the National Innovation Council for Competitiveness (*Consejo Nacional de Innovación para la Competitividad, CNIC*) to provide the vision and lead the thinking on these issues. The CNIC has charted a broad strategy that proposes new directions in the national research and development effort, to improve the relevance and quality of the supply of innovative ideas. Concurrently, efforts are being made in the industry system to encourage the private sector to increase its investment in research and development, which has historically been low, to generate a strong practice of innovation

on the demand side and so improve productivity and competitiveness.

In line with modern theories on innovation systems, the strategy is also concerned with the stimulation and enhancement of the intermediaries who are working to link the research system and the industrial system and to facilitate information flows in both directions.¹ This for short hand has been referred to as *knowledge transfer and commercialization or technology brokering* and constitutes the focus of this report.

There are three (four) main complementary approaches that can be adopted to transfer advanced science and technology knowledge into productive use: management of intellectual property; strategic partnerships for applied oriented research; creation of new knowledge-based firms; and specialist technical advice (Figure 1.1). All have been used widely in the advanced OECD knowledge economies and can be adapted to the realities of Chile's innovation system. Each one of these strategies is further discussed below.

- **Managing intellectual property:** The first, and most frequent approach, is the use of the

¹ Early theories conceived innovation as primarily a science push process. This was followed by a second wave of theories with a focus on the demand side—demand theories. Since the late 1980s and early 1990s, the literature stimulated by the seminal work of Nelson, Lundvall and others, has understood innovation as a more complex and multidimensional process where information flows in multiple directions and networks and channels encouraging the information flows and linking agents between the demand and supply become crucial.

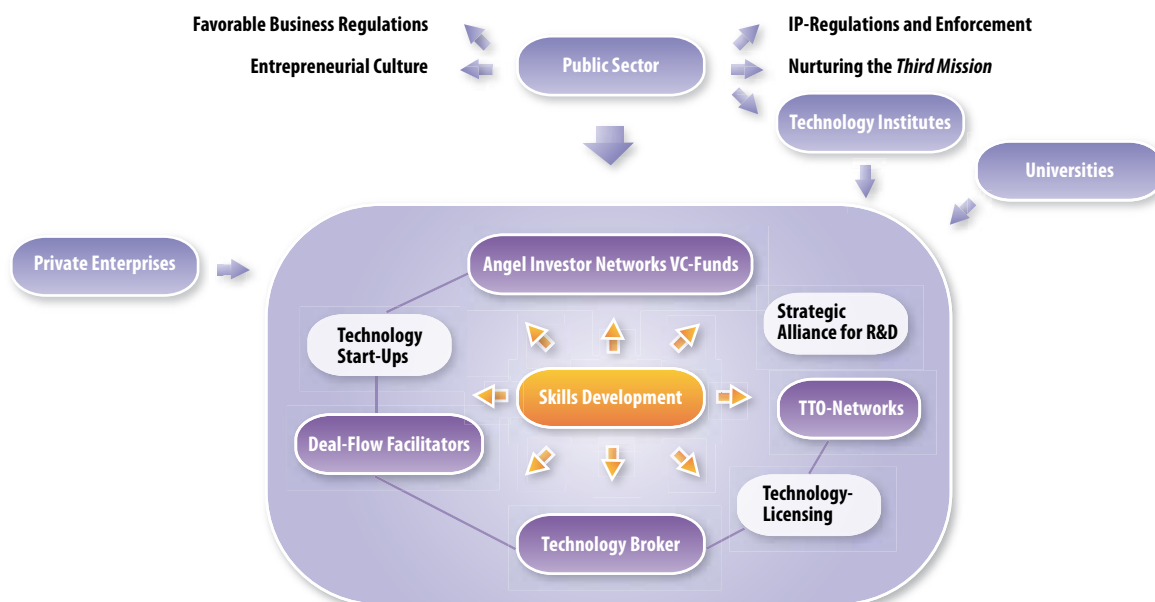
Intellectual Property (IP) and patenting system to create ownership of a knowledge asset that is then offered to the commercial sector for licensing. The IP process grants a legal monopoly in the use of a novel idea for a significant time to enable the inventor to gain a sufficient reward for their prior work in developing the novel idea. These legal processes first establish the legal asset and then the IP is utilized creating value and return to the inventor.²

In Chile the IP system has been little used, although levels of use have recently shown signs of rising from the very low previous base. Chilean universities have not been very active in seeking to establish IP rights and, with a few exceptions, have had little success to date in the second process of generating revenue from the exploitation of IP assets. This is a key area where practice could improve substantially in Chile in order to foster the transfer of knowledge into the productive sector.

Indeed, the use of the IP system is a central and ever growing aspect of OECD knowledge economies, where almost all research performing groups pay careful attention to the potential of their results for commercialization. Several distinct strategies have emerged to cope with the particular demands of this process. These and their relevance to Chile will be discussed in Chapter 3.

- **Developing strategic partnerships for applied oriented research between knowledge centers and the private sector:** The second approach, which is becoming much more common practice in advanced OECD economies, is the creation of medium- and long-term strategic alliances between the research and business communities where new knowledge is created with a specific application in mind. This area is best suited to alliances between significant concentrations of knowledge creators and users. Hence, it aligns well with the focused cluster-based development strategy which Chile

Figure 1.1: Key Elements of a Technology Commercialization and Transfer Model



Source: Authors' elaboration.

2. There are many aspects to the patent and licensing process which are elaborated in the following sections, but for simplicity of exposition, it is dealt with here as a simple uniform process.

is pursuing. So far in Chile, the development of strategic partnerships is at an early stage with the most visible elements of it being the research consortia that have been set up over the last few years. The Government of Chile can draw many lessons from these early experiences that will prove useful in further promoting strategic partnerships along a cluster-based framework.

- **Creating new technology firms:** The third approach, and one that overlaps with the related areas of entrepreneurship, is the creation of new knowledge-based firms by means of an incubation process. Here, the new entrepreneur takes forward the innovation into the business world by solving all the problems of application and commercialization within the new firm. This is a crucial area that has received much attention in advanced knowledge economies, and best practice approaches have been accumulated through many years of experience. This strategy has received support in Chile over the last few years. The attention has unfortunately focused on incubators based predominantly in universities rather than on the broader incubation process and has not brought about successful results on a large scale. There are, however, a few examples of good practice. Considerable attention is given in the following chapters on how to improve and make this effort more effective.
- **Specialist technical advice:** The fourth approach is based on linkages between academics and businesses operating in their fields through advisory positions taken in specific firms. In this instance, the knowledge is embodied in the specialist and the dissemination method is through personal transfer. This is a well established practice in areas such as engineering and medicine. Being essentially personal, it has fewer implications for technology transfer and commercialization policy, other than ensuring that a suitable balance of rewards and responsibilities is set for those who participate in it.

The above cannot succeed in a vacuum. The experience of advanced knowledge countries has shown that their success relies on the existence of *intermediaries or technology brokers* that can facilitate the technology transfer and commercialization process, and the

development of a strong entrepreneurial and innovative culture and a university culture that fosters engagement with the business community as a way of contributing to economic development and social progress (Figure 1.1).

Technology brokers and other intermediaries play a crucial role in all the four strategies described above. In the management of IP, for example, the services are most often provided by a Technology Transfer Office (TTO) at the knowledge generating institution. In some cases, these offices call on private IP specialists but they generally develop the capacity in house since it constitutes their core business. Chapter 3 elaborates on strategies to develop these competence levels in Chile. In the strategic partnerships, internal brokerage services are often developed as an integral part of the partnerships' work. In other circumstances, some of these specialists are found in the large corporate partners or private providers are brought since the complexity of the technology transfer process requires a great depth of expertise. In the knowledge-based firm incubation strategy, the usual model is to collaborate with specialists from service firms rather than to try and build all these services into the incubator management team. Broadly speaking, the aforementioned strategies for technology transfer and the supporting intermediaries are at an early development stage in Chile.

There is also scope for promoting a more entrepreneurial culture as well as a university culture that gives *legitimacy* and fosters collaboration with the productive sector and the community as a key responsibility along with teaching and knowledge generation. Many OECD countries have developed a range of (financial) tools to encourage the faster adoption of this responsibility along with continuous advocacy. In some places, the legitimacy debate is still on-going, but in others (e.g., the United Kingdom or Finland), it is now accepted. Similarly, the Government of Chile can encourage and accelerate the development of an efficient technology transfer and commercialization system through appropriate regulations, institutional support, financial incentives, and communication of best practices. The experience of other public funding programs for innovation highlights the need to pay careful attention to program incentives during the design phase and program evaluation ex-post in order to learn and feed the policy-making process.

This report responds to a request by the CNIC, through its Secretariat, to review Chile's knowledge/technology transfer and commercialization system and identify practical steps to accelerate the development of an effective and dynamic system. The overall objective is to expand the number of firms in Chile that use knowledge as its main competitive strategy. The remainder of the report is structured as follows. Chapter 2 conducts a diagnostic of Chile's current system, and Chapter 3 provides recommendations to upgrade technology transfer and commercialization practices and incentives in Chile considering its current endowments and lessons learned from international reference models. Chapter 4 summarizes the conclusions of the review.

2

Chapter 2:
A Diagnostic
of Technology
Transfer and
Commercialization
in Chile

Chapter 2:

A Diagnostic of Technology Transfer and Commercialization in Chile

The extensive analysis conducted on Chile's national innovation system suggests that the system is underperforming in terms of innovation outputs as measured by various proxies. This performance gap appears to stem from two problems: innovation inputs are less than adequate and the presence of inefficiencies in the transformation of these investments into commercially and economically meaningful ideas, in particular transforming knowledge into innovation. This explains why the national innovation strategy has identified technology transfer and commercialization—a core element of an effective national innovation system—as a key area for public intervention. This chapter seeks to analyze the gaps and obstacles in Chile's national innovation system that are slowing the process of technology commercialization. This analysis is preceded by a brief review of the key performing features of Chile's national innovation system drawing from the existing literature.

2.1 Benchmarking Chile's National Innovation System

Empirical evidence indicates that Chile faces a gap in innovation. Success in innovation outcomes can be tracked by several indicators measuring different aspects of innovation. The two most common international indicators are the level of Chilean firms with product or

process innovations and the level of patenting activities. The first is a very broad measure of innovation that can capture R&D as well as non-R&D sources of innovation (e.g., through acquisition of new machinery, training, and organizational changes) and innovations that constitute an adoption of technologies available outside Chile. Total innovation effort and R&D investments of Chilean firms are less than 1 percent and 0.3 percent of sales³, respectively, compared to an average of 3.7 percent and 1.2 percent for Europe (Figure 2.1), respectively, towards the beginning of this decade. Progress in the first benchmark will be critical in the short to medium term since Chilean firms can achieve important increments in productivity and competitiveness even if they do not represent technological improvements at the international level.

The second measure, level of patenting, is more focused and generally a more useful benchmark to gauge national trends in research based technological innovation, although international comparisons need to be interpreted with some caution since the propensity to patent differs across economic sectors⁴. While monitoring the first benchmark will be important in the short to medium term, progress in patenting will become increasingly important for Chile over time since limiting itself to the adoption of existing technologies could lock the country in a lower level of income in the long run.⁵

³ The figures for Chile correspond to the average of the two innovation surveys covering the periods 2003-2004 and 2005-2006.

⁴ Economic sectors display differences in the relative efficiency and modes of appropriating the benefits of innovation.

⁵ Blomstrom, Kokko and Sjöholm (2002) argue that a similar logic encouraged Singapore into a more knowledge generation stance from its previous greater reliance on knowledge adoption through foreign direct investment and licensing.

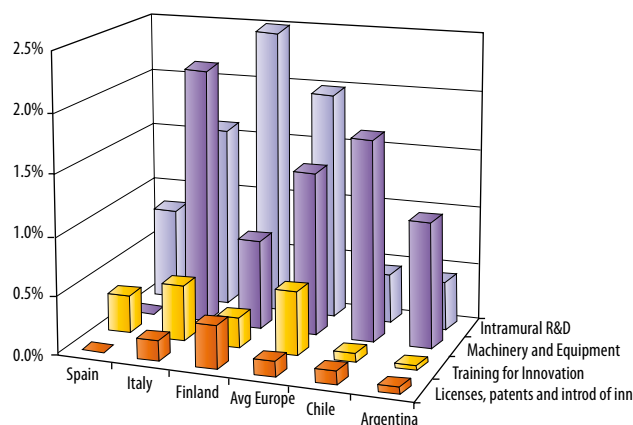
For this reason, Spain has been aggressively upgrading its R&D capacity and other countries such as Ireland and China have moved from a reliance on knowledge adoption through foreign direct investment to a greater emphasis on knowledge generation.

The level of patenting by Chileans in the United States (Figure 2.2) is almost negligible despite increases during the last decade. (The United States is the most advanced market for research based innovations, providing a strong reference point compared to figures for different national markets where practices vary.) Data from the Department of Industrial Property in Chile shows that, during the period 1995-2006, less than 15 percent of patent applications and less than 10 percent of patents approved corresponded to Chilean residents, firms or institutions. Individuals and then companies received the most patents awards, while universities received only 6 percent of patents (Table 2.1). This contrast significantly with the experience of innovative economies, such as Korea, Singapore, Taiwan, Israel, Ireland, Sweden, where the level of patenting has grown significantly and their respective governments identified it as a priority and supported it accordingly. Licensing receipts over the last five years have been 0.5 percent of GDP, half the levels of more advanced knowledge economies with a strong natural resource base such as New Zealand.

What explains Chile's underperformance in innovation outputs? Chile's underperformance in the outcomes of innovation is both the result of a lackluster performance in its innovation inputs and inefficiencies in their use. Public budget funded R&D tends to be oriented to pure academic activity and, until recently, it was not expected to result in patentable inventions. Enterprises in Chile spend relatively little on innovation as a share of turnover as noted earlier.

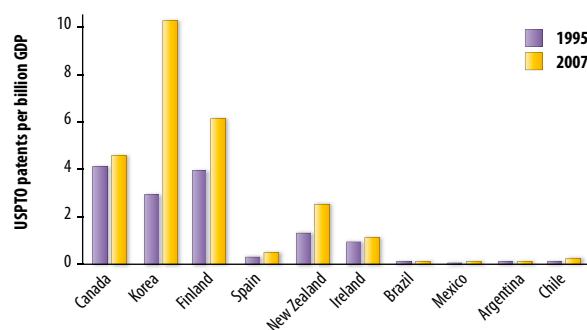
Research analysis shows that economic structure is only partly responsible for this outcome. Applying Chile's economic structure to other countries and using the OECD average R&D levels for those sectors indicates that R&D investment in Finland and Korea would fall by two-thirds but countries such as Australia would reach 90 percent of their present level, which is about three times that of Chile (Rodriguez-Clare and Maloney, 2005). See Table 2.2.

Figure 2.1: Innovation Effort of Firms (% of turnover 2000)



Source: Authors' elaboration based on enterprise innovation surveys in Europe and Chile.

Figure 2.2: Patents Registered in the US: Chile and Comparator Countries by Inhabitants (1995 and 2007)



Source: USPTO and authors' estimates.

Table 2.1: Patents Granted to Chilean Nationals by the Department of Industrial Property (1994-2005)

Applicant	Number	Percent of total
Total	194	100.0
Individuals	111	57.2
Firms	65	33.5
Universities	12	6.2
Research centers*	6	3.1

*Includes foundations.
Source: Academy of Sciences.

Table 2.2:
Simulated Aggregate R&D Investment Rates, (1995-99 average)*

Country	Estimated R&D investment rate using Chilean structure (%)	Observed rate (%)	Estimated/observed (%)
Australia	0.7	0.8	89
Canada	0.7	1.1	65
Germany	0.4	1.7	26
Spain	0.2	0.5	51
Finland	0.8	2.1	37
Italy	0.5	0.6	84
Korea	0.6	1.9	33
Netherlands	0.6	1.2	51
Sweden	1.4	3.0	48
United States	1.1	1.9	57
Average OECD	0.8	1.4	57

* Using OECD Sector Investment Rates and Chilean Structure.
Source: Rodriguez-Clare and Maloney (2005).

The other critical determinant of the low level of Chile's innovation outcomes is the large inefficiencies in the way in which innovation resources are utilized within the national innovation system, e.g., the relative efficiency of transforming R&D investments into commercial patents. Based on Bosch et al. (2005), Figure 2.3 presents the elasticity of patents granted in the US with respect to R&D investments in Chile and other comparator countries from 1963 through 2000.⁶ The regression controls *inter alia* for exports to the US and economic structure.

The negative value for Chile suggests that the country underperforms in patenting efficiency relative to the OECD average as observed in most countries in Latin America.⁷ Further estimations by Bosch et al. (2005) indicate that the main explanation for the inefficiency in Latin America (measured as a whole) was inadequate collaboration between the private sector and the knowledge generating community.⁸ This also appears

to be a very important challenge in Chile where efforts to enhance collaboration between industry and universities are fairly recent as further discussed below.

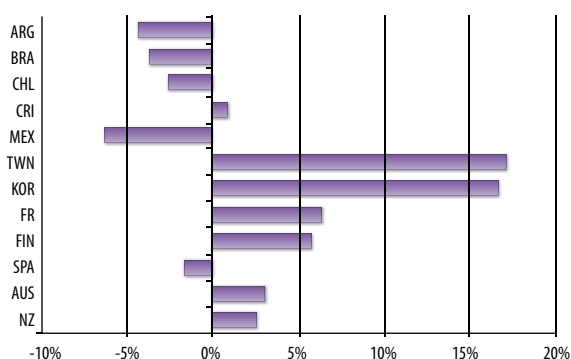
The remainder of this chapter analyzes the factors and incentives that have contributed to inefficiencies in the use of Chile's innovation resources and slowed down technology transfer and commercialization. The causes behind the underperformance on innovation inputs have been analyzed extensively in the literature on Chile's innovation system and are beyond the scope of this report (Benavente et al. 2005, OECD 2007 and World Bank 2007 and 2008). Moreover, the strategy for the national innovation system formulated by the CNIC also discusses them and proposes recommendations to increase innovation inputs and close the gap with other knowledge economies. Rather, this report focuses on the determinants of the large inefficiencies in the use of the limited innovation inputs.

6 The analysis uses data from the US Patent and Trademark Office since the US is the principal locus of patenting activity in the world.

7 See Bosch et al. (2005) for a detailed discussion of the methodology used.

8 This result was derived by estimating a patenting function that includes the interaction between R&D investment and a dummy variable for Latin America and several explanatory variables including the extent of collaboration between private firms and universities as measured by the Global Competitiveness report.

Figure 2.3: Efficiency of R&D Expenditures
(Results of a regression of patenting levels in the US on R&D)



Source: Bosch, Lederman, and Maloney (2005).

2.2 NIS Gaps that Retard Technology Commercialization

As the evolutionary innovation theory argues, innovation systems are complex and dynamic milieus that require the active interaction of many actors and a supporting institutional framework that coevolves together with industry's innovations (Nelson 1992). While many factors and incentives have affected Chile's capacity for technology commercialization and the efficient application of its innovation-related resources, the main ones can be classified into four key areas: insufficient articulation between the productive sector and knowledge centers, underdevelopment of the institutional and policy framework for intellectual property management, weak public technology institutes, and inadequate institutional and financing mechanisms to encourage the formation of new technology firms.

Weak articulation between the productive sector and knowledge centers

The relationship between industry and knowledge centers, i.e., universities and research centers, lies at the heart of many innovation networks, but despite recent promising developments, these alliances are at an incipient stage in Chile. Differences in culture between industry and universities, which have been common in many OECD countries, are also present in

the Chilean context but in a more acute form. Existing incentives in universities and research institutions in Chile have not favored collaboration either. In addition, until recently, public initiatives in support of innovation had not recognized the importance of these linkages so public support had been quite limited. The main shortcomings that discourage collaboration are further discussed below.

First, the incentives and reward structure of academics and researchers in Chile has not favored collaboration. The emphasis in publishing on academic journals has been useful in promoting research quality but has not rewarded any productive use and commercialization. Technology transfer to local industry always requires both knowledge of the commercial world which is largely missing in Chile's universities and far more direct interactions than publishing. The culture of disclosure in the academic world can also often conflict with the culture of trade secrets prevailing in the business world.

Second, the system has not facilitated the appropriation of benefits emerging from technology commercialization. While universities' rules on intellectual property rights are becoming more open and permissive in Chile, some universities do not allow researchers to benefit from the royalties arising from the research output or the sharing of benefits by researchers is very moderate. In some cases, university policies establish that royalties will be determined on a case by case basis by a board which generates high uncertainty to the researcher, diminishes transparency, and creates an additional hurdle in the already challenging process of commercializing knowledge. Limited sharing of benefits and uncertain rules discourage collaboration and commercialization of research ideas. Also, performance at universities and career progression for its academic staff is still solely determined by publications and teaching.

Third, public attention to these issues was limited until recently and the focus of many public programs has been misguided. The principal sources of research funding for universities – institutional funding and CONICYT's funding – have traditionally given more emphasis to basic research (rather than productive or commercial oriented research) as is generally the case in many OECD countries. The missing ingredient is pre-competitive collaborative research – sometimes called applications

oriented research and containing some pure and some applied elements - which has received far more attention from public budgets elsewhere. Applied R&D funds programs at InnovaChile (pre-competitive funds) and CONICYT (FONDEF) have received a small share of the budget. More importantly, the project-based emphasis of FONDEF and similar initiatives under CORFO was unlikely to produce R&D with significant impact (Table 2.3). Barring a few exceptions (e.g., a few undertakings by Fundación Chile and collaborations between CODELCO and Nippon Mining, large scale public-private research collaborations of impact were almost negligible until 2004 when CONICYT, CORFO and FIA jointly established a program to foster such initiatives.

These collaborative programs have funded more than nineteen consortia or strategic alliances for up to five years and were one of the first collaborative R&D experiences to be launched in all of Latin America. CORFO launched another call for consortia in the energy sector in 2008. Although these are positive steps, the consortia remain small. Overall funding to applications oriented research

(consortia, FONDEF and the Pre-competitive Program) in the 2007 budget law amounted to about 22.8 billion, a moderate amount compared to more than 120 billion pesos allocated for basic research, although the latter is probably an upper bound.⁹

CONICYT has also been supporting Regional Cooperative Research Consortia, which are being gradually established in all regions in conjunction with regional governments, universities, and private enterprises. Broadly speaking, regional consortia have taken longer to become operational due to capacity constraints and have demanded greater oversight from CONICYT.

Overall, these consortia programs have provided the first step along the road to conducting strategic research, but a number of issues have emerged that will need to be addressed in future public support initiatives. *First*, there is duplication of research objectives among some alliances (e.g., in the fruit and biomedicine alliances). *Second*, while some alliances (e.g., in the fruit and bio-mining areas) were strongly aligned to the needs of

Table 2.3:
Main Programs to Support Technology Transfer and Commercialization

Innova Chile/CORFO	CONICYT
IP-management	
<ul style="list-style-type: none"> • IP Protection Program • Enterprise Innovation program (support for licensing in) 	<ul style="list-style-type: none"> • Fostering IP-Protection (PBCT)
Development of new knowledge-based companies	
<ul style="list-style-type: none"> • Creation and strengthening of incubators • Angel investor networks • Seed capital lines • Risk Capital for innovative SME* 	
Strategic partnerships for applied oriented research	
<ul style="list-style-type: none"> • Consortia pre-investment and development** • Business consortia • Pre-competitive innovation 	<ul style="list-style-type: none"> • Strengthening industry-science linkages** (PBCT) • Regional partnership initiatives • FONDEF
<p>Source: Authors' elaboration. *Executed by another department. **Initially launched as a joint initiative among CONICYT, FIA and InnovaChile.</p>	

9 This amount includes *inter alia* resources allocated to FONDECYT (28 billion), core funding (9), and universities (75 billion). The last is based on an estimation of the share of funds allocated to higher-education institutions that is devoted to financing R&D according to the Canadian rule. It is possible that these amounts include some level of funding for applied research.

economic sectors, others (e.g., in biomass conversion, food, nutraceuticals and botanic drugs) were not.¹⁰

Third, many of them do not have a critical mass of researchers and R&D infrastructure to become strong technology platforms. These consortia have not yet been able to bring together existing research capabilities in Chile, since many of them have only incorporated a single university or research center. Consortia should be able to integrate most of the researchers working in relevant areas rather than only those from one university as the academic system rarely achieves either critical mass or covers the full range of relevant technologies if only one university is involved. Public technology institutes could also participate more actively in the consortia. In addition, the consortia have not built strong alliances with international research centers in similar fields that can complement local capacities and integrate Chile globally. The Fruit Technology Consortium, for example, comprises 29 partners, including the exporters' association, and a diverse group of large, medium and small fruit exporters and producers. Its core activities are to develop new fruit varieties that can respond to the increasing requisites of international markets. The *Pontificia Universidad Católica de Chile* is the only research institution participating in this strategic alliance. While its objectives are closely linked to sectoral needs, it lacks the critical mass to make an impact (InterLink Biotechnologies 2008)¹¹. *Fourth*, there is inadequate awareness and experience on management of intellectual property (IP). Future initiatives will have to overcome the aforementioned challenges.

Fifth, while these efforts were initially launched as a joint initiative between CONICYT, CORFO and FIA, the three organizations are now managing their own programs. The question arises as to whether it would be more effective for a single organization to take the prime responsibility for these critical programs to avoid duplication and dispersion of efforts.

Underdeveloped IP management culture and supporting institutional infrastructure

Patenting and licensing are critical channels to transfer and commercialize knowledge, but the IP culture and

supporting incentive and institutional framework are barely developed in Chile. As earlier data indicated, the level of patenting by Chileans at the international level is almost negligible despite recent increases, and Chile lags OECD countries in transforming research investments into patents (Figure 2.3). Some universities in Chile have started to change their policies on IP management and increased IP commercialization benefits for researchers, but a culture of technology transfer has not been actively promoted in universities and university funding does not provide the incentives to encourage such activities. Technology transfer offices (TTOs) in universities are at a nascent stage and the capacity for provision of IP protection and commercialization services in the private sector is very limited as well.

In addition, the less than adequate performance of the Department of Intellectual Property at the Ministry of Economy and lack of endorsement of international IP treaties made the process of IP protection more cumbersome discouraging it. Until recently, policy-makers did not realize the potential benefits that could be derived from IP commercialization and consequently public initiatives to stimulate IP education, protection and commercialization were limited.

Technology transfer offices at universities: Leading universities in Chile have recently started to build technology transfer offices (TTOs) to manage their IP assets and other interface activities with the productive sector, but their skills, experience and outcomes vary widely and are not yet performing at international levels. The main problems identified include insufficient skills in intellectual property and licensing; limited networks of contacts both at home and abroad; very limited funding which affects their staffing and their access to legal services and necessary contacts and travel;¹² uncertainties in the royalty and reward structure applied by some universities as noted above; lack of commercial focus by some TTOs; and difficulties in connecting to the international patent system. Insufficient demand for their services by both universities and industry also poses a challenge to the development of these new TTOs. A pragmatic approach was followed in the case of OTRI, where five leading universities comprising 43 percent of

10 See InterLink Biotechnologies, LLC (2008).

11 The consortium will face another challenge given that an appropriate regulatory framework for the development of GMO products is not in place (Inter Link Biotechnologies 2008).

12 Some TTOs have just two professionals.

the research conducted by universities in Chile and two private sector associations came together to establish a TTO, but it has not been effective enough due to limited resources and staff.¹³

Besides TTOs, some universities have established other units to interface with the business community, but experiences of this type are still limited in Chile. A few examples follow. DICTUC, a company set up 70 years ago by the *Pontificia Universidad Católica de Chile*, is a sort of broad TTO, providing advisory and certification services, training and incubation and spin offs (mainly of campus related activities). Yet, its effectiveness is hampered by several constraints. It has to rely on funding on a project by project basis and does not have many experts in intellectual property and licensing even though the project team is expected to take the project through commercialization. Also, the company is still in the process of developing objective project selection criteria to enhance its commercial orientation. The Universidad de Concepción has also set up a technology development centre (*Unidad de Desarrollo Tecnológico or UDT*) in wood, a core economic activity of the region, and so has the *Universidad Adolfo Ibáñez*. UDT has made significant progress in developing technologies for license, but interesting the Chilean industry in new technologies is proving difficult.

Overall, TTOs appear to run on minimal budgets and to survive through external funds they can access from either public or private sources. The predominant mandate to TTOs appears to be a permissive one – staff are encouraged to pursue the TTO mission energetically but with the proviso that there will be no additional resources provided from the core funds of the university. That is, they must fund their work through external resources either by participating in specific publicly funded programs or by attracting donations or building alliances with private sources. While self funding of their activities is a laudable aim in the medium term, international evidence suggests that an initial period of investment is needed before the breakeven point can be reached.

In part, this stance is a pragmatic one of not wishing to overcommit the institution to a new agenda, but in part, it also reflects the fact that the *third mission* of universities – activities related to the needs of society in general and the productive sector in particular – has not yet been fully legitimized.¹⁴ Giving legitimacy to these activities in Chile appears to be a work in progress. The willing academics are becoming more active, but the majority of academics are still to be persuaded of its legitimacy. Working to consolidate the legitimacy of this activity needs to become a priority and pursued vigorously by the country's Rectors with the active support of the CNIC, the Ministry of Education and the Ministry of Economy as the Chair of the Inter-ministerial Committee on Innovation (ICI). The engagement of public technology institutes in IP management was also minimal in the past. INIA, for example, the largest public technology institute held no patents prior to 2002 as further discussed below.

Private technology brokers¹⁵: Competence in the private sector for IP management is also scarce. There is only one enterprise in Chile that currently provides technology brokering services, and its level of activity on technology transactions is limited. This is consistent with the very small number of Chilean firms that either generate their own IP or base their business strategy on the acquisition of IP from external sources. Most Chilean firms source their technology from capital goods providers who offer services to install and train their staff in the use of the new equipment (Figure 2.1). Others, for example, rely on assistance from their customers, especially those in tight supply chains, and others build their businesses on incremental improvements in technical practice that are not suitable for protection through the IP system. Very few rely on external licensing.

Technology markets around the world tend to be incomplete relative to markets in products or services, but the existence of private technology brokers in some countries has facilitated trade in technology by helping to overcome some of the market failures (e.g., information asymmetries and cognitive aspects) that hold back

13 OTRI sponsors comprise: *Pontificia Universidad Católica de Chile*, *Universidad de Concepción*, *Pontificia Universidad Católica de Valparaíso*, *Universidad Católica del Norte*, *Universidad Técnica Federico Santa María*, *Asociación de Exportadores de Chile (ASEXMA)* and *Confederación de la Producción y del Comercio (CPC)*.

14 The *first* and *second* missions concern the training of human resources and scholars and the accumulation of knowledge. These will be further discussed in Chapter 3.

15 Technology brokers are service providers for patent processing, IP consulting and transactions, and licensing services. However, some complement these services with other activities such as business development from patents, IP merchant banking, or patent portfolio building.

the development of such markets (Cesaroni 2004).¹⁶ First, the tacit nature of technological knowledge causes information asymmetries among organizations and encourages opportunistic behavior, increasing transaction costs and reducing technology trade. Second, the existence of such information management problems leads some organizations to internalize it vertically, but this requires extensive R&D resources which is not a feasible option for many companies. In addition, efficient technology transfer requires some firm-level conditions and in-house absorptive capacities to be satisfied.

The experience in the United States has shown that technology brokers or agents with highly specialized technical knowledge as well as specialized negotiation and contractual skills in knowledge processes can help address these two market failures and allow companies to acquire new technologies through arm's length contracts. Besides their pivotal linking role, technology brokers have proven to be knowledge repositories capable of transforming existing ideas into technical solutions that respond to the specific needs of enterprises.

By facilitating the development of IP intermediaries and thus licensing, Chilean firms with weaker technology competences and R&D constraints would gain access to knowledge that allows them to improve their existing processes and products and, more importantly, enter into new product markets. Chilean firms conducting their own R&D would also gain from a more active technology market by being exposed to a wider range of cutting-edge technologies that complement their technology portfolios. Some of them would face the opportunity to commercialize their own technologies, encouraging them to further invest in R&D.^{17,18} Given the government's interest in enhancing technology transfer and commercialization as part of the broader national innovation strategy and the current thin market in technology transactions, the policy question arises as to whether the government can help jump start such a market in technology transactions and how to do it.

IP registry institutions and IP enforcement: The institutional framework for IP registry was fragmented and services did not keep up with international practices. Until 2009, the Department of Industrial Property (*Departamento de Propiedad Industrial*) under the Ministry of Economy was responsible for reviewing patent and trademark applications, granting titles and certificates relative to patents and trademarks, maintaining a registry on patents and trademarks, and acting as the first level to resolve disputes regarding the validity and granting of patents and trademarks. Appeals against resolutions issued by the IP department have been the responsibility of an independent IP Tribunal, accountable to the Supreme Court. Two separate institutions – *Departamento de Derechos Intelectuales* or Intellectual Property Rights under the Ministry of Education and the *Servicio Agrícola y Ganadero (SAG)* or Agriculture and Cattle Service under the Ministry of Agriculture – were responsible for the registry of copyrights and registry of new plant varieties. The division of responsibilities among several institutions complicated the management and processing of IP rights and thinly spread limited IP resources.

These entities have performed below international standards according to users and INECON (2007). Less than adequate funding has adversely affected their performance and generated a considerable application backlog (estimated at about 20,000 applications at the Department of Industrial Property). Reportedly, it takes about six years to grant a patent on average, where the norm in other countries is 1 to 2 years. The IT system of the Department of Industrial Property improved in recent years, but its capacity could not support an expeditious handling of applications and research on patents, and it is not user friendly. Part of the patent database was not available on electronic means and many procedures were handled manually instead of electronically. Staff was insufficient and not experienced enough on IP and did not have regular access to training to maintain and upgrade skills (INECON 2007). The lack of adequate links to the regions has also hindered the patenting process. In sum, the lackluster performance of the department did not facilitate nor encourage patenting activity.

16 Market failures in technology trade can also arise from weak protection of intellectual property rights, which is addressed in the following section.

17 Using a sample of 96 chemical corporations from Europe, Japan and the United States, Cesaroni (2004) shows that the existence of dynamic technology markets affects firms' technology sourcing decisions and their propensity to enter into new product markets.

18 Very few high-tech companies around the world, e.g. Qualcomm, rely almost entirely on their IP assets, but there are a number of well established high-technology companies such as Texas Instruments or IBM that derive an important percentage of their earnings from IP commercialization.

To start addressing these gaps, Law 20.254 was enacted in 2008 converting the Department of Industrial Property into the National Institute of Industrial Property, as a decentralized agency under the Ministry of Economy. The new structure grants the institute greater flexibility to operate and financial independence which is expected to lead to an improved performance. The law also grants the institute greater responsibility for disseminating and promoting intellectual property rights, rather than being a mere registry. The institute became operational

in 2008 and is currently in a transition phase. It faces the challenge of becoming a modern and well functioning organization in line with best international practices in the IP field. The IP registry system, however, remains fragmented.

The enforcement of IP rights remains challenging even though the authorities have increased the number of staff assigned to resolve IP rights, and coordination among institutions engaged in IP enforcement is less than

Box 2.1 International Cooperation Treaties on Intellectual Property

The **Patent Cooperation Treaty** was set up by the World Intellectual Property Organization (WIPO) in 1970 to allow countries to cooperate in the filing of patent applications internationally. It has the benefit of simplifying and reducing the cost of obtaining patent protection in a large number of countries by postponing translation costs and decisions on the selection of countries. Since 1970 many countries have enacted the necessary national legislation to enable them to participate. There are more than 140 contracting states and Chile only became a member in March 2009.

Twelve months after making the initial patent application, an application with a set of claims can be made through the Patent Cooperation Treaty (PCT) system which is accessed through national patent offices or the international bureau of WIPO in Geneva. The application is sent to an examining office, i.e., one of the major patent offices appointed by the PCT assembly, and an international search is carried out. Applications can be made in English, French, Spanish, German, Russian, Japanese or Chinese and the office will deal with the applicant in the language chosen. Thus, no translations to various languages are needed at this stage decreasing costs to the applicant. The application, together with an international search report, is then published after six months. The written opinion that accompanies the international search report is not published.

The patent specification is now in the public domain and accessible on the Internet. The search report and written opinion can be used by the applicant to assess the chances of a patent grant or to refine the patent claim so as to have an easier passage through the next phase, examination in a national system such as the US or a regional system such as the European Patent Office. In practice, the PCT system allows applicants to delay for up to 30 months before making the selection of countries in which patents should be sought, appointing local patent agents in each foreign country, preparing the necessary translations, and paying national fees. In addition, if the international application follows the PCT required, the application cannot be rejected on formal grounds by the national offices. Overall, the PCT system facilitates the patenting process, in particular more speculative R&D projects where it may take time before the commercial prospects become clear.

Chile's patent office can also benefit from the treaty. Its work could be substantially reduced due to the international search report and accompanying written opinion.

Madrid Protocol for the International Registration of Marks: The Madrid protocol was established by the WIPO in 1989 and 78 countries have already adhered to it. This system offers a trademark owner the possibility to have the trademark protected in multiple countries by filing a single application in his or her national or regional office, rather than translating it to multiple languages and paying the application costs in several countries. The trademark offices of countries within the Madrid protocol have a limited time to indicate the possible refusal of the trademark. If such refusal is not issued, the trademark is considered registered in those countries. The system also simplifies the subsequent management of the trademark since it is possible to renew the registration through a single step.

The Hague System of International Registration of Industrial Designs. The Hague system was also established by the WIPO and operates in a similar manner to the Madrid protocol.

Source: WIPO and authors.

satisfactory (INECON 2007). Penalties for infringement appear to be low and likely inadequate to deter such behavior. Nor have there been programs to educate the Chilean public into the role of IP in international competitiveness so consumers do not exert any pressure on firms in this regard.

Adherence to international cooperation treaties pending. Until March 2009, Chile remained one of the few countries that had not adhered to the Patent Cooperation Treaty system making patent filing more burdensome. The Treaty, established by the World Intellectual Property Organization in 1970, allows countries to cooperate in the filing of patent applications internationally, with the benefit of simplifying and reducing the cost of obtaining patent protection in a large number of countries (Box 2.1). More than 140 countries are signatories. Similarly, Chile has fallen behind in relation to international filing of trademarks and designs by failing to implement the Madrid and Hague protocols, respectively.

Limited public initiatives to educate and stimulate protection of intellectual property rights. Traditionally, policy-makers had not given much priority to IP protection as a means to facilitate commercialization of knowledge, and consequently, there were very few public initiatives to educate the public, researchers and the business community and raise awareness. Direct funding of universities did not foster IP protection and commercialization either, and other public funding initiatives to stimulate demand for IP protection have been limited and isolated (Table 2.3).

In recent years, for example, InnovaChile initiated a program that provides partial financing of costs associated with the processing of intellectual property rights, *inter alia* inventions, industrial designs, plant varieties, software and other digital applications, and defense of these rights vis-à-vis third parties. The program covers up to 80 percent of the costs with a ceiling of 50 million pesos (approximately US\$75,000) and allows five years for its implementation.¹⁹ Enterprises, technology centers, universities and individuals can apply to the program but are required to do so through an advisory entity on intellectual property rights, that is, an entity that has been qualified by InnovaChile as having the

requisite financial capacity and expertise. In principle, the mandatory leading role of entities with the relevant expertise in the application process helps InnovaChile in the pre-screening of viable projects. However, it could potentially raise some conflicts of interest since these advisory entities are ultimately the service providers to the party interested in protecting his/her intellectual property rights and they could hold the latter captive to their services even if the final beneficiary is not fully satisfied with them.

CONICYT has also implemented some small initiatives to support the intellectual property process (Table 2.3). It has conducted competitions inviting institutions with expertise on intellectual property rights to conduct patenting contests. The two calls for proposals carried in 2004 and 2005 have led to a total of 15 patenting contests where 93 projects were selected to receive financial support (up to 25 million pesos per proposal) for patenting. These contests were useful in starting to raise awareness on patenting among the research community, professionals and enterprises. Far more seems necessary.

Unrealized potential of technology institutes

Chile has a fragmented set of technology institutes with an uneven performance. They are generally linked to a ministry and mostly located in Santiago with a few regional offices (Table 2.4). While they are all classified as technology institutes, their public missions and functions vary markedly. Some are more focused on technology transfer and technology diffusion, and others are primarily focused on generating information on natural resources and other national strategic issues for regulatory purposes and, in many cases, for dissemination to relevant producers as well (Table 2.5). Over two-thirds of their funding resources come from the public sector.

Many of them are perceived as inefficient and face the challenge of aging staff and retaining young qualified staff since they are not able to compete with salaries in the private sector. Any effort to enhance their performance needs first to take account of their mission and the different public goods they can offer.

¹⁹ Peso conversion 660.

*Table 2.4:
Technological Institutes*

Institute	Ministerial association	Budget	Staff (researchers)
Air Photographic Service	Defense	1145	257
Agriculture and Livestock Institute (INIA)	Agriculture	17646	1046 (55)
Agricultural Research Fund (FIA)	Agriculture		
Chilean Antarctic Institute (INACH)	Foreign Affairs	2161	28
Chilean Nuclear Energy Commission (CCHEN)	Mining	6115	300 (120)
Fisheries Promotion Institute (IFOP)	Economy	7052	440 (89)
Fisheries Research Fund	Economy		
Forestry Institute (INFOR)	Economy	2636	74 (44)
Fundación Chile (Private foundation)		12241	300 (n.a.)
Hydrographic and Oceanographic Service (SHOA)	Defense	2870	273 (-)
Military Geographical Institute (IGM)	Defense	3612	316 (-)
Mining and Metallurgic Research Center (CIMM)	Mining	1500	50 (45)
National Hydraulic Institute (INH)	Public Works	750	61 (14)
Natural Resource Research Institute (CIREN)	Agriculture	n.a.	n.a.
National Service for Geology and Mining (SERNAGOMIN)	Mining	5831	313 (51)
National Standardization Institute (INN)	Economy		73 (-)

Source: Advansis and Secretariat of the CNIC.

INIA, dedicated to enhancing the productivity of the agricultural sector, and Fundación Chile, a private foundation, are the two largest in terms of funding with nearly 45 percent of total resources budgeted annually. The public sector constitutes INIA's main client, but the institution has gradually increased its interaction and the number of joint projects with the private sector. It provides extensive training and knowledge dissemination activities to small producers. Most of these activities, however, are oriented to traditional sectors in agriculture with very little impact on the newer export clusters with higher value added potential. R&D activities have increased in recent years from very low levels, and the institution has started to patent some of the outcomes. Prior to 2003 it held no patents. About 5 percent of its staff is engaged in research, but the incentive structure constraints the institute's capacity to retain highly qualified staff and thus its potential impact.

Fundación Chile is the most prominent of all the institutes having received international recognition. It is a non-profit organization that was founded in 1976 by the Chilean government and the ITT Corporation with the mission of transferring state-of-the art technology and skills to priority clusters in alliance with local and international networks.²⁰ It has a mixed public-private sector board with 11 members, five of which correspond to the private sector.²¹

Fundación Chile has created over 30 companies, developed technology consortia with universities and private companies, adapted state-of-art technology for product and process innovation in the public and private sectors, and promoted technology diffusion to small and medium enterprises. It is best known for the pioneering of salmon firms in Chile that was critical to the take off of the sector, but its impact has also been important in

²⁰ In 2005, Billiton, Escondida Mining, became a co-founding partner.

²¹ The public representatives include CORFO's executive vice-president, the President of CONICYT and three other experts appointed by the President of the Republic.

other economic sectors. Today, its areas of intervention are agribusiness, marine resources, forestry, environment and energy, ICT, and education. Fundación Chile's early withdrawal from some of the companies it founded did not allow it to benefit from their subsequent expansion, which has constrained its resources and its capacity to grow in a substantial way.

Financing and institutional shortcomings in the promotion of knowledge-based enterprises

Generating new firms based on the findings of research and development is crucial to technology commercialization in Chile. This process is notoriously challenging worldwide, even more so in emerging markets such as Chile. The difficulties concern the articulation of funding from the research idea to the various development phases that a new enterprise undergoes -- and possibly its eventual listing on the stock exchange -- as well as the provision of broader incubation support during the early stages of the new enterprise (Figure 2.4).

The funding difficulties start at the early proof of concept and prototyping stages as this work is beyond the remit of the research grant funders and well before any external investor can appraise the likelihood of commercial value and proceed with the investment. Even after this stage is successfully passed, there have been significant gaps in start up finance as there are good reasons why the traditional sources of funding are reluctant to play their normal role. There are inevitably technology risks which deter investment when comparing the opportunity to traditional and established businesses. Additional areas of risk include: timing -- it takes longer to develop a novel product than an established product; commercial -- even if the product does what it says, the market may not adopt the innovation for several reasons not least of which is inertia; and, experience -- the entrepreneur is new to business and the team is usually unproven.

Not surprisingly, the financing market for new technology based companies in Chile remains at a nascent stage despite the growth observed over the last three years--a growth that is explained to a large degree by the new public financing instruments (Table 2.6). According to GEM's estimates (2008), the venture capital (VC)

Table 2.5: Technological Institutes and Research Foundations

Institute	Technology transfer	Information Services	Regulation/Certification
Air Photographic Service	*	✓	✓
INIA	✓	✓	
FIA	*	✓	
INACH	*	✓	
CCHEN	*	✓	✓
IFOP	*	✓	✓
Fisheries Research Fund			
INFOR	*	✓	✓
Fundación Chile	✓	✓	
SHOA		✓	✓
IGM		✓	✓
CIMM	✓	✓	✓
INH	*	✓	✓
CIREN	*	✓	
SERNAGOMIN	*	✓	✓
INN	*	✓	✓

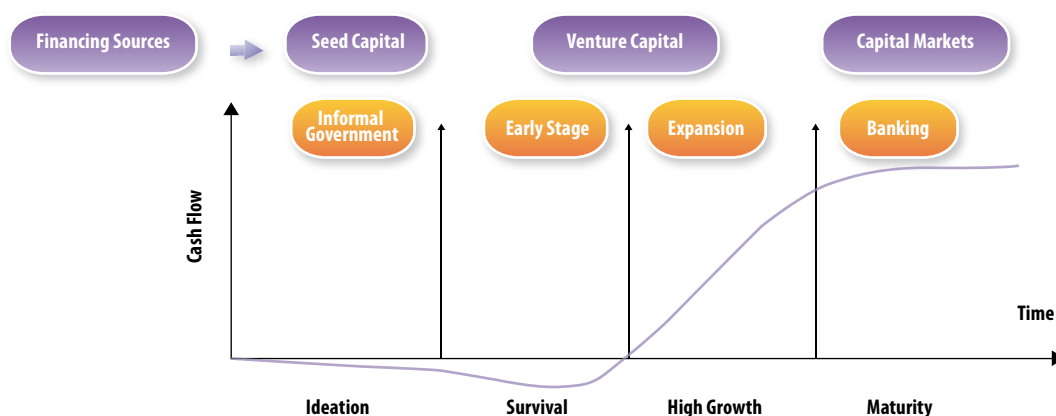
*Some moderate level of technology transfer activities conducted.
Source: Advansis and authors.

market was close to 200 thousand million pesos in 2007 compared to about 90 million pesos at the beginning of the decade, including public financing, but seemingly, only a small share of the market has been channeled to knowledge- or technology-based companies.²² Venture funds appear to have prioritized traditional businesses areas, given their greater familiarity with them and perceived lower risk. In addition, the deal flow of knowledge-based companies seems to be relatively low. GEM estimates suggest that the deal flow is probably small compared to the available venture financing, but financing for technology-based ventures is still difficult to come across in the early stages.

The Government of Chile has tried to stimulate the growth of this market through reforms to the capital markets law as well as the provision of financing for

22 Other authors suggest estimates closer to 130-150 million pesos.

Figure 2.4: Lifecycle of New Enterprises



Source: Authors.

seed capital, angel investors and venture capital funds. The capital markets reform of 2001 liberalized investments of mutual and investments funds and insurance companies and provided fiscal incentives to companies listed in Chile’s emerging market, but this reform had little or no impact on the venture capital industry. The capital markets reform of 2007 contained more direct and aggressive measures to spur new venture financing, including tax exemptions to capital gains from seed and VC funds²³; and an extension of fiscal incentives to the emerging market for another 8 years, which could eventually become an exit strategy for VC fund investments. It also opened the way for CORFO to further promote the VC industry by authorizing it to directly invest in VC funds (up to 40 percent of capital).

Presently, CORFO has three complementary programs to support financing of new enterprises: seed capital, angel investor networks and venture capital programs. The first two are administered by InnovaChile. The *first* program (seed capital) was established around 2002 with two complementary lines to entrepreneurs and enterprises with less than 18 months of operation. The first line offers grants for feasibility analysis (up to 80 percent of projects costs and a limit of 6 million pesos), and the second line offers grants to initiate the seed capital project (up to 80 percent of costs with a maximum of 40

million pesos). Project proposals have to be presented through “sponsors” certified by InnovaChile. There are about 28 sponsors, most of which are incubators linked to universities.

The 2008 evaluation of the seed capital program pointed to several gaps (SERCAL 2008). First, the program has not had a permanent monitoring process of key performance benchmarks. The evaluation also suggests that most projects were not technology based; performance of sponsors varied markedly; sponsors appeared to apply different pre-selection criteria; and

Table 2.6: Evolution of Venture Capital in Chile (Thousand million pesos)

Accumulated investment	2001	2005	2007
Seed capital	0.2	3.1	8.9
Early stage VC	0.0	0.6	1.7
Growth VC	6.7	20.0	49.3
Late stage VC	84.4	77.8	146.4
Total	91.3	101.5	206.3

Source: GEM (2004).

²³ The incentives apply up to 2022.

they often lacked relevant expertise (SERCAL 2008)²⁴. Interviews conducted by the evaluators indicated that only 25 percent of “sponsors” prioritized technology-based projects as opposed to projects with commercial innovations and the concept of technological innovation also differed among them. A large number of “sponsors” appeared to focus on their subcontracting role for InnovaChile, rather than on building networks to help link the new ventures to the market and identifying additional financing for subsequent stages. The program does not contain incentives to foster leverage of additional financing.

A *second* program, started in 2006, has tried to catalyze the formation of angel investors’ networks to provide financing to companies in their early stages of operation -- the financing stage which currently seems to face the biggest gaps in Chile. The program finances the initial coordination and operation of angel investors networks for up to 3 years and 180 million pesos. It has supported the operation of the Southern Angels, the first angel investor network set up in 2004, and four other networks have been established more recently.²⁵ The program is still at an early stage but a few observations follow. The program requires the network to show a minimum cumulative net worth of participants of US\$13.3 million. This has held back the participation of potential angel investors who felt reluctant to disclose all their net worth. Also, investments of angel investors do not benefit from fiscal incentives like VC funds, even though the former are exposed to higher risks.

The *third* program, CORFO’s venture capital program, seeks to expand financing opportunities for small enterprises with high growth potential, but financing has been primarily channeled to traditional business areas rather than knowledge-based companies. The program provides a long-term credit to investment and venture capital funds that in turn invest the funds in a company through equity or debt. The credit ceiling

is equivalent to 2 and 3 times the private investment for traditional and innovative enterprises, respectively. These lines of credit have helped finance more than twelve new funds during the last four years, mainly to non-innovative projects. Following the 2007 capital markets reform, InnovaChile is considering further steps and a more pro-active role, including equity investments in knowledge-based venture capital funds.

InnovaChile has operated an incubator support program as a complementary tool to the three financing programs mentioned above, but program results have been mixed. The program offers several grant lines to facilitate the creation, strengthening and operation of incubators.²⁶ The program requires that incubators be associated with knowledge, technology centers or training centers, although most enterprises that have benefitted from them have not originated at universities or knowledge centers. In some cases, academic directors have been appointed to lead the incubators, but many have not had sufficient time or the required expertise for such a challenging task. Early on, the emphasis was on the creation of a large number of incubators throughout the country but not on impact. About 23 incubators have benefitted from the program, but their overall performance has not been strong and results have shown a wide variance. Many of them have failed to meet the targets set in their original project proposal. Some of them have emphasized their role as ‘sponsors’ of InnovaChile’s seed capital program discussed above rather than their role as incubators. However, a few of them such as Octantis and *3ie* show promise, and their business models, particularly *3ie*, could be considered for other incubators. *3ie* incorporates all of the stages of the incubation process, helps secure financing, and engages pro-actively in articulation functions, canvassing periodically the needs and demands of a few related sectors and seeking partners to provide solutions to the identified problems.

24 Performance was based on several criteria *inter alia* projects presented and approved by InnovaChile, successful number of projects on the basis of subsequent performance of the enterprises, and their access to networks and active market role.

25 The other four are *Patagonia Angels*, *Incured*, *Valor Sur* and *Angeles Sur*.

26 There are five financing lines. The first line supports the establishment of incubators and staff training and covers 100 percent of project costs for the incubator and up to 50 percent of costs of entities associated to the incubator, with a limit of 15 million pesos. The second line supports technology missions overseas and covers 100 percent of project costs and up to 10 million pesos per incubator. The third line supports technical assistance and covers 100 percent of the project and up to 15 million pesos per incubator. The fourth line supports dissemination activities and covers 100 percent of costs and up to 6 million pesos per incubator. The fifth line supports the formation of strategic alliances by incubators to achieve economies of scale and foster the adoption of best national and international practices and covers 70 percent of costs and 120 million pesos per incubator.

2.3 Conclusions

The diagnostic of Chile's national innovation system points to the need to increase resources allocated to innovation as well as to improve the incentives and institutional framework that facilitates the transformation of knowledge into new commercial technologies. The latter, however, is particularly challenging due to the lack of a strong culture of innovation in the business community and limited interest of universities on the *third mission* to date. A number of them, however, have recently started initiatives that appear to signal a change and a desire to revisit their role with regard to their contribution to Chile's society and economic development.

Over the last few years, a number of public initiatives have been put in place to support technology transfer and commercialization. Many of these initiatives are still at an early stage but an assessment of their preliminary impact suggests that changes might be necessary to enhance outcomes. Also, for the most part, these initiatives have emerged independently and thus the need to bring them under a common umbrella to enhance their complementarity and effectiveness and to secure a more systemic and coherent approach with wider coverage, both sectoral and geographic. The national innovation strategy provides an umbrella framework to guide the elaboration of a medium- to long-term plan to stimulate technology transfer and commercialization in Chile. The chapter that follows provides strategic directions and recommendations for the elaboration of such a plan.

3

Chapter 3: Fostering Technology Commercialization in Chile: Options for Consideration

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Fostering Technology Commercialization in Chile: Options for Consideration

The previous chapter highlighted that technology commercialization and the necessary institutions, incentives and competences are at nascent stage in Chile. Considering Chile's current endowments and drawing on other international experiences, the report proposes several strategic directions and recommendations to create a milieu in Chile that will be more prone to technology transfer and commercialization (Figure 1.1). Changing the culture and incentives of key actors in the innovation system and building the necessary institutions and competences will be a long-term effort. As the Association of University Technology Managers (AUTM 2002) noted:

*"commercialization of activities can take a significant amount of time...because of the time needed to develop a portfolio of intellectual property to license, build up a body of expertise and develop a **culture of technology transfer** within the institution—as well as giving licenses the time needed to develop and market products."*

The above also applies to other intermediaries in the system such as public technology institutes and private specialist providers and to the need to change the innovation culture of the business community.

That said, progress can be made with strong public commitment and consistency in public policies. Change can start now. Market failures in innovation in general, and technology markets in particular, provide

a rationale for public intervention. Progress made by more advanced knowledge economies, which was supported by public initiatives, also provides a strong argument for public interventions. Within about 10 to 12 years, Chile cannot only increase its R&D and human capital for innovation levels, as committed in the national innovation strategy, it can also narrow its gap (relative to OECD countries) on the efficiency of R&D use relative to technology transfer and commercialization outcomes such as patenting and licensing and increase

Figure 3.1: Technology Transfer and Commercialization in Chile: Recommended Areas of Policy Intervention



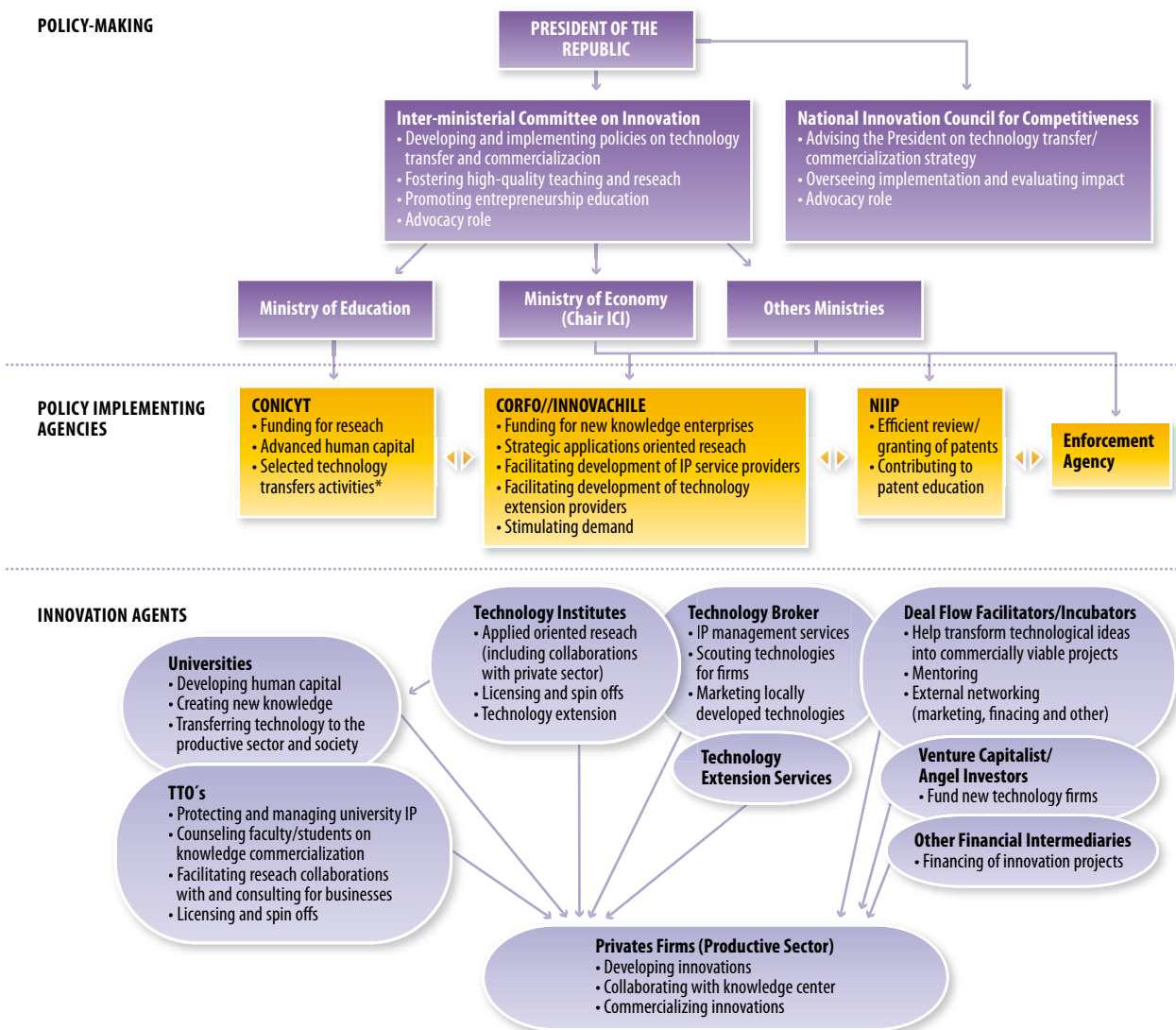
Source: Authors.

the number of knowledge-based firms (see Annex I for a set of indicative performance indicators).²⁷

There is strong public commitment to increase funding to stimulate innovation, but improvements in the technology transfer and commercialization system will

not only involve an increase in funding but also changes in incentives, funding reallocations and institutional building. Constant *communication* on the importance of technology transfer and commercialization to Chile's competitiveness and celebration of successes will also be crucial to foster a change in culture at universities

Figure 3.2: Building a Dynamic Technology Transfer and Commercialization System in Chile. Summary of Key Agents and their Functions.



Source: Authors.

*This would include inter alia collaboration with CORFO on strategic applications oriented research.

27 The human capital targets set for 2021 are (i) increase in the percentage of population between 24-34 with tertiary education from 18 to 35; (ii) an increase in IALS scores; (iii) overall increase in WEF's Higher Education and Training index (currently on position 42); (iv) an increase in full time equivalent researchers from 18,500 to 50,000; (v) an increase in the number of Ph.Ds in science and engineering from 219 to 1579 per year. The R&D targets set for 2021 are (i) an increase in total R&D from 0.68 percent of GDP in 2004 to 2.3 percent of GDP; and (ii) an increase in private R&D from 0.25 percent to 1.23 percent of GDP.

and the business community. The CNIC, the Inter-ministerial Committee of Innovation and other critical public funding agencies can all contribute to this important effort.

Increased funding will need to go hand in hand with a strong evaluation framework, especially since policies and programs to foster technology commercialization will entail learning and experimentation. Adjustments in some of the programs are likely to be necessary, and others should come to an end as market gaps are closed.

Thus, the *monitoring and evaluation framework* will be crucial in guiding the policy-making process.

The chapter proposes complementary interventions in seven key policy areas to build a more dynamic technology transfer and commercialization system (Figure 3.1), which are further discussed in the remainder of this chapter. The key agents of this system and their core functions are depicted in Figure 3.2 and the key public programs in Table 3.1 below (see also Annex I with a matrix of recommendations).

Table 3.1:
Recommended Main Programs to Support Technology Transfer and Commercialization

Innova Chile/CORFO	Others
IP-management	
<ul style="list-style-type: none"> • Program to develop a strong network of TTOs at research centers • Pilot program to seed development of private technology brokers • Enterprise innovation (including licensing in) • IP protection and commercialization • Awareness generation and IP education (in collaboration with NIIP) 	
Development of strategic partnerships for applications oriented research	
<ul style="list-style-type: none"> • Consortia pre-investment and development (in collaboration with CONICYT) • Pre-competitive innovation 	<ul style="list-style-type: none"> • Fondef (CONICYT)
Accelerating the formation of new technology-based firms	
<ul style="list-style-type: none"> • Strengthening of incubators • Pilot program to seed the formation of deal flow facilities • Early stage financing: seed capital, angel investor networks, early stage VC fund (public-private) • Programs to foster VC funds (public-private) 	
Developing the skills base	
<ul style="list-style-type: none"> • Program to seed the development of university degrees in technology management and professional associations in the field 	
Technology extension services	
<ul style="list-style-type: none"> • Program to develop and strengthen capacity of technology extension providers • Enterprise innovation 	
Nurturing universities third mission	
	<ul style="list-style-type: none"> • Direct budgetary transfers to research universities linked <i>inter alia</i> to performance on technology transfer (Ministry of Education)
Stimulating an entrepreneurial culture	
<ul style="list-style-type: none"> • Awareness generation events 	<ul style="list-style-type: none"> • Program support to help integrate entrepreneurial education throughout various disciplines in higher education institutions (Ministry of Education) • Program support to help integrate entrepreneurial education at the secondary level (Ministry of Education)
Source: Authors' elaboration	

3.1 Improving IP Management: Institutions, Regulations, and Practices

Intellectual property is the bedrock on which licensing can take place and new technologies can be developed and benefits captured by Chileans firms. Without IP protection, the benefits of commercializing innovation are limited, all of which leads to a reduced rate of innovation effort with the associated adverse impact on productivity, competitiveness and growth. All forms of intellectual property (patents, copyrights, designs, trademarks, and plant breeders' rights) can be licensed. IP management, however, is a complex process that can only thrive if there is a supporting institutional and regulatory milieu, and financial support. Government support for developing such a milieu is justified because of the extensive market failures associated with the theme of knowledge.

In the case of IP management, competences in Chile in the private sector, government agencies, universities and public technology institutes are at an early development stage because these matters have not received much attention and support in the past. The need arises to expand competences and improve incentives in this area by (i) promoting the development of key intermediaries or "technology brokers", (ii) stimulating the demand for IP services, (iii) improving the efficiency of public institutions responsible for approving, registering and enforcing IP rights, and (iv) signing of critical IP international agreements. This section discusses possible public interventions to facilitate this process. The above needs to take place in an environment where universities embrace collaboration with the business community and contributing to economic progress (*third mission*) as an integral part of their mission. The range of tools that the government of Chile can use to encourage the faster adoption of the *third mission* merits a separate discussion (see section 3.6).

IP intermediaries and "technology brokers"

Successful commercialization of technology in Chile requires the establishment and strengthening of linkages between technology developers and those who commercialize it. These linkages are generally referred to as technology brokers. In the broadest sense these professionals or organizations are intermediaries who

carry out the functions of finding technical solutions for users, finding users for new technologies, and sometimes assisting with technology packaging. Technology brokers may carry out some or all of these functions and they can range from Technology Transfer Offices (TTOs) of universities, research organizations and public technology institutes to private entities and individual technology transfer and licensing consultants.

Technology transfer offices. There is a need to rapidly develop an effective network of TTOs and upgrade the coverage, quality and depth of services provided by the currently existing TTOs to help the academic community with IP management and foster knowledge transfer generated at universities. This can include analysis of new inventions, filing of patent applications, protecting and maintaining IP rights, and licensing of IP. TTOs can also provide assistance with the formation of spin off companies. In addition, TTOs can play an important role as articulators between the knowledge and the business community, e.g., by providing consulting services and training, and facilitating technology solutions to the business community.

Strengthening the capacity of TTOs demands a pragmatic approach given the small IP market by global standards. The small scale issue could be addressed through the development of a national network of TTOs that serves the academic community rather than only those who are employed by a single university as implemented in other countries that have sought to overcome the lack of critical mass (Box 3.1). In part this is a pragmatic response to the current scarcity of experienced professionals in this field in Chile, but it is also a response to the permanent challenge of the IP world where costs outweigh revenues in all but a very few institutions around the world even though the management of IP has been widely adopted internationally. The issue of critical mass is particularly relevant in Chile where R&D capacity is thinly spread outside the metropolitan area. It seems appropriate to develop a small number, say about two (or three) TTOs in the non-metropolitan regions and a similar small number in the metropolitan area. Each of these offices can develop a service offer for all the universities in their regions and develop specific specializations that are offered across the network in a cooperative manner. Public technology institutes could join the TTO network most closely linked to its core business.

Box 3.1 International Experiences with Networks of Technology Transfer Offices

Many research universities in OECD countries are pursuing alliances as a means to offer technology transfer services in a sustainable manner. The cases of the University of London and the University Technology Enterprise Network (UTEN) in Portugal are illustrated below.

The University of London has large research intensive colleges – Imperial College and University College - with yearly research budgets exceeding US\$150 million and each has its own technology transfer office. The next tier of colleges in terms of size of research budget - including Kings College and Queen Mary College plus two others – have created an alliance called SIMFONEC. This alliance offers a full range of technology transfer office services to four colleges, each of whom has a significant research budget but insufficiently strong to sustain a full high quality service. Being within the same federated university and the same metropolitan area eases communications between the partners, but detailed regulations and rules of engagement have been put in place to ensure that the individual colleges and their academics receive the services needed.

UTEN in Portugal took the process a step further by planning to build an integrated national system of technology transfer offices to support all the country's research universities. The initiative was launched by the Ministry for Higher Education and Science as part of a broader strategy to increase the quality and research orientation of the universities through strategic alliances with prestigious research groups in leading global universities and research centers, especially in the United States. Alliances are being built *inter alia* with Harvard, Carnegie Mellon, and the University of Texas, Austin. The UTEN component draws on the expertise in technology commercialization at the University of Texas, Austin, and the Austin Technology Incubator and IC2. The strategy includes upgrading professional skills and exchange of personnel to achieve international connectivity as well as leaven experiential competences.

The University of California, a multi-campus university, also set up its TTO as a centralized structure serving all of its campuses spread throughout the state. Over time, as the demands and business opportunities at the local campuses have increased substantially, many functions have been devolved to the local campuses while the central structure has remained responsible for overall coordination.

Source: Cunningham and Harney (2006) and authors.

One major challenge under this approach will be to arrange accessibility across the partner institutions for all academic and research staff to the services that may not be located in the university where they work. An adequate design together with financial incentives can act as a powerful lever to secure that cooperation. A second challenge will be to agree on the distribution of risks and rewards for the combined operations in a way that respects the rights of all the individual parties involved. It would be desirable for the network to have a clear duty of active outreach to all R&D performing units as well as the business community, not least to promote the use of IP as a key part of all research programs. Finally, this network will not be successful unless it overcomes the problems identified in the previous chapter of limited skills and insufficient staff, lack of commercial orientation, limited funding for legal, consultancy and travel expenses, and limited networks of contacts both at home and abroad. International

networks are critical for identifying technologies and finding users for technologies developed in Chile.

Recommendation: The government through InnovaChile could launch a program to promote the formation of a strong network of TTOs within the next one to two years. The following could guide program development.

- The program should envision a move and commitment towards the sustainability of these offices understanding that this process could take 7 to 10 years. That said, it should target sustainability from its inception to prevent the problems identified with other public initiatives.
- The program could invite the TTOs to prepare a long-term development plan with clear impact indicators (see Box 3.2 below for illustrative purposes on intermediate- and long-term impact indicators).
- It could support skills development, network building at home and abroad, and outreach activities, and

could possibly finance the hiring of critical specialists that are currently missing (including professionals with marketing skills) and specialized consultants and other necessary operational costs on a declining basis.

- The temporary subsidization of critical staff and other operational costs appears necessary considering that it will take time for the demand of IP services to expand in Chile and the lag between IP service provision and revenue generation. At the same time, the lack of quality services for IP management will stifle demand growth.
- The program could be implemented in phases, e.g., two phases, where access to the next phase would be subject to satisfactory performance during the previous one according to pre-defined indicators, e.g., patents filed and granted, clients served, licensing agreements reached, and revenues raised.

As highlighted earlier, the TTOs can only thrive in a university milieu that considers technology transfer and commercialization as a legitimate responsibility and fosters it. While a range of interventions can be used to encourage the *third mission*, the development of a code of practice on IP management seems to be a priority and a highly complementary instrument to the TTOs strengthening program. Currently, IP policies and practices differed markedly across universities and only a few have incorporated policies commonly accepted in advanced knowledge economies. The code would be adopted on a voluntary basis but, if widely used, it would facilitate mobility across the academic sector; would overcome a tacit barrier to multi-institutional collaboration; and would also enable a more business like approach towards work conducted with consortia involving several universities and businesses.

Box 3.2 Technology Transfer Performance Indicators*

License agreements:

- No. of licenses executed (exclusive/non-exclusive). **
- No. of licenses that included equity.
- No. of licenses active on last day of fiscal year.
- No. of licenses executed in fiscal year licensed to start-ups.

License income:

- No. of licenses yielding income in fiscal year.
- No. of licenses yielding running royalties.
- Total license income of the institution (% attributed to running royalties, cashed-in equity, license income of all other types).

Patent-related activity:

- No. of invention disclosures received. **
- Total patent applications filed in Chile and US. **
- No. of patents issued in Chile and US. **

Start-up companies:

- No. of start-ups during fiscal year that depended on licensing of institution's technology.
- No. of start-ups during fiscal year where institution holds equity.
- Level of investments achieved by the aforementioned start ups

Licensed technologies, post-licensing activity:

- No. of licensed technologies that became available for commercial or consumer use during fiscal year.

Other:

- Income from negotiating new research agreements and other non-licensing duties. **

*Indicators are best measured as percentage of research activities conducted at the knowledge centers forming part of the TTO network.

**These could also apply as intermediate indicators.

Source: Association of University Technology Managers

Recommendation: Within the next one-two years, the CNIC could spearhead the development of such a code with collaborations from the Ministries of Education and Economy, the academic community and international experts with experience on IP management in universities. Inputs could also be sought from the commercial community as the expected outcome is clarity in how to handle opportunities for commercialization and on the responsibilities of the various parties involved. Similar codes have been developed in other countries. For example, the Government of Ireland in consultation with stakeholders developed a Code of Practice for Managing Intellectual Property from Publicly Funded Research (Box 3.3)²⁸ and a Code of Practice on the Management and Exploitation of IP arising from Collaborative Research.²⁹ See section 3.6 for a further discussion on policies and instruments to nurture universities' *third mission*.

Private technology brokers: There is a need to encourage the establishment of private intermediaries who have IP management as part of their core services, complementing the initiatives of other technology intermediaries such as TTOs. These technology brokers could help find technical solutions for users, find users for new technologies, and sometimes assist with technology packaging. In some cases, these specialist providers also engage in business development from patents and other activities.³⁰ Chilean firms and consortia conducting R&D, for example, would benefit from the services of such specialist providers since they would help reduce information asymmetries and transaction costs and increase the chances of successfully commercializing new technologies (*licensing out*). It would also expose these R&D groups to a wider range of cutting-edge technologies that complement technologies developed in-house, possibly leading them to *license in* some of those technologies. Technology brokers could also assist Chilean firms with weaker technology competences gain access to new knowledge and to improve their products or enter into new product markets by *licensing in* technologies and adopting new technology packages.

Seemingly, there is only one firm currently engaged exclusively in IP commercialization with a limited business

portfolio. This is not unusual since private technology brokers tend to be active in countries with very dense R&D activities, extensive protection of IP rights and IP management' skills and culture, and strong demand for innovation by enterprises--conditions that are not yet in place in Chile. The United States is the country with the most developed market of technology brokers; several private technology brokers are also quite active in a few other countries such as the United Kingdom. Given Chile's commitment to innovation and plans to boost firms' demand for R&D and technology services, it is rational to consider a pilot program to jump start the development of private technology brokers as part of a comprehensive technology transfer and commercialization strategy.

How can the government jump start the development of a private technology market? Developing a technology market in Chile will prove challenging, but the experience of private technology brokers in other countries offers some guidance in this regard.

- First, the number of active technology brokers in Chile is likely to be small, even after considering Chile's ambitious strategy to boost R&D and innovation. The university research community will rely to a large extent on their own TTO networks, while enterprises use both external services providers and their own networks for IP commercialization services. The experience of more advanced knowledge economies also indicates that only a small subset of enterprises seeking to upgrade their technologies engage in technology licensing (Figure 2.1). Most firms that want to upgrade their technology approach engineering firms that focus on their sector for a packaged solution including capital goods embodying improved technologies; firms seeking IP solutions tend to be a small subset of this larger body of firms.
- Second, firms that are most successful in IP commercialization tend to combine external services with some internal IP management capacity (Lichtenthaler et al. 2008).
- Third, recent attempts to overcome imperfections in technology markets through internet marketplaces

28 http://www.forfas.ie/media/icsti040407_ip_code_of_practice.pdf

29 http://www.forfas.ie/media/acsti051125_ip_code_of_practice.pdf

30 The experience of more developed technology markets indicates that the extent of functions covered by technology brokers differs. Most brokers are mainly engaged in patent processing, IP consulting and transactions, and licensing services. A few also engage in other activities, for example, more downstream activities, business development from patents, IP merchant banking, or patent portfolio building.

for technology have not succeeded (Lichtenthaler et al. 2008). These platforms were passive by nature and failed to provide potential licensees with more custom-made solutions to their technical needs by contrast to more traditional technology brokers. As

a result, these enterprises are transforming their business model combining their internet platform with far more active services.

- Fourth, the origin of such market intermediaries has been very diverse (Benassi et al. 2009).³¹ In

Box 3.3

The National Code of Practice for Managing Intellectual Property from Publicly Funded Research

In 2004, the Irish Council for Science, Technology and Innovation issued a national code of practice for managing intellectual property from publicly funded research. The code was built on a national consensus among stakeholders and designed as a user-oriented framework. It explains general principles for managing IP and entails tools for implementing those principles in Public Research Organizations (PROs). The code is embedded in Ireland’s wider technology-commercialization context.

The code of practice was developed by consulting a wide variety of stakeholders. Stakeholders involved included, for instance, funding bodies, public research organizations, university management, technology transfer offices, the venture capital community and industry representative groups, as well as entrepreneurs, Irish companies and multinational companies based in Ireland. This participatory progress led to a common understanding on the code. In consequence, the code was widely endorsed by both, government and private sector bodies. Adoption of the code is voluntary.

The code emphasizes the responsibility of the public research organization (PRO) to commercialize technology arising from publicly funded research. It embeds IP in the overall effort to commercialize technology. It is recommended that the PROs ensure -- where practicable -- that adequate resources are provided for commercializing technology. Commercialization should be incorporated into the PRO’s strategic planning.

The code contains 12 principles (see graph). Half are dedicated to IP management and commercialization activities. Other principles focus on IP strategy and technology transfer offices, as well as ownership, sharing of benefits, conflict of interest and monitoring and evaluation. The code defines general guidelines for actors’ functions and general procedures and processes to be incorporated. For example, the principle “IP management strategy” suggests that technology transfer offices should be established to help carry out this function. Technology transfer offices are encouraged to define and publish their mission priorities and policies. It further explains that the responsibilities of the technology transfer office should include (i) identifying, evaluating and protecting IP; (ii) advising on commercial and IP issues in research contracts; (iii) planning and executing commercialization strategy; (iv) marketing inventions; and (v) negotiation exploitation and other technology transfer agreements. Overall, timeliness, confidentiality and effectiveness are recurring themes through all 12 principles.

In a separate implementation section, the code contains concrete advice and references materials for carrying out the principles. For each principle, the section provides necessary background information such as legal information, templates, check-lists, and key reference material. The “Monitoring and Evaluation” section, for example, presents a set of indicators.

Source: <http://www.forfas.ie/media/icsti040407> ip code of practice and authors.

Principles for Managing IP from Publicly Funded Research



31 There are no complete databases on technology brokers even in those countries where they are more developed, such as the United States or the United Kingdom, but a few surveys of technology brokers have been recently conducted (see Benassi et al. 2009).

some cases, the venture founders come from IP management units of universities, public technology institutes or private enterprises. In other cases, for example, the founders were entrepreneurs who went through the process of commercializing their own technologies and recognized the benefits of establishing technology intermediaries to fill clear market gaps.

- Fifth, the degree of sectoral specialization among brokers varies—some are focused on one or two industries, especially when the industries are very complex such as electronics and ICT, while others cover a wider range.

Hence, jump starting the development of a technology market with private intermediaries is likely to entail interventions to stimulate both the supply and demand sides. (The latter is discussed in the following section).

On the *supply side*, InnovaChile could launch over the next one to two years an open competitive process to select a few (two or at the very most three) potential technology brokers that would benefit from a temporary subsidy until the market has sufficiently developed to make them viable. Chile's technology base is too small to support too many (two or three) agents, and for the program to be successful the approach has to be pragmatic. The following guidelines could be considered for program design.

- The program could cover about 5 years, and the subsidy could comprise two components: a basic subsidy and a performance-based component.^{32,33} Private technology brokers typically operate on a combination of flat fees and success fees since many transactions never result in complete deals. The success fee is usually a percentage of the value of the licensing agreement (5 to 15 percent).
- The basic subsidy could cover some of the initial operational costs given that it will take time and resources to stimulate the demand and there will be a need for the technology broker to conduct

substantial promotional activities. (The basic subsidy, for example, could cover a percentage of costs related to training, networking development and promotional activities and, to be refunded, the broker would have to show progress against indicators agreed in the initial business plan. Alternatively, it could be a percentage of services provided such as patents processed or value of assistance with technology packaging.³⁴) The performance based fee would be linked to successful IP commercialization transactions (e.g., 10 to 15 percent of the licensing agreement)³⁵ encouraging the provider to actively seek successful deals.

- The program would define rigorous selection criteria that would concern *inter alia* the team's experience, knowledge of Chile's priority clusters (as defined in the national innovation strategy), quality of the business plan, and local and international networking capacity.
- The selection criteria could regard favorably collaborations with established international brokers so that providers have strong access to international technology networks and a solid base in knowledge processes and IP commercialization from the start. InnovaChile could review the performance of the provider against agreed outcomes in the business plan on a yearly basis and withdraw support if performance were inadequate.
- From an *evaluation perspective*, the program could monitor progress made in terms of (i) patents processed, (ii) value of assistance provided with technology packaging, (iii) number of licensing agreements successfully reached and value of those agreements, and (iv) new products developed or processes changed by beneficiary companies due to *licensing in* of new technologies.

Fostering greater IP awareness and stimulating the demand

Generating awareness and education on IP rights and management would be of great value given the limited

32 The basic subsidy could also be linked to some intermediary performance indicators, e.g., promotional activities, patents processed, etc.

33 The performance based component could be a percentage of the (net present) value of the licensing agreements. Typically, licensing agreements have an up-front fee and yearly royalties.

34 The two approaches present trade offs. The first approach would be simpler to estimate. In the second case, the subsidy would be more closely linked to some intermediate performance indicators but it would be difficult to estimate. For example, InnovaChile would need to predefine the value of assistance for technology packaging (which would be very difficult) or the provider would have the incentive to artificially boost the price of such assistance.

35 This could be estimated on the basis of the net present value of the licensing agreements since such agreements typically have an up front and a royalty component.

understanding by the research, business community and the public on the matter. The CNIC could spearhead this effort in collaboration with the Ministries of Economy and Education, the National Institute of Intellectual Property and public funding agencies (CORFO and CONICYT). It could comprise *inter alia* seminars for the business community and researchers with media exposure, regular articles in the press and specialized technical journals, as well as dissemination of successful cases. Educational and promotional activities will be a long-term effort but can be started now.

These efforts can be complemented with more specific interventions to stimulate the demand. Such support for the demand side can be temporarily justified on the basis of information asymmetries and the limited understanding of IP protection and commercialization benefits and credit access constraints. The Enterprise Innovation Program and Industrial Property Rights Program (Table 2.3), sponsored by InnovaChile, are already available to stimulate the demand for IP services, but there seems to be inadequate knowledge of them. More dissemination appears necessary and the scope of activities supported can be improved.

In particular, the Enterprise Innovation Program includes a financing line to support activities related to *licensing in*, and the Industrial Property Rights' Program could be revised to better match funding support for patents to projects' needs and expanded to cover *licensing out* activities.³⁶ Currently the Industrial Property Rights' program extends patent funding for up to 5 years even though it is difficult to know up front the project's viability and in which countries the patent should be filed. The funding could be extended in two phases in line with the project's evolution. For example, a patent funding scheme run by Enterprise Ireland provides an initial sum of about US\$25,000 to fund a Patent Cooperation Treaty application and related legal work. This 100 percent funding takes the project to a stage 30 months down the road from initial patent filing. At this stage, the project is assessed and 50 percent grant support can be made available for patent filing in countries that can be justified by a well developed business plan and some evidence of commercial progress. In addition, the requirement

that applications to the patent program be submitted by certified providers (instead of the final beneficiary) should be evaluated since the former approach could render the final beneficiary captive to the service provider, regardless of service quality.

Enhancing the capacity of institutions responsible for IP granting, registry and protection

IP granting and registration: The transformation of the Department of Industrial Property into the National Institute of Industrial Property, a decentralized agency with its own budget and more operational flexibility, constitutes a positive step. The challenge is now to develop an institution with the capacity (skilled staff, IT systems, and international networks) to operate according to best international practices within a 5 to 7 year period. Most countries have made great strides in recent years in making patent examination more transparent and in providing electronic access to files, and patent applicants in Chile could have access to similar systems. It is essential for patent applicants, their advisors and attorneys to be able to search published patent documents, the registers of filing and other details concerning the progress of filed patents, and to determine whether a patent remains in force. The time to approve patents can be reduced substantially (from about 5-6 years to less than a year on average) in line with international standards.

To this end, it would be desirable for the National Institute of Industrial Property (NIIP) to formulate a comprehensive institutional development plan. The Ministry of Economy could play a vital role in providing guidance to the plan and monitoring its implementation. The plan would need to give priority to filling critical technical capacity gaps observed in the past; accelerating process automation initiatives; building international networks; and promoting IP education. Staff training could include internships overseas in similar agencies. Similarly, it would be desirable for education and promotional activities to be coordinated with other public funding agencies such as InnovaChile, which are also involved in stimulating the IP demand. The institute's development plan would benefit from clear performance benchmarks--both intermediate progress indicators (e.g., increased competencies of staff,

³⁶ The program, for example, could extend matching grants of up to 50 percent of *licensing out* costs, but these would be repaid when outcomes are successful.

IT systems in place, educational activities implemented) and medium term indicators (e.g., time to examine and grant patents and user satisfaction with services). Adequate funding of the institution will be necessary to support these efforts and attract and retain competent and specialized IP staff.

In the medium term, the integration of all IP registry functions under the National Institute of Industrial Property, including functions currently entrusted to the Ministry of Education and the Ministry of Agriculture, could be considered. Such integration would allow a more effective use of scarce IP resources and benefit from economies of scale in the development of necessary international linkages.

IP enforcement: Enforcement of IP rights is essential for the public to respect them and for the business and research community to value them. Thus, the process of strengthening the capacity of customs and the Investigating Brigade for Economic Crimes (*Brigada de Investigadores de Crímenes Económicos*) on IP enforcement needs to continue. In addition, penalties may need to be revised to act as effective deterrents. These two matters, while necessary, are beyond the scope of this report.

Accelerate signing of international IP cooperation treaties

The endorsement of the Patent Cooperation Treaty in March 2009 will reduce costs and complexity of filing patents in more than 140 states. Similarly, adherence to other important cooperation treaties such as the Madrid Protocol for the International Registration of Marks and the Hague System of International Registration of Industrial Designs, which would simplify registration of marks and industrial designs, could be achieved within the next few years.

3.2 Developing Strategic Partnerships for Applications Oriented Research

The second key area of intervention concerns the promotion of strategic partnerships that pursue a medium- to long-term research agenda relevant to the international competitiveness of priority economic clusters. So far in Chile, this strategy is at an early development

stage. The most common and visible elements of it are the technology institutes, which have shown an uneven performance, and the research consortia between universities and the business community that have been set up over the last few years. This section proposes recommendations for expanding the capacity and impact of strategic partnerships for applications oriented research, where the (public) technology institutes constitute a special case. The technology institutes need to move towards becoming entities that conduct applications oriented research and transfer it to the productive sector in different forms (*inter alia* provision of consulting services, technology packages, licensing and spin offs) and incorporate greater participation from the productive sector in their boards.

Strategic partnerships led by the business community: The research consortia between universities and the business community launched over the last few years took time to develop but have provided a useful learning experience. The experience of consortia has reached an important stage where some of them recognize the merits of sustainable programs of applications specific R&D to address challenges in their clusters. The requirement to establish a legal entity has provided a foundation upon which a sustainable effort can be built. In particular, this requirement induced the parties to face the often difficult issues of collective decision-making and sharing of value created from R&D outcomes, before launching their consortia.

Nurturing and consolidating the best of these experiences, especially those that are closely linked to Chile's economy, and building new research capabilities dedicated to other key clusters is the next step along this road. Public funding for the first such consortia will come to an end within about one-two years. Thus, a new public program to foster longer-term strategic alliances between the business community and knowledge centers could be launched within the next one-two years providing continuity to the best performing ones. Public support for existing consortia needs to be selective and support for those with weak performance, lack of critical mass or poorly connected to the productive sector would need to be phased out.

Based on the lessons learned from the current consortia operating in Chile and other international experiences,

it would be desirable for the next program to consider the following guidelines.

First, the new effort should move from the present “R&D project” culture to a sustained long-term effort with dedicated teams employed permanently on the work (i.e., the building of *long-term applied research and technology platforms*). This will require the following;

- Strong alignment to priority economic sectors and building of critical mass (including collaboration by several knowledge centers) to be competitive on a global basis. The merger of smaller research projects with duplicative or complementary objectives could be encouraged.
- Majority funding from the private sector partners in the consortia, coming from a membership charge, fees for services or an endowment, or from all three sources. This is also consistent with the broader policy priority of expanding the level of privately funded R&D in Chile.
- Sustained support from public budgets to encourage some R&D work of a longer term nature but of a sufficiently low proportion of total R&D investment (e.g., 10 or 20 percent over the medium to long term) so that it does not compromise the private ownership and service culture in each consortia. However, given Chile’s limited consortia experience and coordination failures associated with bringing together business and researchers that have not worked together before, it may be desirable to provide a higher share of public funding in the short term but reduce it towards 20 percent in the medium to long term.
- Public financing commitment for at least 10 years. Financing could be provided in phases, e.g., two phases, and funding availability for the second phase would depend on satisfactory performance during the first phase.
- Concentration of research talents into permanent teams with a sufficient critical mass to offer continuity, and in appropriate instances, a more permanent research institute with advanced equipment and pilot plants available for multiple users. (For example, a pilot plant facility in support of food and nutrition has already been identified.) The public funding agency would need to define policies for the maintenance and open use of large scale equipment and pilot plants, and the parties to

the consortia would need to commit to such policies. (See for example the experience of Australia.)

- Clear corporate governance with a majority of Board members from private businesses who are members or users of the organization and with transparent and regular reporting both to build the history of successful cooperation and to report on the use of public funds.
- Organizational goals and management culture that emphasizes becoming the best in the world to sustain the competitive advantage of member companies as they have to face increasing competition.
- Scholarship programs to attract young talent at early stages in their careers so seeding the future cadre of advanced researchers working closely with business on high quality research.

Second, the participation of leading international research centers in the consortia alongside Chilean universities and public technology institutes would be highly desirable linking Chile to cutting-edge knowledge. In critical S&T areas with research capacity shortages, consortia members could consider attracting highly recognized researchers to lead the strategic alliance team. The public funding program to foster strategic alliances could include resources for such initiatives along with the provision of scholarships to seed the future cadre of Chilean researchers in the field. Countries such as Singapore and Malaysia have similarly invited leading international researchers in those S&T areas where they lacked the capacity and felt the need to built local capacity in an accelerated manner.

Third, in some clusters, there could be a need for the strategic alliances to conduct both R&D as well as to provide more basic, yet important, technology extension services for those small and medium enterprises (SMEs) with less technology competences to avoid spreading limited capacities. The approach to be followed would depend on the cluster structure and technical needs. Public funding programs would need to provide the financing incentives for the strategic alliances to cover such activities and provide services to a larger group of users, rather than limit service provision to core funding members.

Fourth, it would be desirable to integrate all initiatives for promoting large-scale strategic alliances between

the business community and knowledge centers under a single program and a single institution to avoid duplicative efforts. Given the commercial orientation that needs to underpin these alliances, InnovaChile might be better suited to lead these efforts in collaboration with other public agencies of the national innovation system, in particular CONICYT.

Fifth, given that the best S&T capacities of Chile would likely be associated with the consortia, it would be crucial to have a technical review process comprised of international experts. The experts would need to review the technical merits but, most importantly, the relevance and potential impact to the industry.

Sixth, monitoring indicators could include some *intermediate progress targets* such as number of (i) member firms, (ii) financial resources committed by the firms, (iii) number of participating knowledge centers, and (iv) advanced human capital trained, and *longer-term impact indicators* could include (i) patents produced, (ii) value of licensing agreements, (iii) spin offs, (iv) new products and processes by member firms, and (v) impact of these on firms' performance.

Seventh, it could be necessary to review the anti-trust policy framework before such strategic alliances become embedded in Chile. The anti-trust policy framework seeks to protect consumers' interests by ensuring that collusive anti-competitive practices between firms are illegal and fosters a strong competitive supply of goods and services. Cooperative research, however, is by definition collusive among firms with common interests, and thus the legal framework needs to determine how far co-operation should be allowed.

Similar issues were faced in the USA when the pre-competitive research agencies in micro electronics, like SEMATEC and MCC were established in Austin, Texas, to undertake pre-competitive research to meet the competitive and security challenge from Asian producers. These agencies focused on developing the next generation of technology platforms and tools that could be used by all the consortium members for their next generation of products. The National Cooperative

Research Act was passed after these two centers were initiated to legitimize and govern the practice for co-operative research^{37,38}. The legal revisions incorporated a definition of pre-competitive research (generally defined as that which precedes the stage where technologies are embodied in products or services) as legitimate areas for co-operation between firms. Inevitably, there were grey areas in the boundary between pre-competitive research and product development, especially for those firms in SEMATEC that were developing technologies for the Department of Defense, which was one of the shareholders of the consortium.

Eight, both communication between the consortia research teams and the member companies and knowledge of IP management need to improve. Communication practices among consortia have varied hugely and much more attention is needed to ensure efficient dissemination and receptiveness of member companies to the output from pre-competitive programs. Similarly, awareness and capacity of IP management differs markedly among consortia. The active engagement of technology ambassadors and brokers becomes important to address both of these issues – whether they are inside the consortia, inside the member firms or independent service providers. Again, Chile could benefit from examining advanced consortia practices in other countries and consortia staff could conduct an internship in well established consortia in OECD countries, e.g., Australia, to learn in a practical setting how consortia manage IP issues and disseminate outcomes among members. The gap in technology management and IP protection skills within the consortia is common to other institutions such as TTOs deserving a more systemic approach as further discussed in section 3.4.

Finally, funding to large scale strategic alliances between industry and knowledge centers would need to increase substantially to have an impact, but it should not totally replace other smaller initiatives that seek to foster applications oriented research, for example, FONDEF and the Pre-competitive program, sponsored by CONICYT and InnovaChile, respectively. These programs support universities and other knowledge

37 See Gibson et al. (1994) for further information on MCC.

38 The National Cooperative Research Act of 1984 was amended in 1993 and renamed as the National Cooperative Research and Production Act. See <http://www.usdoj.gov/atr/foia/divisionmanual/204293.htm> for further information.

centers in the implementation of smaller scale projects with direct applications to the productive sector. That said, these two programs could be operated in a more integrated way to avoid duplicative support and more closely linked to priority clusters. In funding terms, its relative weight should be smaller than that of large scale strategic alliances. The reverse was true in recent years.

Enhancing the impact of technology institutes: The performance and impact of Chile's public technology institutes can be enhanced. Prior to devising a strategy for them, it is important to distinguish between (i) those whose primary public mission is to contribute to technology transfer and (ii) those whose primary public mission is to generate information on natural resources and other issues of national strategic interest as well as to develop standards for producers and consumers in those areas. While the latter set of institutes can fulfill an important public service, it is the former whose mission is more closely related to the objectives of this report. These two distinctive missions have often been confused.

Fundación Chile, INIA and CIMM are three institutes whose primary mission is more closely linked to technology transfer. Fundación Chile has shown a better performance but faces the challenge and opportunity of continuing to advance the technology transfer frontier and helping to fill crucial technology market gaps. Over the years, it has become engaged in a growing number of sectors but, in the future, it could be desirable for the institute to have a greater focus which would allow it to attain deeper technical expertise in its priority sectors of intervention. An increase in its endowment fund could be necessary to achieve these challenges.

The other two institutes could benefit from more fundamental changes. The institutions could further enhance their "intelligence services", quality and relevancy of research, commercialization of research outcomes, and provision of new technology packages. Improvements in these areas will imply (i) greater collaboration with the productive sector to help identify sectoral priorities and increase the relevancy and impact on technology transfer; (ii) important changes to the governance and funding framework; and (iii) the

formulation of a new medium-term strategic plan closely linked to their core mission and to the current challenges faced by Chile's most promising agricultural clusters and the mining sector. The institutes' performance targets could include *inter alia* sale of services to the productive sector; pricing policies; number of patents and licensing revenues; and participation in high impact collaborative research with the productive sector. Changes in human resource policies appear necessary so the institutes can retain qualified staff, and early separation packages could be necessary in some circumstances to accelerate the renewal of human resources.

The institutes' funding incentives can be strengthened as well. International experience points to a decline in direct budget funding as percent of the total budget and increased share of revenues generated through direct sale of services and competitive means with the dual purpose of promoting excellence and motivating relevancy. Base financing (e.g., 30-40 percent of total financing) would still be necessary to provide some stability and allow the institutes to engage in longer-term intelligence services and applied research, anticipating sectoral needs, and possibly finance pilot plants as well. Based financing, for example, could be estimated on a 10-year framework with a 5-year renewal process conditioned on satisfactory performance.

To enhance the governance of these institutes, the CNIC has proposed the creation of a special technical committee (*SNITEC*) that would be responsible for providing strategic direction, signing performance agreements and monitoring their implementation, and appointing the institute's director and board members, including appointments to Fundación Chile's board that correspond to the public sector. The committee would be accountable to the Inter-ministerial Committee on Innovation. The ample participation of representatives from the private sector in the boards of the technology institutes would be much desirable to foster relevancy. Overall, the proposed framework could provide a long-term vision for the institutes, define performance standards and put in place an independent mechanism for monitoring outcomes over time, which could stimulate change.³⁹ This framework presents some challenges,

39 The CNIC has suggested a similar governance framework for the other public technology institutes which would be mainly geared to the generation of information on natural resources and other issues of national strategic interest and the formulation of standards for producers and consumers in those areas.

however, since the institutes would still report to their traditional ministries that would be responsible for their yearly budgets. This dual responsibility could generate some tensions or a *principal-agent* problem.

Alternatively, the institutes could report to their traditional ministries which in turn form part of the Inter-ministerial Committee on Innovation. The institutes' directors and board members, strategic plan, and budgets would be proposed by the corresponding ministry but would be subject to validation by the Inter-ministerial Committee on Innovation. The SNITEC could still be appointed as a high-level technical committee accountable to the Inter-ministerial Committee on Innovation and responsible for providing guidance to the Committee on the future development of the institutes and overseeing progress.

The full deployment of a new governance framework would entail legislative changes, but the process of change could begin now. In the short term, the Government of Chile could set up a special technical committee by decree, and performance agreements could be signed between the corresponding ministries and the institutes subject to approval by the Inter-ministerial Committee on Innovation and prior review of the aforementioned technical committee. To enhance accountability of the institutes, performance agreements and SNITEC's reviews on progress achieved could be made public.

3.3 Accelerating the Formation of New Technology Firms

The third pillar of a technology commercialization strategy concerns the formation of new firms based on the findings of R&D work. These firms are rooted locally and provide a clear and visible demonstration of the personal and broader economic return that can be derived from the application of knowledge.

This strategy has received considerable attention and resources in Chile over the last few years. Unfortunately, the attention has been focused on incubators based predominantly in universities rather than the *incubation process* so it has not been successful on a broad enough scale to achieve the desired significant effect. However, a few of them, *inter alia* Octantis and 3IE, are examples of good practice that can provide the foundations for the next initiatives.

The particular set of firms that are most relevant are those that are "born global" meaning that they target a high value international market from their inception. These firms have different needs to the traditional start ups which only address the local or national market, and the incubation strategy needs to emphasize the package of services that address the needs of these firms especially when linked to priority clusters. In Chile the nearest to this conception is the Octantis incubator which also adopts the label accelerator since it supports firms with high growth potential move to a faster growth path. Other good practices have emerged, for example, in 3IE with a focus on faculty and student entrepreneurs and in *Fundación Chile* with an emphasis on international search for innovative technologies to underpin the formation of new local businesses.

The key in all of these examples is that incubation is a much wider process than an incubator and really revolves around the entrepreneur and the business idea rather than an incubator building. Assistance packages to these fast growth and born global firms are usually in the area of early stage finance and venture capital and stimulating the deal flow and incubation process. While the primary emphasis of the incubation process should be on born global companies with greater potential, support can also be adapted to new knowledge-based ventures with a more national or regional focus.

Early stage finance and venture capital

Articulation of funding through the various development stages of new technology firms is a challenging process worldwide and even more in Chile as discussed in the previous chapter. New technology firms in Chile, as in other countries, are finding the biggest financing constraint in the early stages when the firm is exposed to the highest technical and commercial risks and the experience of the entrepreneur is still limited. Some progress has been made in Chile in the development of angel networks, although this has been slower than ideal not least because of the detailed requirements to access the scheme. Even though this activity is riskier than that of existing venture funds, the latter benefits from fiscal incentives while the former does not. Early stage funds are still scarce in Chile and more efforts are needed to overcome this as a barrier to new technology firm growth.

The 2007 amendments to the capital markets law provide an opportunity for CORFO to engage more actively in the promotion of early stage financing as many other OECD countries have been doing over the last two decades. Within the next three years, CORFO could sponsor a pilot private-public technology venture fund primarily focused on early stage finance.⁴⁰ The pilot would provide a demonstrative effect and encourage similar initiatives by the private sector in the future. A direct participation of CORFO in the fund and its governance might be more effective in steering the fund towards technology and early stage finance as opposed to the current CORFO schemes which extend financing to venture funds through credit lines. For the most part, these venture funds have focused on later stages and only a small share of their portfolio supports knowledge-based firms. CORFO could place a limit on the upside of its contribution to the pilot early stage fund to help attract private sector participation to an area that they are unfamiliar with (information asymmetry) and perceived as very risky—an approach that has been followed in some OECD countries.⁴¹

In addition, the formation of angel networks could be further stimulated. First, restrictions on the formation of angel networks (such as a minimum net worth of US\$13.3 million) could be relaxed to make their formation easier and instead support for the network could be based on the number of deals successfully conducted. Second, the Government of Chile could explore options for providing some fiscal incentives to angel investors similar to what currently applies to venture funds. In the United Kingdom, for example, there is a personal tax incentive for investments in new companies (including non-technology firms) that operates through the personal tax allowance system.

Stimulating the “deal flow” and incubation process

Stimulating the technical community to engage in commercialization and building the deal flow merits more attention. Some of this work involves building support so that this type of activity is considered legitimate in

the academic community, as mentioned in section 3.5. In addition, there is a need to put in place facilities to assist new business ideas move forward to the stage where they are ready for investment which is a lot more challenging than drafting a convincing business plan.

As a first step, InnovaChile is starting to formulate a program to benchmark incubators in terms of capacity⁴² and outcomes (such as successfully graduated incubators, their sales and exports) as a means to encourage improvements in their performance and to link its financing support to performance to overcome gaps in previous support initiatives. The benchmarking process should distinguish among those incubators with a focus on born global ventures and those with a more national or regional focus, given differences in services required, but should seek to promote excellence in both circumstances.

This is a welcome initiative that could be taken a step further in the medium term in order to develop a market of “deal flow” promoters that would actively seek ideas from the research base with commercial potential and help accelerate their preparation so that they can be presented to early-stage/venture capital financing. The functions of the deal flow promoters would comprise (i) scouting ideas from the research base; (ii) assessing the technological viability of the project; (iii) estimating the commercial potential of the innovation, (iv) generating, presenting and marketing new information about the project, and (v) helping identify financing (Figure 3.3). International experiences suggest that more than 300 *promising technical ideas* might need to be scouted to produce just 15 projects attractive to an investment company. “Deal flow” facilitators in active technology markets tend to operate on the basis of flat and success fees. The latter could be an equity stake in the company or a commission by the investment company since they brought a successful deal.

InnovaChile could stimulate the development of such a market through a small initial subsidy akin to the model proposed for private technology brokers. The “deal flow” promoters could possibly emerge from the

40 The difficult conditions of global financial markets have reduced the current appetite for risky ventures and activity in VC markets has temporarily “dried up” even in traditionally active markets. Thus, it seems opportune to postpone such endeavors for a few years.

41 The return on the public contribution, for example, could be limited to the return on other long-term government instruments.

42 Capacity indicators could concern *inter alia* business model and governance, international and local network capacity with the technical, commercial and investment community, and services offered.

Figure 3.3: Functions of Deal Flow Facilitators



Source: Authors.

foundations of successful incubators and in alliance with other partners given the need to bring together a range of complementary skills (both technical and commercial). The program's subsidy could comprise a basic subsidy for specific services provided and a success-fee for every project that receives external investment.⁴³ The basic subsidy is lowering the agents' set-up costs in the initial stage of their existence, when the market for new technology-based ideas is at a nascent stage. Overall, the remuneration-scheme would be heavily focused on success providing a strong incentive to create actual deal-flow. The program could cover about five years, at the end of which it is expected that some of the "deal flow" facilitators would have become viable. The number of viable operators is likely to be small (possibly two) given the expected size of Chile's technology market in the medium term.⁴⁴ Active promotion of the program would be desirable to increase demand for their services. Currently, there seems to be little awareness among potential users of available support to assist them in developing their ideas and concepts further.

A question arises as to whether *private technology brokers* (section 3.1) and *deal flow facilitators* are more likely to be viable if such structures are integrated due to possible synergies and economies of scope. In highly developed technology markets, private providers often specialize in one of the two functions and in some cases they conduct both. One option would be for InnovaChile to launch a program to promote private providers for technology brokering and deal flow facilitation (along the lines described above and in section 3.1) and allow the potential providers to determine whether they have the capacity to conduct both functions or prefer to specialize in one of them. Forcing potential providers to carry the two functions could set entry criteria that are overly restrictive to the potential detriment of market development.

3.4 Developing the Skills Base for Technology Transfer

The expansion of activities in the three aforementioned areas (IP management, strategic partnerships, and formation of new knowledge-based firms) will require a deepening of skills and competences related to technology management and brokering and patent law in Chile. A two-pronged approach can be followed to accelerate the development of such critical skills.

First, there is a need to fill the most immediate gaps in competences. Some pragmatic options are proposed below:

- Attracting *diaspora* and contracting international specialists on technology management and brokering, with hands on experience of doing the day-to-day job; offering competitive international salaries to recruit the best talent; and including a duty to train other team members in the new agencies/intermediaries as a key element of their employment contract.
- Building sustainable alliances with equivalent agencies/intermediaries that are more advanced to fast track change and learn from their experience, while recognizing that the alliance needs to be structured in a way that offers something to both

43 For example, the basic subsidy for services provided could be paid after the delivery of a satisfactory business plan at the third or fourth assessment stages (Figure 3.1). It could possibly cover 50 percent of the estimated average costs of the analysis at the respective stage. The success fee could be 10 to 20 percent of the investment made by a VC fund or another external investor.

44 This already takes into account the government's commitment to expand substantially expenditures in science, technology and innovation.

- parties in order to be successful.
- Offering internships for Chilean staff in external agencies/intermediaries to learn and build critical international networks.
- Active sharing of experiences across agencies within Chile rather than all learning the same lessons in isolation.
- InnovaChile's programs to foster TTOs and private technology brokers could provide financing support (e.g., as matching grants) for the aforementioned activities. The support will be more effective if it is included as an integral part of the business development plan of the TTO or broker rather than financed as isolated activities.

In parallel, there is a need to create a professional cadre of specialists or technology managers, which implies both specialist degrees in universities to train those entering the profession and professional associations to organize accreditation and continuous professional development. Seeding the development of both of these elements is important to the long-term future of the knowledge economy in Chile and some proposals are presented below.

- *Strengthening/developing university programs on technology management:* InnovaChile, could conduct, within the next two years, an open competition offering support to about 3 or 4 universities to strengthen existing or develop new technology management programs with an emphasis on developing programs that can attain international quality. The support, for example, could be extended for about four to five years providing partial financing for the revision or development of new curricula, overseas sabbatical to highly recognized programs, attraction of international teachers, other linkage activities with internationally recognized programs, and overseas internships in relevant institutions for the top 15-20 percent of students. Key *impact indicators* could include: (i) number of students graduated and (ii) their insertion in the labor market in relevant professional positions.
- *Seeding the formation of professional organizations:* Similarly, InnovaChile could seed the formation of a professional organization by extending a small

initial subsidy. It could conduct an open competition inviting proposals and offer partial financing of initial operational costs of the organization, for example during the first three to four years.⁴⁵ As the professional base expands, the organization would move towards sustainability through membership fees and provision of services such as training, but the initial support seems justified due to network failures and small professional base. Critical *impact indicators* would be sustainability of the organization following program completion and training activities conducted.

Similar activities (strengthening of university programs and development of a professional organization) can be sponsored to enhance competences in patent law.

3.5 Stimulating Firms' Interest in Technology and Innovation

Working on the demand side of technology transfer and commercialization is as important to the effectiveness of the innovation system as is the efficiency of the linkage with the supply side even though the former is not the main focus of this report. Here, the main issues are provided and a framework is defined for policy to address the need to stimulate firms' interest in technology and innovation. The overall objective is to expand the number of firms in Chile that use knowledge as the main competitive strategy, where knowledge is shorthand for both process innovations to improve productivity and product innovations. Not all firms will develop in this way even though the technology upgrading agenda requires to be addressed across the board.

Addressing this need has to be tailored at two levels. The first and most relevant to the main topic of this report is for leading clusters whose orientation is predominantly the competitive international market. Here, the tools described in the strategic partnership section (section 3.2) are most relevant, working alongside fiscal incentives to encourage firms to invest more in R&D both internally and collaboratively. The objective being to develop leading edge applications oriented research that underpins knowledge based innovation strategies by Chilean firms. This is the most innovative area and

45 The subsidy could be provided against satisfactory completion of goals agreed ex-ante in the organization's business development plan.

where partnerships between public and private sectors have been used to great effect.

At this stage, however, some firms around leading clusters are still far from the technology frontier, which points to the need for combining the strategic alliances for applications oriented research with technology extension services in some of the clusters. As discussed earlier (section 3.2), these technology extension services could be self-standing or the aforementioned strategic alliances could cover both some R&D activities and technology extension services depending on the specific cluster structure and needs. The latter might be appropriate in some sectors to avoid spreading capacities thinly. As firms' capacities in leading clusters advance, the need for technology extension services will diminish relative to the need for higher R&D investments to maintain the cluster at the technology frontier. The services of technology centers in Spain, for example, have evolved along these lines as the technology capacities of the cluster they were serving have matured.

The second is for other firms who lie outside the priority clusters. Here the most frequent response is for a shared-cost grant scheme to be implemented linked to accredited suppliers who have been vetted for the quality of services they offer. InnovaChile has a grant scheme of this type that could be further disseminated and is planning to complement it with the further development of suppliers of technology extension services. The program will cover priority clusters and other sectors on a needs basis. International experience highlights the importance of allowing the business community to take the lead in the governance of such institutions to foster close linkages to the needs of the productive sector and considering the sustainability of these centers. Key program indicators can include increased revenue generated by selling of technology services, declining public support, and improved productivity (sales per workers) of firms assisted.

3.6 Nurturing Universities' Third Mission-- Contributing to Economic Growth

Changes in the behavior and practices in universities is one of the main areas that needs to underpin Chile's

innovation focused development strategy. In the first half of the 20th century, a small number of universities in industrial countries collaborated in research and development with the private sector⁴⁶, while the majority devoted themselves to teaching (*first mission*). Large scale-scientific research (*second mission*)⁴⁷ at universities took off during the middle of the century and, by the end of the century, an increasing number of universities in OECD countries were involved in outreach, research and technology development with the business community (*third mission*). By comparison, excluding a few Chilean universities such as Universidad Católica del Norte, most are timidly engaged with the third mission. In some cases, university management allows it but does not encourage it, while in others inertia or a cultural bias against academic involvement with business persists.

Recommendations: The Government of Chile can put in place a series of incentives and initiatives to encourage Chilean universities to engage more actively with the business community as a way of contributing to the country's economic development and thus to the social progress and standard of living of its population. A summary of key recommendations is presented below and a more detailed discussion follows.

- *Short term:* The CNIC can develop an advocacy campaign on the benefits derived from universities embracing the *third mission* and convene a special Committee to address issues relevant to the *third mission* with relevant participation from key stakeholders as well as independent experts.
- Key issues to be addressed by the Committee would include *inter alia* (i) the formulation of a code of practice on IP management, (ii) the development of proposals so that financial support to universities takes account of the *third mission*; and (iii) the formulation of a plan for integrating education on entrepreneurship in universities.
- FONDEF and the Pre-competitive program could be operated in a more integrated fashion and linked to the adoption of best practice IP rules.
- *Medium to long term:* The CNIC together with the Ministries of Education and Economy would continue advocacy efforts on the *third mission*.

⁴⁶ Collaboration was more prevalent in the US.

⁴⁷ The *second mission* involves research in the broadest sense not only scientific research.

- It would be highly desirable to simplify and increase the effectiveness of direct budgetary transfers to universities, including *inter alia* criteria related to the *third mission*.
- Universities could be encouraged to review criteria for measuring performance and worth of academics, including *third mission* related aspects.

In the short term (one to three years), the CNIC can initiate an awareness campaign of the social and economic benefits that can emanate from universities embracing the *third mission*. The communication campaign could comprise events with wide media exposure as well as an active dialogue with universities to convey the benefits of such collaboration and motivate greater commitment to the *third mission*. Moreover, the CNIC could convene a Committee with participation from the Ministers of Education and Economy, rectors of Chilean universities, a few private sector representatives and some independent experts to discuss a process for universities to embrace the *third mission* more forcefully. The Committee could facilitate this process by disseminating best practices on how internationally recognized universities have moved forward on this mission. It could invite to the country high-level representatives from salient universities that have successfully integrated the *third mission* over the past few decades (e.g., universities from the United Kingdom, Australia and Finland), and possibly invite a Vice-Chancellor of an internationally recognized university as a senior advisor to the Committee. It could similarly organize visits of representatives of Chilean universities to those countries to learn first hand about IP management policies, technology transfer impact of universities, and public policies to foster the *third mission*.

As part of this effort, the Committee could form working groups entrusted with the following key issues: (i) the formulation of a code of practice on IP management by universities and other knowledge centers as discussed earlier in section 3.1, (ii) the development of proposals so that financial support to universities takes account of the *third mission*; and (iii) the formulation of a plan for

integrating education on entrepreneurship in universities, a topic that will be further discussed in the following section. The Committee could sponsor National Annual Awards for University Entrepreneurship and Technology Transfer with high visibility, to reward top universities and *knowledge* centers that have shown the highest impact and progress on the *third mission* flank.

In parallel, the Government could launch the proposed program to support the formation of a strong network of technology transfer offices (section 3.1) and start applying financial rewards as tools to stimulate the change in attitude and culture. For example, FONDEF and the Pre-competitive program which seek to encourage universities and other knowledge centers to conduct research with direct applications to the productive sector, could require that leading researchers in these projects be associated with institutions that have adopted best practice IP rules. The rationale for this is strong since universities with sound IP policies provide the best incentives for those research resources to have an impact in the productive sector.

In the medium to long term, the CNIC together with the Government of Chile could continue the awareness efforts (e.g., the aforementioned national awards program), support the consolidation of the technology transfer offices as discussed in section 3.1, and support the expansion of financial incentives to promote the change in culture. The last one will be challenging but budgetary support needs to better aligned with impact. The communication and consultation process discussed above will give legitimacy to new policies and ease their implementation. Direct budgetary support from the Ministry of Education to research universities could incorporate performance criteria that are related to the *third mission*.⁴⁸ Presently, direct support constitutes close to 40 percent of all budgetary funding to universities (OECD and World Bank 2009) and is complex, inequitable, and fragmented among four different programs that do not follow an overarching goal. Special funding for CRUCH universities amounts to about 80 percent of direct funding support, with

48 Direct budgetary support includes (i) special support for CRUCH universities, (ii) competitive resources under the Institutional Development Fund, (iii) competitive resources for innovative institutional programs under MECESUP, and (iv) the pilot "performance program" signed by five universities with MECESUP. The first and third programs are available only to CRUCH universities, and the second is available to CRUCH universities and technical institutions. Indirect budgetary funding includes scholarships and subsidized loans to students enrolled in CRUCH universities, guaranteed loans to students in accredited universities, and vouchers to institutions attended by top students according to PSU results. In addition, all research universities can participate in competitive research-related programs administered by CONICYT and InnovaChile.

95 percent of it determined by historical shares rather than objective criteria.⁴⁹ The other 5 percent is defined by 5 parameters, of which 3 are related to research activity but do not incorporate any variables related to technology transfer or research impact.⁵⁰

It would be desirable to simplify and increase the effectiveness of direct budgetary transfer to universities. For example, it could be rationalized along two basic programs--*core financing* to provide some basic degree of stability and *performance-based related funding*--and these could reach about 15 percent and 25 percent of overall public university funding, respectively, over a period of 10 years. The share of total direct transfers would be close to current levels, but the significant change in allocations among the two categories would better align incentives. Performance based-funding could be linked to institutional goals (distinguishing between teaching and research universities) and, for the latter, it could incorporate criteria related to technology transfer

(e.g., number of patents, patent quality, licensing revenue, and participation in high impact collaborative research). A critical policy question to address will be whether core financing is limited to public universities or also extended to all private universities, ending the current discriminatory treatment between private universities on the basis of historical practices. In the short term, a few steps could be undertaken in this direction by ensuring that MECESUP's performance programs and special funding to CRUCH universities (at least the 5 percent based on objective criteria) take account of some of these parameters such as the number of patents and participation in collaborative research.

Complementing the above, the Government of Chile could encourage universities to review the criteria for measuring performance and the worth of academics so that it is not solely based on teaching skills and publications, but other criteria such as patenting, earnings from consulting and resources mobilized from

Box 3.4

Changing University Policies to Embrace the Third Mission: Recent International Experiences

Providing a balance of incentives to encourage the academic community to give equal weight to their work on commercialization as to their traditional activities as teaching and research has proved a challenge. A growing number of leading research universities, however, are making a positive move in this direction. When the Victorian University of Manchester and the University of Manchester Institute for Science and Technology in the U.K. merged three years ago a new contract of employment was offered to academic staff from the two universities. In the contract there was an explicit provision that their career progression would be judged by their performance in three areas – teaching and research in the traditional way and their contribution and successes in working with firms and commercializing technologies. Operationalizing the weight to be given to the three components in any specific promotional decision is still being settled, but there is an explicit recognition of the value placed on the third activity grouping which is central to promotion.

Complementing these changes has been the introduction of courses that give academics knowledge and skills in business relations and the creation of new enterprises. The University of Chalmers in Gottenburg, Sweden was a pioneer with elective courses in masters and PhD programs. The BBSRC in the U.K. has followed with training on these subjects for all its supported researchers and many others are now including such skill development in their programs.

In China, selected universities that are striving to become world leaders and contribute to the country's economic and social development have adjusted their performance evaluation framework to recognize commercialization and technology transfer activities in addition to teaching skills and publications (Yusuf and Nabesima, 2007).

Source: Yusuf and Nabesima and authors

49 CRUCH universities comprise all public universities but only the private universities established prior to 1981.

50 The first parameter is the number of students per number of undergraduate degrees, and the other four are calculated on the basis of the number of undergraduate students, number of CONICYT research programs, number of ISI publications, and number of academics with graduate degrees to the number of full time equivalent academics.

external sources are also rewarded (Box 3.4). Sabbaticals could also include commercialization of IP.

These changes would involve extensive communication efforts with universities and the public to explain the objectives of these policies and gain their support. (See OECD and IBRD/World Bank (2009) for a further discussion of tertiary education in Chile.)

3.7 Fostering an Entrepreneurial Culture

Initiatives to stimulate technology transfer and commercialization will be more effective if rooted in a broader entrepreneurial culture—a matter that has received little attention to date in Chile. Increasing entrepreneurship in Chile requires a comprehensive approach that encompasses the development of a cultural and educational environment supportive of it. Little has been done to date to celebrate successful cases of innovation and entrepreneurship. A few universities in Chile have included some entrepreneurial courses, but this is not yet a widespread approach. Most of these courses are still concentrated on business schools, while most departments of engineering and science have not incorporated them, even though these departments need to become a fertile ground for the creation of new technology entrepreneurs.

Creating an entrepreneurial culture will be a long process, but the experiences of other countries, e.g., Ireland, suggests that attitudes can change over time. Ireland, for example, has evolved from being an agricultural society with a low entrepreneurship level in the early 1970s into a knowledge society with a dynamic early stage entrepreneurial activity. This change has been facilitated by a comprehensive strategy that has included *inter alia* retraining of the labor force, incubation structures, seed and venture capital funds, and support for R&D, but changes in the education system and the cultural environment towards entrepreneurship have also played a role.

The general culture towards entrepreneurship can be changed over time by continuously displaying cases of entrepreneurial success, informing the public of

opportunities and support available to launch new ventures, and encouraging others to follow. The Irish Government, for example, implemented its strategy to foster entrepreneurship through its two main development agencies, the Institute of Industrial Research and Standards (IIRS)⁵¹ and the Industrial Development Authority (IDA). The IIRS published books with case studies on successful entrepreneurs in Ireland which achieved widespread publicity and a daily column in national newspapers giving details of business opportunities and championing entrepreneurship. A program on national TV, featuring case studies of entrepreneurs, has now been running for ten years and has attracted wide attention. Participating entrepreneurs competed for the title of “Entrepreneur of the Year”. Previous winners include names such as Esat Telecom Group, which are recognized internationally today. InnovaChile could sponsor similar activities in Chile and champion a culture of entrepreneurship.

Education can also play a critical role in shaping attitudes, skills and culture towards entrepreneurship. While some individuals are born with a higher propensity toward entrepreneurship, students are more likely to undertake an entrepreneurial career the more exposure and learning they have to entrepreneurship and entry-level entrepreneurial skills. This is why entrepreneurship education has been growing rapidly in the United States and has started to gain acceptance in Europe since the early 1990s as countries have sought to narrow the entrepreneurial gap with the United States.⁵²

International experts on entrepreneurial education point to the following framework. The primary and secondary levels can start to teach entrepreneurial attitudes, while post-secondary education can further nurture these attitudes and substantially improve the skills for entrepreneurship. The Irish Government, for example, has sponsored a number of initiatives to promote entrepreneurship among young people. Students can now opt for a transition year at age 15-16 where they take a year out from formal study and engage in a broader range of experience such as starting a business. Many students group to start micro-enterprises. Shell Oil sponsors a Young Entrepreneur of the Year Program.

51 It has now become part of Enterprise Ireland.

52 Despite recent efforts, the US still leads Europe by a substantial amount. In 2004, there were over 400 chairs of entrepreneurship in the US compared to about 100 in Europe (Katz).

Box 3.5

Entrepreneurship Education as a Lever for Change: The Experience of the United Kingdom

The Government of the United Kingdom is promoting a wide range of policies that seek to build a more competitive economy in which entrepreneurship and innovation are the engines of growth. In this context, it is supporting entrepreneurship education to facilitate the development of graduates with innovative and entrepreneurial mindsets.

Activities vary across education levels being more dynamic at higher levels and gradually expanding to others. These initiatives started in 1999 with the launch of the Science Enterprise Challenge, which established 13 science enterprise centers around the United Kingdom. Many of these were consortia of universities, and 43 universities (out of approximately 140 universities) were involved with this initiative. The initial focus was on enterprise education for scientists, and a national network –United Kingdom Science Enterprise Challenge– was established to share best practice. The funding of the Science Enterprise Challenge ended in 2004, and most universities then used part of their Higher Education Innovation Fund (HEIF) to continue financing entrepreneurship education. As HEIF is not specific to science, many institutions introduced some aspect of enterprise education for students across a range of curriculum areas. The Science Enterprise Challenge has now expanded substantially and become Enterprise Educators. It now supports over 600 enterprise educators from more than 90 Higher Education Institutions to develop their practice, network with peers, and collaborate in enterprise and entrepreneurship teaching and research across all curriculum areas. The National Council for Graduate Entrepreneurship, established as an independent organization in 2003, is also playing an important role in promoting graduate entrepreneurship. Its mission is to foster a long-term cultural change in universities; inform national and regional policies on entrepreneurship in universities; share the institutional environment for entrepreneurship; and increase the number of enterprising graduate businesses.

The University of Nottingham--named the first 'Entrepreneurial University of the Year' at the *Times Higher Education Awards* in 2008--provides one of the best examples on enterprise education, which is now well established and embedded through the curriculum. While some universities have already made good progress, others are still striving to embed entrepreneurial education.

A number of initiatives on enterprise education are underway at the secondary level. The government paper "Enterprise Britain" (2002) paved the way for the introduction of enterprise education for all 14/15 year olds and many others within the 11-16 age bracket. The Enterprise Network has coordinated this effort since 2006, and its remit has now been extended to students from 5 to 19 year olds. But, for the most part, entrepreneurship education at this level is based on discreet sessions and has not been fully embedded within the curriculum.

Source: K. Beresford, Enterprise Educators and National Council for Graduate Entrepreneurship and Enterprise.

In the United Kingdom, the government is also fostering entrepreneurship education since the late 1990s. Activities were first started at the tertiary level and are gradually being expanded to other levels (Box 3.5). The experience of the United Kingdom points to the challenges of integrating entrepreneurship education in the curricula but also indicates that progress can be made. Within Latin America, the *Instituto Tecnológico de Monterrey* in Mexico is recognized for its early focus on developing professionals with entrepreneurial skills, culture and attitude. The first initiatives to teach entrepreneurship date back to 1978 and these gradually evolved into the *Programa Emprendedor* (Entrepreneurial Program), jointly designed between academics and the private sector. Today, all its degrees

include entrepreneurial courses as an integral part of the curricula.

It would be desirable for Chile to develop a plan on entrepreneurship education, starting with the tertiary level and expanding it to other levels over time. Universities in Chile, for example, could start teaching entrepreneurship throughout various disciplines and across the campus, not only in business schools. Teaching on entrepreneurship could be available to all students at the tertiary level of education, especially in science and technology programs, where potentially new technology-oriented entrepreneurs can emerge. Furthermore, incorporating teaching on entrepreneurship in scientific and engineering universities would increase

the exposure of the scientific research community to the opportunities that exist for commercializing research and development, further strengthening the links between academia and the real economy.

International experience teaches us that entrepreneurship education requires a multidisciplinary approach and a different paradigm to the traditional teaching of business education. The latter usually follows more structured formats. By contrast, the literature on entrepreneurship has characterized the entrepreneurial experience as chaotic: entrepreneurs practice disruptive forms of innovation as opposed to small business owners who practice management skills as their principal activity of their enterprise⁵³. According to them, entrepreneurial education must reflect the unstructured environment that students will eventually face in their entrepreneurial careers. Entrepreneurial programs vary among universities that teach them, but best practices tend to share a number of features. Common features are project-based experimental learning that integrates theory and practice; student business starts ups; facilitating interactions and mentoring with practicing entrepreneurs; network development; and finance.

Schools and universities teaching entrepreneurship actively engage local community leaders and entrepreneurs in advisory boards.⁵⁴ Entrepreneurial programs can also have a specialized focus such as the technology management programs. Given the challenge of integrating entrepreneurship teaching throughout various disciplines and developing relevant pedagogical approaches, universities have benefitted from the guidance of specialized institutions. The Kauffman Institute, Enterprise Educators and the European Foundation for Entrepreneurial Research have helped universities in the United States, the United Kingdom and the European Union, respectively. Chilean universities could benefit from the guidance of similar institutions.

Recommendations: Chile can promote a more dynamic and entrepreneurial culture through entrepreneurship

awareness and education. Some guidelines for launching such initiatives follow.

Entrepreneurship recognition and awareness:

- InnovaChile could start championing a culture of entrepreneurship through national awards, regular publications and other media events on successful entrepreneurial cases as highlighted for the case of Ireland above.
- Awards could be broadly based and recognize the initiatives of existing and new entrepreneurs, including researchers, university students, secondary students and other groups.
- These initiatives could be started now and continued over the medium and long term considering that cultural changes happen gradually.
- Engaging recognized entrepreneurs and enterprises in some of these activities would make them more effective. The CNIC could reinforce these efforts through its public messages.

Entrepreneurship education:

- To create a more entrepreneurial culture, it will also be critical to develop a plan to integrate entrepreneurship education at the different educational levels which could be done in a progressive fashion.
- The experience of other countries suggests that it is easier to start incorporating changes at the higher educational levels. The proposed Committee to promote *the third mission* of universities, discussed in the previous section, could undertake the task of formulating a plan for integrating entrepreneurship education within its responsibilities.
- In the short term, a pilot program could be implemented to start integrating entrepreneurship education in higher institutions and, to avoid creating a multiplicity of activities and funding lines for universities, this program could be embedded within an existing one, e.g. the pilot performance contract program.
- In the medium term, the above initiative could be extended to all universities, and similar activities could be initiated at the secondary level, first on a pilot basis. The CNIC could collaborate with the Ministry

53 See for example Carland, Hay and Bolton (1984).

54 The Intotalo Academy in Finland, which teaches both pre- and post-secondary students, also represents another interesting experience of entrepreneurship teaching. The model follows a community-based learning approach. It emulates an innovative working environment and helps students network with practicing entrepreneurs in the community (<http://www.intotalo.com/>).

of Education and the Ministry of Economy (Chair of the ICI) to expand entrepreneurship education to the secondary level.

- Initiatives to enhance entrepreneurship skills will need to go hand in hand with other efforts to enhance science education from the primary level on.

3.8 Evaluating, Learning, and Adjusting

Policies to foster technology commercialization will entail some degree of learning and experimentation and thus evaluating their impact and feeding results into the policy-making process will be crucial. In some cases, public programs can accelerate the development of missing market agents, but these agents will need to become self-sustainable over time and program support should be eventually phased out. In others, a public agency sponsoring a program may be tempted to extend support to a group of beneficiaries it helped create even though its performance is substandard. Mechanisms must be in place to allow policy-makers to learn from evaluations and adjust policies and programs accordingly. Sound evaluation policies will minimize the potential risks of *principal-agent* problems.

The following are some elements to take into account when designing programs and evaluation policies.

- *Developing effective measurement mechanisms and clear baseline indicators.* If evaluations are to move beyond legitimizing government programs, it is important to define clear baseline and performance indicators and, to the extent possible, control groups at the outset. Control groups can help measure the performance of agents that receive the benefits compared to those that do not.
- *Performance-based benefits.* In as much as possible, financial support should be performance based. This could have the dual benefit of easing impact measurement and establishing clear incentives to modify behavior.
- *Independence of evaluators:* Some degree of independence of evaluators will be critical for evaluations to be objective and thus credible. If not, there is a risk that the evaluation will be used to endorse outcomes and justify how well a public program functions. Independence will be particularly important to ensure that programs that are not performing well are adjusted or phased out or that

support to beneficiaries performing below standards is withdrawn.

- *Evaluating overall impact.* While detailed evaluations of each program will be desirable, it will also be necessary to assess the overall coherence and complementarity of the various policy interventions that seek to promote technology commercialization, especially since it is likely that more than one public agency will be involved in fostering this process.

3.9 Conclusions

Creating a milieu conducive to technology commercialization and transfer will be a challenging and long-term process but necessary for Chile to become a dynamic knowledge economy. The chapter proposes seven complementary initiatives to move forward in this direction: (i) improving institutions, regulations and practices to foster an efficient and more dynamic *IP management system*; (ii) developing *strategic partnerships* between the business community and knowledge centers to conduct research applied to key economic areas and improving the performance of the technology institutes; (iii) accelerating the formation rate of *new technology firms* and the necessary financing mechanisms; (iv) developing the requisite *skills and competences* to support the above; (v) strengthening technology extension capacities and stimulating its demand; (vi) nurturing *universities' third mission* of contributing to economic growth; and (vii) fostering an *innovative and entrepreneurial culture*.

The proposed agenda is challenging and requires a long-term commitment. Many of the proposed reforms entail an important change of culture among key stakeholders, in particular universities and the business community. It will be critical to engage key stakeholders early in the process and build a strong national consensus around a long-term vision for technology commercialization and transfer in Chile. Continuous communication of this vision by high-level policy makers will help maintain the direction and momentum.

4

Chapter 4: Conclusion

Chapter 4:

Conclusion

Chile's technology transfer and commercialization system, one of the most critical components of the national innovation system, depicts numerous gaps. These gaps are driven by two factors: low innovation inputs (e.g., less than adequate levels of human resources and other resources allocated to research) and inefficiencies in the use and processing of these scarce inputs. Addressing both of these will be critical to enhancing technology commercialization in Chile and to realizing the goal of moving forward as a knowledge economy. The proposed national innovation strategy recognizes the importance of increasing innovation related inputs, proposes long-term targets and broad directions to achieve those targets. However, this will not suffice. It also recognizes the importance of creating a milieu that will be more conducive to technology transfer and commercialization. In that spirit, this report seeks to provide guidance and identify strategic interventions to stimulate the creation of such a milieu.

The earlier diagnostic has identified gaps in most of the elements that need to be in place for an effective technology transfer and commercialization system to operate: stakeholders exposed to weak incentives, institutional gaps and missing market links, financing gaps, weaknesses in the design of public support programs, and a need for a more entrepreneurial and innovative culture.

Moving forward will require a coherent long-term plan based on complementary interventions and continuous monitoring and evaluation of policy interventions. The report proposes seven areas where strategic interventions and support appear to be necessary: (i) improving institutions, regulations and practices to foster an efficient and more dynamic *IP management system*; (ii) developing *strategic partnerships* between the business community and knowledge centers to conduct research applied to key economic areas and improving the performance of the technology institutes; (iii) accelerating the formation rate of *new technology firms* and the necessary financing mechanisms; (iv) developing the requisite *skills and competences* to support the above; (v) strengthening technology extension capacities and stimulating its demand; (vi) nurturing *universities' third mission* of contributing to economic growth; and (vii) fostering an *innovative and entrepreneurial culture*.

Finally, while the impact of some of these proposed changes will be observed in the short run, building a dynamic milieu for technology commercialization will be a long-term process. Thus, it is vital to build a national consensus behind a long-term strategic view and engage key stakeholders—in particular universities and the business community—early in the process. A change of culture is both necessary and feasible. The business community can learn to work on a more

open innovative system together with universities and other actors, while universities can learn to appreciate that collaborating with the business community in technology transfer and commercialization can be compatible with a long-term research agenda. The development of critical market links (e.g., new financing agents and technology brokers) will also be a gradual process that will require a steady effort.

The CNIC can play a leading role in helping define a long-term strategy and the Inter-ministerial Committee of Innovation in securing its implementation. CORFO and other agencies such as CONICYT will also have critical roles to play as executing agencies.



Annex 1

Annex 1: Fostering Technology Transfer and Commercialization in Chile: Summary of Proposed Recommendations*

Policy area of intervention	Short term (1 to 3 years)		Medium to Long term (4 to 12 years)	
	Intervention	Performance indicators **	Intervention	Performance indicators **
Overall performance on Technology transfer and commercialization	<ul style="list-style-type: none"> Interventions detailed below 		<ul style="list-style-type: none"> Interventions detailed below 	<ul style="list-style-type: none"> Increased patenting levels in the US to 80⁵⁵ Increased annual rate of new knowledge-based businesses (measured by national enterprise surveys) Increased ranking of Chile on WEF technology indicators (from 44 to about 35) Increasing ranking of Chile on WEF innovation indicators from 56 to about 45
Improving IP management: institutions, regulations and practices	<ul style="list-style-type: none"> Develop a strong network of TTOs at research centers (InnovaChile) Pilot program to seed development of private technology brokers (InnovaChile) Foster IP awareness and stimulate the demand <ul style="list-style-type: none"> Awareness efforts (CNIC, Ministries of Economy and Education, NIIP, InnovaChile and CONICYT) 	<ul style="list-style-type: none"> About 2-3 TTO networks initiated implementation of sound strategic plan; revenue generated from signing of research collaboration agreements; number of patents registered in Chile and the US; and number of licensing agreements executed. About 2-3 institutions participating in the pilot program for promoting private technology brokers 	<ul style="list-style-type: none"> Continue development of TTOs network (InnovaChile) Continue implementation of pilot program to seed development of private technology brokers (InnovaChile) Continue initiatives to generate IP awareness and stimulate demand (CNIC, Ministries of Economy and Education, NIIP, InnovaChile and CONICYT) 	<ul style="list-style-type: none"> Licensing revenues produced by TTOs Number of patents filed and issued in Chile and the US linked to TTO support About 2-3 self-financing TTO networks operating Number of self-financing private technology brokers NIIP: Time to examine and process patents reduced to less than a year on average
<p>*Responsible government entity or public funding agency in brackets **End of period ***Current global conditions suggest the program launch could be postponed for a few years</p>				

55 The estimations assume that (i) Chile 's R&D growth increases to 2.3% of GDP by 2021 and yearly GDP growth is 5.5%, in line with the targets of the National Innovation Strategy for Competitiveness, and (ii) Chile becomes more efficient in the transformation of R&D investments into patents by closing the current efficiency gap with Taiwan of 11%. See Bosch, Lederman and Maloney (2005) for methodology.

Policy area of intervention	Short term (1 to 3 years)		Medium to Long term (4 to 12 years)	
	Intervention	Performance indicators**	Intervention	Performance indicators**
	<ul style="list-style-type: none"> o Implement specific programs to stimulate demand (InnovaChile) • Develop and implement Strategic Development Plan for the National Institute of Industrial Property (<i>NIP in collaboration with Ministry of Economy</i>) • Enhance enforcement of IP rights • Signing of Madrid Protocol for the International Registration of the Hague System of International Registration of Industrial Designs (Government of Chile) 	<ul style="list-style-type: none"> • NIP: increased staff competencies; new IT systems fully operational; and adequate financing support • Madrid Protocol for the International Registration of Marks and the Hague System of International Registration of Industrial Designs signed 	<ul style="list-style-type: none"> • Implement Strategic Development Plan for the NIP (NIP in collaboration with Ministry of Economy) and enhance enforcement of IP rights 	
Developing strategic partnerships for applications oriented research between knowledge centers and the business community	<ul style="list-style-type: none"> • Consolidate leadership of strategic partnership programs under a single public funding agency (InnovaChile) • Launch new program to expand strategic partnerships within the next one to two years accounting for lessons learned from current experiences <i>inter alia</i> <ul style="list-style-type: none"> o Leadership by the productive sector o Close linkages to needs of productive sector o Building critical mass to achieve impact o Moving to a longer-term effort o Build alliances with international research centers o Inviting international peer reviewers • Review need to adjust anti-trust legislation to allow pre-competitive research cooperation as legitimate objective. (<i>Ministry of Economy</i>) 	<ul style="list-style-type: none"> • Consortia programs merged • About 5 large public-private consortia programs linked to priority economic clusters granted (new or expansion of existing ones) • About 25-30% of co-financing by firms • At least 2-3 knowledge centers (including international centers) participating in each consortia 	<ul style="list-style-type: none"> • Consolidate and expand strategic partnership initiatives (InnovaChile) 	<ul style="list-style-type: none"> • Number of patents generated out of the consortia support • Value of licensing agreements produced • New products and processes by member firms • Impact on firms' productivity (sales per worker) • Co-financing by firms in new consortia programs of 50% or more
<p>*Responsible government entity or public funding agency in brackets **End of period ***Current global conditions suggest the program launch could be postponed for a few years</p>				

Policy area of intervention	Short term (1 to 3 years)		Medium to Long term (4 to 12 years)	
	Intervention	Performance indicators	Intervention	Performance indicators
Enhancing the capacity of public technology institutes	<ul style="list-style-type: none"> Review governance, funding structure and labor incentives Develop medium-term strategic plan for each institute with clear performance targets (including program to strengthen human capital) 	<ul style="list-style-type: none"> Strengthened governance structure in place Increased revenue from sale of technology services 	<ul style="list-style-type: none"> Implement revised governance structure Implement a medium-term strategic plan for each institute with clear performance targets 	<ul style="list-style-type: none"> Increased revenues from sale of technology services At least 35% of revenues derived from non-direct budgetary sources Increased patenting levels Increased participation in R&D projects with the productive sector
Accelerating the formation of new technology-based firms	<ul style="list-style-type: none"> Increase early-stage financing opportunities (CORFO) <ul style="list-style-type: none"> Sponsor a public-private early stage fund** Stimulate the formation of further angel-networks through seed funding and redefinition of relevant formation criteria. Explore options to provide fiscal incentives akin to venture capital funds. Improve performance of incubators through benchmarking program, linking public support to capacity and performance. Adapt assistance packages to the needs of firms—born global vs. those with national or regional focus (InnovaChile) 	<ul style="list-style-type: none"> Incubator support programs closely linked to performance About 2-3 institutions participating in pilot program for promoting deal flow facilities 	<ul style="list-style-type: none"> Consolidate initiatives for early-stage financing (CORFO) Pilot program to seed the formation of deal flow facilities that will become self-financing over time (InnovaChile) 	<ul style="list-style-type: none"> Increased annual rate of new knowledge-based businesses (measured by national enterprise surveys) At least one/two self-financing deal flow facilities operating in Chile About 4-5 strongly performing incubators focused on technology firms Increased value of the VC industry Increased shared of the VC industry in early stage financing
<p>*Responsible government entity or public funding agency in brackets **End of period ***Current global conditions suggest the program launch could be postponed for a few years</p>				

Policy area of intervention	Short term (1 to 3 years)		Medium to Long term (4 to 12 years)	
	Intervention	Performance indicators	Intervention	Performance indicators
Developing the skills base	<ul style="list-style-type: none"> • Fill most immediate skill gaps in technology management and brokering through pragmatic approach (InnovaChile) <ul style="list-style-type: none"> o Attract diaspora and contract international specialists o Build sustainable alliances with intermediaries/agencies overseas o Offer internships for Chilean staff in intermediaries/agencies overseas o Active sharing of experiences across agencies within Chile • Seed the development of university degrees in technology management and professional associations in the field (InnovaChile) 	<ul style="list-style-type: none"> • Development and strengthening of technology management programs • At least 50 technology managers completed internships overseas • Professional association of technology managers established 	<ul style="list-style-type: none"> • Consolidate initiatives (InnovaChile) 	<ul style="list-style-type: none"> • Internationally accredited or “recognized” technology management programs (2-3) • Graduates of technology management programs employed in relevant areas • Professional association of technology managers fully operational
Strengthen capacity for technology extension and stimulate demand	<ul style="list-style-type: none"> • Develop program to strengthen technology extension capacities • Stimulate demand through matching grant program 	<ul style="list-style-type: none"> • At least 5 centers assisted or under development 	<ul style="list-style-type: none"> • Continue strengthening of technology extension capacities but with reduced public financing • Continue to stimulate demand through matching grant program 	<ul style="list-style-type: none"> • Improved productivity (sales per workers) of firms assisted • Revenue generated by selling of technology services
<p>*Responsible government entity or public funding agency in brackets **End of period ***Current global conditions suggest the program launch could be postponed for a few years</p>				

Policy area of intervention	Short term (1 to 3 years)		Medium to Long term (4 to 12 years)	
	Intervention	Performance indicators	Intervention	Performance indicators
Nurturing universities' <i>third mission</i>	<ul style="list-style-type: none"> • Develop awareness campaign on third mission and convene special Committee to foster and address issues relevant to the third mission (CNIC, Ministry of Economy, Ministry of Education, rectors of universities, and private sector) • Formulate and disseminate code of practice on IP management (CNIC, Ministry of Economy, Ministry of Education, rectors of universities, and private sector) • Link participation in FONDEF and the Precompetitive program to IP management rules (CONICYT) 	<ul style="list-style-type: none"> • Code of practice on IP management adopted by main research universities • Financing from FONDEF and Pre-competitive Program explicitly linked inter alia to sound IP management practices • FONDEF and Precompetitive Program operated in a more integrated fashion 	<ul style="list-style-type: none"> • Continue awareness efforts on third mission (CNIC, Ministry of Economy, Ministry of Education, rectors of universities) • Simplify and increase effectiveness of direct budgetary transfers to universities, including third mission related incentives (Ministry of Education) • Encourage universities to review criteria for measuring performance and worth of academics, including third mission related aspects (CNIC, ICI, and Ministry of Education) 	<ul style="list-style-type: none"> • Direct budgetary transfers to research universities linked inter alia to performance on technology transfer
Stimulating an entrepreneurial culture	<ul style="list-style-type: none"> • Awareness generation through media events, publications, and national awards (CNIC, ICI, and InnovaChile) • Implement pilot to integrate entrepreneurial education in the curricula of higher education institutions (CNIC, Ministry of Education, and Ministry of Economy as Chair of ICI) 	<ul style="list-style-type: none"> • Entrepreneurship education included in the curricula of a wide range of fields in at least 3 universities 	<ul style="list-style-type: none"> • Consolidate initiative at the higher education level and progressive expansion of entrepreneurial education to secondary level (CNIC, Ministry of Education and Ministry of Economy as Chair of ICI) 	<ul style="list-style-type: none"> • Increased annual rate of new knowledge-based businesses (measured by national enterprise surveys) • Entrepreneurship education included in the curricula of a wide range of fields in about 65-75 percent of universities • Entrepreneurship education piloted in the curricula of about 10-15 percent of secondary schools
Evaluation	<ul style="list-style-type: none"> • Monitoring and evaluation capacity in place at CNIC, Ministry of Economy, CORFO, and CONICYT. Adequate collaboration mechanisms in place. • Relevant impact indicators included in all programs related to technology transfer and commercialization 	<ul style="list-style-type: none"> • Evaluation of selected programs completed 	<ul style="list-style-type: none"> • Evaluation of overall impact of public interventions related to technology transfer and commercialization conducted every 4-5 years (CNIC) • Evaluation of each public program conducted every 4-5 years 	<ul style="list-style-type: none"> • Public interventions and programs supporting technology transfer and commercialization adjusted to reflect lessons from impact evaluations and increased maturity of system and agents • Phasing out of programs where market gaps have been filled
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