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# ERAWATCH COUNTRY REPORTS 2011: Chile

ERAWATCH Network

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## *Acknowledgements and further information*

This analytical country report is one of a series of annual ERAWATCH reports which cover the EU Member States, Countries Associated to the EU Seventh Research Framework Programme (FP7) and, since 2011, selected third countries (ERAWATCH International).

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# Executive Summary

Chile is a country located at the end of South America with a population of 17 million in 2011, and one of the highest GDP per capita among countries in Latin America. Despite the earthquake of February 2010 and the effects of the international financial crisis, the country had a vigorous growth in 2011, with GDP growth of 6,0%. The country is characterised by its lack of diversification of economic activities. The mining sector is the leading activity followed by the natural resources sectors such as agricultural, fishing, and forestry.

The main actors in research governance are government organisations and institutions (the Presidency and the ministries in charge of managing R&D funding agencies), public research institutes, Higher Education Institutions (HEIs), centres of excellence and the private sector (enterprises). Although progress has been made to the governance of the system and it has changed in the last 6 years, it remains highly bureaucratic. The most relevant remaining problems are the lack of a main entity in charge of higher education, and the lack of co-ordination between different agencies. There is also an accrued interest in constituting a Council that gives a global vision and strategy to the system.

The highest share of GERD is performed by the Higher Education sector. However, BERD has been growing in importance in the last years, and research is increasingly performed in centres of excellence involving a mix of public and private, and national and international organisations. With an R&D intensity of 0.5% in 2010, Chile has one of the lowest levels of public investment in R&D in Latin America, and is well below the EU27 average of 1.91% in the same year. Overall, the Chilean business sector has a low rate of innovation. Given the high return in the primary sector (i.e. processing and exports from natural resources), there is no real incentive to innovate more in these sectors than the current low levels across all economic sectors. Universities have had very limited relationships with industry, (perhaps) mainly because of a lack of demand, but certainly due to the academic tradition of not emphasising industry needs. Moreover, the climate and framework conditions for improving the science-industry complex and the circulation of knowledge are not being supported.

There is evidence that Chile is moving strongly towards competitive funding mechanisms. The policy mix is characterised by the importance of investment from the public sector. However, public funding for science lacks focus, and there is the need to enable the development of a co-ordinated and comprehensive system. The major weaknesses in the policy mix are the delay in the support for collaborative research and technology transfer. The government has declared the importance of the attraction of foreign investment in technological areas that are expected to be strategic. Current developments in policies and programmes include the support to sectors through Consortia financing (i.e. Innova Chile's *Technology Business Consortia*), support to international centres of excellence in partmership with local entities, support for technology brokers, intermediaries and technology diffusion (i.e. the *Nodes Programme*). One of the weakest aspects of Chilean research and innovation policies is the lack of mechanisms for systematic public evaluation and monitoring of institutions, agencies, programmes and policies. Research infrastructures have been an increasing government priority since 2004.

Given the less-developed status of the Chilean innovation and research system, international knowledge access and transfer is considered as very important. The government, public research institutes, universities and enterprises view international cooperation as an opportunity to accelerate learning and to increase research capabilities quickly. Mobility of researchers is enabled particularly with the countries that have signed S&T co-operation agreements with Chile. The *Scholarships Chile* Programme is the most important source of national funding for Chileans studying nationally and abroad. European funding is playing a small role if any in mobilising national research.

The following table gives a short assessment of the interaction between different policies in place in the knowledge triangle.

**Knowledge triangle**

| | Recent policy changes | Assessment of strengths and weaknesses |
|---|---|---|
| Research policy | Increased support for scientific research through individual research projects (i.e. National Fund for Scientific and Technological Development).<br>Increased funds in support of human resources, including support for scholarships (i.e. Scholarship Chile Programme) and new programmes to attract researchers from abroad (i.e. CONICYT).<br>New programmes and increased budgets to prevent brain drain (i.e. programme for the Insertion of human capital in academia and industry)<br>Recently created programmes supporting technology transfer and commercialisation by taking advantage of knowledge from abroad (i.e. Programme to Attract International Centres of Excellence). | + Increased focus on international cooperation as an opportunity to accelerate learning and increase research capabilities<br>- Lack of focus on research topics supported for individual researchers, which might trigger obtaining critical mass in research.<br>+/- Knowledge is increasingly being shared between researchers, but not between these and industry partners.<br>- Interaction, coordination and linkages between key players in the national innovation system are very weak.<br>- Lack of policy actions explicitly addressing the lower employability of women in the labour market for researchers. |
| Innovation policy | Establishment of technology transfer programmes to increase the number of companies that innovate (i.e. Programme for the Promotion and Innovation Management in Chilean Enterprises, Programme for the Attraction of International Centres of Excellence for Competitiveness).<br>Increased support to innovative entrepreneurship through programmes that track investment, promote the transformation of science into business applications, including from entrepreneurs from abroad (i.e. Go to market, *Global Start-up Entrepreneurs Programme*)<br>Greatest impulse to seed capital from universities (i.e. *CORFO's business incubators*) and risk capital jointly with foreign funds (i.e. through the *Risk Capital Fund*) in support of innovative businesses and projects.<br>2013 has been chosen as the 'Innovation Year'<br>CORFO launched a fund for Social Innovation and entrepreneurship<br>Improved framework conditions for private investment in R&D thanks to Tax Exemption Law. | + CORFO is currently undertaking a restructuration in order to diminish bureaucracy and increase accessibility to enterprises.<br>+/- CORFO's restructuration sometimes does not consider its linkages with CONICYT and programmes' duplication/overlapping.<br>+/- Framework conditions for improving the science-industry complex and the circulation of knowledge are not being supported. However, there have been some attempts through pilot initiatives implemented in 2011 (i.e Programme InES of MECESUP and Offices for Transfering and Licencing (OTLs) in Universities)<br>+/- Large number of supported universities (15) through OTLs. However, these have not been able to achieve critical mass for investment requirements, nor economies of scale in respect to the number of funded projects.<br>+ The new R&D tax exemption law considers exemptions for intramural R&D that should stimulate and increase private sector investments, and trigger the demand for knowledge workers.<br>- Innovation policy is not involving or connecting with research policy.<br>- SMEs demand for business services is very low, and linked to the lack of innovation capabilities and culture in enterprises.<br>+ The lack of local demand for innovation in enterprises has been substituted by foreign demand (i.e. 'Go to market' Programme, and pilot initiative 'ContactChile').<br>+ Better management by CORFO in its Incubators programme, which has increased |

| | | |
|---|---|---|
| | | the effectiveness of the instrument.<br>+ Innovation culture is better diffused.<br>- Lack of funds mobilisation for innovation addressing major societal challenges and contributing to sustainable development. |
| Education policy | Increased available funds in support for Scholarships<br>Increased focus in improving the quality of the education system | + Increased interest in setting-up dedicated programmes that enrich the educational offer by matching the needs of the productive sectors of the economy.<br>- Persistent low rates of S&E graduates<br>+ Strong focus in increasing the number of PhD holders, both nationally and internationally (i.e. through the Scholarships Chile Programme) that will increase the Chilean knowledge base.<br>+/- Persistent challenge in offering the necessary framework and demand conditions for hosting PhD graduates from abroad and prevent brain drain. |
| Other policies | New CORFO initiative for developing a venture capital fund for renewable energies<br>Increased support to venture capital networks, including universities with strong links with investors | - Business incubators do not work directly with SMEs (i.e. only as associates). The performance of services delivered to SMEs is poor.<br>- There are not many spinoffs in Chile and programmes supporting them have been cancelled. |

The following table gives a short assessment of the national policies/measures

**Assessment of the national policies/measures**

| | **Objectives** | **Main national policy changes over the last year** | **Assessment of strengths and weaknesses** |
|---|---|---|---|
| 1 | Labour market for researchers | Continuous importance given to the training of human resources, notably supporting Scholarships nationally and abroad (i.e. Scholarship Chile Programme).<br>New programmes and increased budgets to prevent brain drain (i.e. programme for the Insertion of human capital in academia and industry)<br>Policy documents underline the importance of having an adequate supply of researchers and critical mass in the knowledge base to achieve the country's challenges. | +/- The labour market for researchers is growing but is highly concentrated at universities<br>- Programmes in place are not sufficiently equipped for covering future needs of the labour market for researchers (and notably for covering the demand of returning PhDs from abroad).<br>- Low-intersectoral mobility of researchers |
| 2 | Research infrastructures | The Ministerial Committee for Innovation (CMI) has been promoting strengthening the investment in infrastructures for research in the last years | - There is no national research infrastructures roadmap or national strategy.<br>+/- CONICYT's focus since early 2011 is on developing laboratories for natural sciences (i.e. astronomy centres), by taking advantage of international co-operation funding. |
| 3 | Strengthening research institutions | Focus on improving the quality of research through the "Centres of Excellence" initiative, by linking them to international knowledge production, and focusing on the development of applied R&D in | + The 4 International Centres of Excellence receiving CORFO funds (3 from the EU and one Australian) are expected to produce research of excellence that is adapted to the capabilities available in Chile, and |

| | Objectives | Main national policy changes over the last year | Assessment of strengths and weaknesses |
|---|---|---|---|
| | | markets. | complement the R&D being produced in their countries.<br>+/- It is necessary to reinforce the third mission of universities.<br>- Universities have low levels of research, and the bulk of the activities is generated by only a few universities<br>- Not all the universities are well linked to international research networks (i.e. particularly small universities) |
| 4 | Knowledge transfer | Support for the private sector in the form of collaborative business networks, and technology transfer has been increasing (i.e. Programmes Consortia, and Associative transfer between universities)<br>Support for the establishment of Offices for Transfering and Licencing (OTLs) in Universities<br>Programmes supporting innovation in universities through science | - Perceived lack of effective technology transfer, as well as inadequate institutional and financing mechanisms that hampers the creation of new technology-based firms<br>+ There are some inititatives to promote knowledge transfer, and that should be evaluated in the next years (i.e. OTLs, InES Programme, Go to market Programme, R&D Programme)<br>- Interaction, coordination and linkages between key players in the national innovation system are very weak. |
| 5 | International R&D cooperation with EU Member States | Pilot programmes to attract talents and knowledge from abroad (i.e. *Programme for the Attraction and Insertion of Researchers of Excellence*; and the *Programme for foreign entrepreneurship,* of Chile Start-up). | + Important number of bilateral and multinational agreements in S&T co-operation, including with the EU.<br>- Current programmes are only focusing on entrepreneurship from abroad, but not research/science.<br>- Chilean participation in FP7 is growing at accelerated rates. |
| 6 | International R&D cooperation with non EU Member States | Cooperation with non EU Member States is in the scope of bilateral or trilateral agreements, and no recent changes have been registered.<br>Tighter cooperation in R&D with Mexico has been in top of the agenda since 2009. | + Chile cooperates in a triangular way by linking developed countries with other developing countries in Latin America and the Caribbean.<br>+ Financing through scholarships to students of other Latin American countries with the support of the Inter-American Development Bank. |

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# 1 INTRODUCTION

The main objective of the ERAWATCH International Analytical Country Reports 2011 is to characterise and assess the evolution of the national policy mixes of the 21 countries with which the EU has a Science and Technology Agreement. The reports focus on initiatives comparable to the ERA blocks (labour market for researchers; research infrastructures; strengthening research institutions; knowledge transfer; international cooperation). They include an analysis of national R&D investment targets, the efficiency and effectiveness of national policies and investments in R&D, the articulation between research, education and innovation as well as implementation and governance issues. Particular emphasis is given to international research cooperation in each country.

# 2 PERFORMANCE OF THE NATIONAL RESEARCH AND INNOVATION SYSTEM AND ASSESSMENT OF RECENT POLICY CHANGES

## 2.1 MAIN POLICY OBJECTIVES/PRIORITIES, SOCIAL AND GLOBAL CHALLENGES

The Council for Innovation and Competitivenes (CNIC) was created in 2006 in order to define a medium and long-term strategy for RTDI, and to monitor and evaluate this strategy. The first strategy was materialised in 2 volumes (2007 and 2008). These included strategic guidelines for science, innovation and entrepreneurship, and for advanced human capital, including a long life learning strategy. It also included guidelines regarding the governance of the RTDI system. In accordance to the structure of the RTDI system, policies are designed by the Intergovernmental Committee for Innovation, composed of 8 Ministries and representatives of the three main agencies of the system: CORFO, regarding business innovation; CONICYT, concerning science and advanced human capital; and FIA, for innovation in the agro-fisheries sector. This Committee is in charge of defining the RTDI national policy.

The policy objectives and priorities of the current government are included in the Innovation Plan towards 2014, published in March 2012: "Chile: Innovation Pole for Latin America". The policy document establishes as the main challenge of the country to "increase significantly the productivity of the economy, in which innovation has a fundamental role".

The main components of the National Innovation Plan are:

1. Culture and framework. Emphasis is given to activities that favour the development of an appropriate framework supporting innovation, promoting the generation of networks, exchange of experiences and education for innovation and entrepreneurship, open innovation and social innovation.
2. Human Capital. The quality of education, and particularly higher education, should be increased. Emphasis should be given to attracting specialised human capital, develop critical mass in different sectors, strengthen technical education, as well as expanding the role of life-long-learning and in-the-job training.
3. Institutions and regulations. The fragmentation of the RTDI system should be eliminated. The effectiveness of the different institutions in the national innovation system should be reviewed, the system should be decentralised, and the good use of public resources should be guaranteed.
4. Better connectivity with the best universities and research centres in the world, in order to turn Chile into an Innovation Pole in Latin America.
5. Financing. It should be adapted to the needs of SMEs, eliminating barriers and guaranteeing continous financing that is adequate for the needs of enterprises. Financing should be available for all phases of entrepreneurship (seed capital, business angels, risk capital, and guarantees.
6. Research and Development. Recognised as fundamental for innovation, the national objective is to duplicate the levels of R&D intensity from 0.4% in 2009 to 0.8% in 2014. Emphasis is given to the attraction of international research centres, the strengthening of successful instruments and programmes, the implementation of the R&D Tax Exemption Law in enterprises, the insertion of researchers in industry and academia, the increase of regional capabilities, and the introduction of new funds for scientific equipment and infrastructure.
7. Technology Transfer and Diffussion. Linkages between universities and enterprises should be strengthened, as well as the promotion of intellectual property and

innovative enterpreneurship. The sharing of good practices should be favoured, particularly from SMEs in relation to knowledge, capabilities and technologies.

8. Entrepreneurship and commercialisation. The government will support instruments that eliminate market failures by supporting all phases of the entrepreneurial process. The main objective is to render the creation of enterprises faster and cheaper, simplify processes and shorten the amount of time needed to access support instruments, and favour the development of disruptive innovations and technologies.

Finally, the Plan gives emphasis to innovation culture, and acknowledges the need to make the plan dynamic and open, particularly to areas such as renewable energies, seismology, Antarctic studies, green innovation, water, technology development through astronomy, and cloud computing.

## 2.2 STRUCTURE OF THE NATIONAL RESEARCH AND INNOVATION SYSTEM AND ITS GOVERNANCE

Chile is a country located at the end of South America. It limits with Argentina, Peru and Bolivia. The population of Chile is around 17 million and its GDP per capita at €10,316 PPP (Ch$ 6,9 m) is the highest among the countries of Latin America. Total GDP in 2011 was of €216b (Ch$ 145,152b). The effects of the earthquake of February 2010 and those of the international financial crisis were overcomed. The country had a vigorous growth in 2011, with a GDP growth of 6.0%[1]. However, GERD in Chile is very low, equalling only 0.5% of GDP in 2010 (Ministry of Economy, 2012). In addition, given the changes made in 2010 to the methodology used for collecting and presenting R&D statistics as a consequence of the accession of Chile to the OECD, it is difficult to estimate real trends when a longer time series (i.e. more than four years) is taken (see section 2.2.1 for a complete explanation).

The country is characterised by its lack of diversification of economic activities. The mining sector is the leading activity followed by the natural resources sectors such as agricultural, fishing, and forestry.

### Main actors and institutions in research governance

Figure 1 offers an overview of the main actors and institutions in the Chilean research system. The main actors are government organisations and institutions (the Presidency and the ministries in charge of managing R&D funding agencies), public research institutes, Higher Education Institutions (HEIs), centres of excellence and the private sector (enterprises).

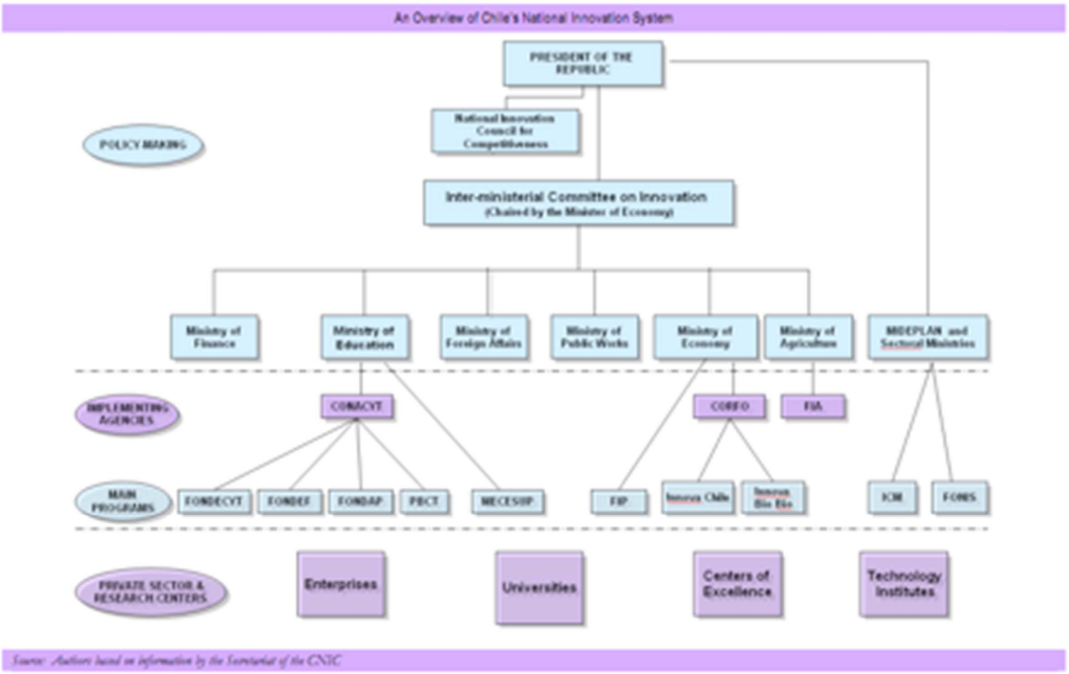
In addition, the innovation system includes fourteen public technological institutes (PTI)[2] specialised in different sectors (i.e. agriculture, forestry) and managed by different sectoral Ministries; and the Chile Foundation, a non-profit organisation with a mission to transfer technology. The PTIs provide specialised information and give technical assistance to the Ministries that manage them. They also develop technical studies that help in the decision making process of regulatory matters, and assure the control of norms according to pre-defined standards. Some of the PTIs have R&D activities and work as technology transfer units (i.e. the Institute of Agricultural Research – INIA, and the Centre for Mining and Metallurgical Investigation – CIMM).

The Presidency is at the top of the research system, and it is supported by two main actors: the Ministerial Committee for Innovation (CMI) including seven Ministries (finance, economy, mining, foreign affairs, agriculture, defence and education); and the Council for Innovation and Competitiveness (CNIC). The CNIC was created in 2006 with the mission of developing a long-term strategy for RDI in Chile. It acts as an advisory council to the

[1] Central Bank of Chile, April 2012 Data subject to methodological revisions. After revisions, the 2010 values were adapted to a level of 6.1%.
[2] See Erawatch Research Inventory Chile country fiche 2012; section "Public Research Organisations".

government and is composed inter alias by fourteen innovation experts; three representatives of the education sector (higher education and technical education); and by representatives of the National Commission for Science and Technology (CONICYT), the Chilean Economic Development Agency (CORFO), and the Foundation for Agriculture Innovation (FIA). The function of the CMI is to execute the policy according to the advice given by the CNIC. Research funding in Chile is concentrated in two agencies: CONICYT for basic research and advanced human capital; and CORFO for applied research. CONICYT functions under the Ministry of Education, and CORFO under the Ministry of Economy. The two agencies administrate most of the public funding for STI (generally above 90%), and are responsible for dozens of programmes and funding instruments. Concerning science policy advice, the CNIC is the only formalised articulator and advisory body to the Government.

**Figure 1: Overview of the Chile's research system governance structure**




Source: Fostering Technology Transfer and Commercialisation, World Bank 2009

The three most relevant Ministries to the RDI system are the Ministry of Economy, the Ministry of Education and the Ministry of Labour. The *Ministry of Economy, Development and Tourism* (MINECON) is responsible for industrial policy, including the promotion of innovation and entrepreneurship. The *Ministry of Education* carries responsibilities for the development and enhancement of the tertiary, secondary and primary education. The *Ministry of Labour* supports the work of the National Commission for Certification of Labour Competences, a governmental organisation in charge of the design and implementation of the support measures for the development and upgrading of human resources and promotion of life-long learning.

Although progress has been made to the governance of the system and it has changed in the last 6 years, it remains highly bureaucratic. However, the most relevant remaining problems are the lack of a main entity in charge of higher education, and the lack of co-ordination between different agencies. There is also an accrued interest in constituting a Council that gives a global vision and strategy to the system.

Although the budgets for both the CONICYT and CORFO have increased since 2005, and these have been used for implementing instruments in support of the identified failures in both agencies (i.e. lack of information, lack of co-ordination, lack of transparency and accountability) more changes seem necessary in order to increase their effectiveness (particularly regarding their processes) and to address the *principal-agent disconnection*

that affects them both. On the direction of reforms, CORFO is currently carrying out a restructuration in order to reduce the times needed for its operational activities, especially the times to deliver the subsidies to beneficiaries. CORFO will also reform its organisational chart in order to orient its activities of innovation and competitiveness in a more coherent way[3].

### The institutional role of regions in research governance

Chile is divided in 15 regions[4]. There is a geographical concentration of economic power and intellectual capital in Santiago, the country's capital city. Santiago, Concepción, and Valparaíso constitute the most important poles of research. As shown in Table 1, GERD is also highly concentrated in the Metropolitan Region (MP). The participation of the other regions in total GERD is between 0.8% and 9% of total GERD.

**Table 1: Regional distribution of GERD in Chile, 2008**

| Region No. | Name of region | Share of regional GERD in total (%) |
|---|---|---|
| XIII | Metropolitana | 54.9 |
| V | Valparaíso | 9.0 |
| VIII | Bio-Bio | 7.7 |
| XII | Punta Arenas | 4.2 |
| X | Los Lagos | 4,0 |
| II | Antofagasta | 3.5 |
| XIV | Osorno | 3.3 |
| IX | Araucanía | 3.1 |
| IV | Coquimbo | 1.9 |
| XV | Arica | 1.8 |
| VII | Talca | 1.6 |
| I | Parinacota | 1.5 |
| III | Copiapo | 1.4 |
| VI | Bernardo O'higgins | 1.2 |
| XI | Coihayque | 0.8 |
| **Total** | | **100.0** |

Source: Ministry of Economy. Survey of RDI

The main players engaged in regional RDI policies are the Regional Governments (GORE). The GOREs generate and/or develop strategies, which in varying degrees include objectives for science, technology and innovation. There are also Regional Development Agencies (ARDPs) that formalise the institutional structure of RDI policies in regions. However, these institutional structures have lost importance since 2010, and only 2 of them are still functioning in the Metropolitana Region (XIII) and the Bio-Bio region (VIII). In addition, the Corporations for Regional Development (CRDPs) are public-private organisations focusing on regional economic development, with support from the public sector, and in some cases from private and international funding. Both, the ARDPs and the CRDPs, have as main objective to promote innovation in regions, with the ARDPs having the public sector as the driving force, and the CRDPs driven by the private sector that can convoke (or not) the public sector.

Regions allocate resources via a number of different support measures, particularly through the National Fund for Regional Development (FNDR). There is a specific fund for regions under the Chilean Innovation and Competitiveness fund (FIC) (Law 20.026) focusing in building adequate infrastructures. The Fund is built through a special tax collected from mining activities. Although the total budget changes every year - as it is linked to the collected taxes-, mining regions receive about 60% of the Fund, which in 2011 was of €167m

[3] The reform was announced by the current government, and shoud be completed before the end of the current political period.
[4] Since 2009, before there were thirteen regions

(Ch$ 112,224m). It is a general opinion that most of the regions do not have the capacity to allocate the funds, and face significant challenges to absorb them. Furthermore, the Fund only allows that 20% of the total budget can be transferred to universities and research centres. Until now, the regional universities have been the main beneficiaries of this fund, due to lacking other absorbing firms or organisations. CONICYT has also a regional research fund –called *Regional Programme-*, which accounted for 1.8% of its total budget in 2010.

Between 2010 and 2011, the Under-Secretary for Regional Development (SUBDERE) implemented with the support of the European Union the Project *"Support for Strategies and Systems of Regional Innovation"*, through which the EU gives financial support and shares European best practices. In the scope of this project, regional innovation strategies were developed, starting in 2011[5] in a pilot exercise with seven participating regions[6]. All projects will finish their implementation in 2012,

**Main research performers**

GERD is almost equally performed by the Higher Education sector and the business sector, both having shares of around 40% in 2008 and 2010. The Higher Education sector decreased from 43% in 2007 to about 40.8% in 2008[7]. It is considerably higher than the EU average of 22% for the same year. The government sector performed 9.7% of the total GERD in 2008, decreasing from 2007 by 0.2%. The business enterprise sector performed 40.4% of GERD (2008). GERD performed by the Private non-profit sector (PNPs) was equal to 9.1% of total in 2008 and is considerably higher than the EU average of about 1%[8].

BERD has been growing in importance in the last years, and research is increasingly performed in centres by consortia involving a mix of public and private organisations. In the last year three international Centres of Excellence have initiated activities in Chile: the Fraunhofer Institute of Germany; the Commonwealth Scientific and Industrial Organisation (CSIRO) of Australia; and the INRIA from France. It is expected that the centres work on R&D related to biotechnology, the mining industry, informatics and applied mathematics respectively.

The most important R&D performers in the Higher Education sector are the University of Chile (UCh) and the Catholic University of Chile, both located in Santiago de Chile.

## 2.3 RESOURCE MOBILISATION

### 2.3.1 Financial resource provision for research activities (national and regional mechanism)

**Progress towards national R&D investment targets and public support for RDI**

Analysing GERD and R&D intensity from a time series perspective is difficult given recent methodological changes used for collecting and presenting R&D statistics as a consequence of the accession of Chile to the OECD. In order to understand this difficulty, Table 4 provides a comparison of the data series for BERD and GERD as a percentage of GDP in Chile using both statistical methodologies. Chile's gross domestic expenditure on R&D (GERD) was equal to €685m (Ch$ 462,375m) in 2010, increasing considerably the levels of 2008 with €490.3m (Ch$ 374,589m). This was equal to 0.5% of GDP in the same year. In 2010, GERD was predominantly financed by the public sector (43.58% of total), followed by the private sector (41.3%), the Higher Education sector (12%), and abroad (1,7%). Astronomic research has been the most important component of R&D financed by abroad.

[5] Last calls were open until September 2011.
[6] The regions chosen for the pilot exercise were numbers XV, I, II, IV, RM, VI and VIII.
[7] Figures based on the data from Ministry of Economy, Division of Innovation, Chile
[8] Data from Eurostat

The global financial crisis was not too much felt in Chile. However, early 2010 was marked by a destructive earthquake and the budget for research and innovation activities was freezed in order to replace for the damages in capital goods in the country. The average annual growth in GBAORD in the period 2006-2010 was 18.5%. The growth rate of the budget allocation for RDI in 2011 was reduced reaching only 5.2%, and was equal to €636m (Ch$ 427,392m). The most important increase in support for scientific research was for the National Fund for Scientific and Technological Development (FONDECYT), supporting individual research projects.

**Table 2: R&D expenditures (GERD and BERD) as a percentage of GDP (2006-2010)**

| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| GERD/GDP Chile (new methodology) | | 0,33% | 0,4% | 0,40% | 0,50% |
| GERD/GDP Chile (old methodology) | n.a | | | | |
| GERD/GDP EU27 | 1,85% | 1,85% | 1,92% | 2,01% | 2,00% |
| BERD/GDP Chile (new methodology) | | 0,13% | 0,17% | 0,16% | 0,22% |
| BERD/GDP Chile (old methodology) | 0,25% | | | | |
| BERD/GDP EU27 | 1,17% | 1,18% | 1,21% | 1,24% | 1,23% |

Source: Chilean data for 2006, from Council for Innovation and Competitiveness; from years 2007 and 2008, from Ministry of Economy, Division of Innovation. EU data from Eurostat, 2012

The National Innovation Strategy of the CNIC and the agenda 2010-2020 provided a target as to where the national research system should stand by 2020. By 2020 the government wished to double GDP per capita from 2005 levels of €7,100 (Ch$ 4.9m) through increased public support for research, notably for fundamental research, and by providing incentives for focussing on strategically relevant areas. Priorities were also set in order to achieve the general goals of the strategy. Under the statistical methodology used until 2006, when R&D intensity was measured as 0.67% in 2004, the goal was to reach 2.3% in 2020. However, given the changes in methodologies, and that R&D intensity was only equal to 0.4% in 2008, the objectives were revised down by the Piñera government as to reach only 0.8% of R&D intensity by 2014 as a mid-term goal. Nothing is currently stated clearly about the targets set before for 2020.

### Main funding instruments, competitive versus institutional funding

Exact figures on the division of funds in institutional and competitive funding are not available. However, there is evidence that Chile is moving strongly towards competitive funding mechanisms. Since 2005, when the FIC began generating significant funds for the implementation of innovation policies, funding for research in Chile happens mostly through competitive grants. The main agencies, CONICYT for basic research, and CORFO and InnovaChile for applied research, provide a large share of allocations through competitive funding mechanisms. Private non-for-profit foundations providing funds also exist, but these funds are small (approximately 2% in total), and often very specifically focus on certain topics. Institutional support is provided for universities and in a few cases to research centres. Every year the government provides funding for universities in two ways: first through the Direct Fiscal support for Universities (AFD), and second through the Indirect Fiscal support for Universities (AFI). Both supports constitute a larger part of the base of public budget, accounting to 46% of total allocations to universities (Cáceres et al., 2009) in 2008. Only a part of these funds go to R&D. Funding of PTIs is channelled through the corresponding ministries as a basic non-competitive funding. This funding finances salaries, fixed charges, and some R&D[9]. However, the PTIs have differing funding bases; while some generate completely their own budgets, others are financially fully dependent on the

[9] In the past, the PTIs were not allowed to perform R&D. Nowadays, some of them perform some R&D.

ministries. The rest of their budgets comes from competitive project funding from the agencies CORFO and CONICYT. The basic institutional funding for all PTIs in 2010 was €95k (Ch$ 64.1m).

The majority of the funding for RTDI in Chile is via matching funds. They are provided via the following measures: the National Fund for Scientific and Technological Development (FONDECYT), the Centres of Excellence Funding Programme (FONDAP), the Shared Major Scientific Equipment Programme (PIA), the National Fund for Health Research and Development (FONIS), and the Regional Programme for Scientific and Technological Development. With the objective of fostering basic research, FONDECYT annually funds on average 430 new projects with an average budget of €45k (Ch$ 30m), and about 200 new projects supporting individual researchers. Its total budget for 2011 is of €92.2m (Ch$ 61,944m); it is the most important measure of CONICYT in terms of the budget size. FONDAP too focuses on basic research with an orientation to develop excellent research and the training of human resources (i.e. post-graduates). The PIA is a measure that supports collaborative research by funding R&D, equipment, and connecting research centres to collaborative research networks.

**Recent policy changes affecting the funding of research**

Public funds in support of R&D were freezed in 2010 following the February earthquake in favour of short-term priorities for the reconstruction of the country. This tendency did not continue in 2011, as research funds and advanced education scholarships have increased by 7%, even though government budgets were still limited. Available budgets R&D and postgraduate scholarships increased by 31% in 2012.

The support for technology transfer and diffusion, and business innovation remains a high government priority. New CORFO programmes in support of technology transfer started in June 2011, such as the *Applied R&D programme*, focusing on the application of Chilean technologies in different sectors; and the *Go to Market initiative,* focusing on the commercialisation of R&D products funded by public and private funds. Additionally, support for enterpreneurship has considerably increased between 2010 and 2011 by about 30% in relative terms.

**Mechanisms to build mutual trust between science and society**

Building mutual trust between science and society and strengthening scientific evidence for policy making is seemingly important. Concerning the public involvement of society in science, Chile has dedicated programmes on innovation and society, but not yet programmes focusing on research or science and society. Policymakers are interested in creating a similar strategy for research as the already existing one for innovation, but this has not yet materialised. The programme "*Explora*" of CONICYT provides information and awareness on innovation particularly to students, but also to the society as a whole. The ChileVa Initiative of the Innovation Council supports secondary level students to discover S&T as means for a better future for Chile. Since March 2012, the initiative joined forces with the Explora Programme, organising a learning week on science and innovation at national level.

The Interministerial Committee of Innovation, presided by the Ministry of Economy, as part of the Innovation Plan towards 2014, has launched an initiative for the promotion of innovation called "2013, the Innovation Year", which aims to raise awareness and about innovation in society.

CORFO has also launched campaigns promoting the benefits of innovation. The Ministry of Economy has been working since 2008 in promoting innovation through a web site[10].

**Funding for societal challenges**

Societal challenges in Chile are related to poverty, delinquency, unemployment, health, and housing. Since 2005, there have been rising funds for management of urban waste, and

[10] See: www.innovacion.cl.

control and protection from pollution, under the Committee of clean production of CORFO. In 2012 CORFO launched a fund for Social Innovation and Entrepreneurship. The objective is to give rise of innovative solutions to reduce poverty and the social problems associated. The fund is addressed to institutions or individuals.

### 2.3.2 Providing qualified human resources

**National context**

According to the second R&D Survey in universities and the government, there were 17,910 people employed in R&D in 2010. About half (52%) of them (9.453), were researchers –3.947 researchers with Ph.D.s, 1.813 with Master's degrees, and the remaining 3.102 were other professionals with higher education degrees (including university). Universities employed more than 80% of the researchers with Ph.D.s (FTEs) and only 5% were employed by the private sector. According to two 2011 R&D surveys[11], 62% of the researchers worked in higher education, 22% in enterprises, 11% in non-for-profit private organisations and 5% in the public sector. Researchers constitute only 0.3% of the total workforce.

Total enrolments in higher education (including universities, professional institutes, and technical training centres) accounted for 34.3% of the overall human resources supply in 2006 (OECD-World Bank, 2009)[12]. Total annual Ph.D. graduates in sciences and engineering per million inhabitants was 13.4 in 2006 (CRUCH, 2006), which is higher than Argentina (10.7), but lower than Mexico (28.1) in the same year (RICYT, 2011). According to a target set by the CNIC in 2008, the country has to increase the number of annual Ph.D. graduates to 1,572 by 2020 from the low levels of only 210 new Ph.D. graduates registered in 2007. The current low levels are not enough to tackle research and innovation adequately.

**Articulation of education policies within the knowledge triangle**

In terms of education policies, these are largely connected to improve the performance levels in terms of quantities and quality. Recently, an international panel of experts evaluating the National Innovation Strategy has proposed to focus on developing a national integrated Qualifications Framework (QF). This should define competences for different levels of training and be linked to occupational areas. It should equally involve the main relevant bodies (i.e. National System of Occupational Competency, (SNCCL) and the National Accreditation Commission (CNA)) (CNIC, 2010). The final objective of this exercise is to set-up dedicated programmes that enrich the educational offer by matching the needs of specific productive sectors of the economy. Up to January 2012, ChileValora has accredited 470 occupational profiles in 17 economic sectors, mainly related to mining, agriculture, and the fishing industry.

Doctorate and master scholarships are funded through FONDECYT, PIA, and the Millenium Science Initiative. The major funding programme is *Scholarship Chile*, which is running since 2009. It has the objective to foster the training of knowledge workers. The Programme provides scholarships for studies in Chile and abroad. For 2012, the programme *Scholarships Chile* (financing scholarships nationally and abroad) has a total budget of €86.56m (Ch$ 55,401m). In consideration of the insertion of graduates to the Chilean labour market, CONICYT is implementing two other programmes: the *Support to the insertion and attraction of human capital in the Chilean productive sector* programme, focusing in providing trained knowledge workers for industry; and the *Support to the insertion of human capital for academia* programme, supporting the insertion of graduates to the labour market for researchers and academia. These programmes have very small budgets, equalling

[11] One survey was done among the private sector, and a second one included the higher education system, non-for-profit organisations and the public sector.
[12] There are no statistics on the total number of graduates.

in total €5.6m (Ch$ 3,584m) in 2012, but they have the potential of increasing gradually as the students return to Chile.

Some positive efforts are being persued to improve the system such as raising the expenditure in education and tertiary education, support for scholarships (i.e. *Scholarship Chile* Programme) and some pilot programmes to attract talents and knowledge from abroad (i.e. *Programme for the Attraction and Insertion of Researchers of Excellence*; and the *Programme for foreign entrepreneurship,* of Chile Start-up). There are also initiatives in support of entrepreneurship (i.e. Start-up Programme – implemented in 2010) however with limited impact until now.

Despite the progress, the low rates of S&E graduates persist in combination with the lack of a system for life-long learning and low numbers of students enrolled in tertiary education. Moreover, high student fees in public Chilean universities prevent a large number of young people to enrol in higher education. Despite the increase in the number of available scholarships, the scholarship system involves a mix of grants and a bank loan, which increases the individual debts of students. This constitutes a strong barrier for enrolling into tertiary education programmes. Students have organised large protests around the country in 2011 and 2012, claiming for free education that allows them to obtain a university degree.

**Main societal challenges**

Investment in higher education is the key element needed for the adequate supply of qualified human resources for the country. In 2007, Chilean public expenditure on tertiary education was low in comparison with the EU average of 1.12% of GDP, reaching only to 0.3% of GDP in Chile (OECD, 2007).

There are no available studies regarding the balance between demand and supply of qualified human resources. An analysis of Ph.D. graduates in sciences and engineering per million inhabitants showed considerable lower levels in supply given the country's levels of GDP per capita (CNIC, 2008). The current industrial structure of Chile, might be a pull factor of the low levels -given its specialisation on primary sectors (i.e. agriculture and mining)-, and limited availability of R&D intensive jobs. Moreover, researchers undertake fundamental research in areas that have little effects in terms of productivity for the country.

### 2.3.3 Evolution towards the national R&D&I targets

**Evolution of BERD**

Expenditure in R&D from the business sector is decreasing since 2004. Although as shown in Table 5, it increased by 2.1% in the period 2004-2010. As it can be seen in Table 4 and Table 5, and taking into consideration the methodological changes that R&D statistics have gone through (see section 2.3.1), BERD in proportion of GDP fell from 0.31% to 0.25% between 2004 and 2006, and it fell further by 2008 reaching only 0.17%. A slight recovery was registered in 2010 reaching levels of 0.22%. These levels were considerably below the EU average of 1.23% in 2010.

**Table 3: BERD and GDP in Chile (2004-2010), Million Euros (current)**

| | 2004 | 2008 | 2010 | Growth rate (2004-2010) |
|---|---|---|---|---|
| BERD | 237.42 (Ch$194b) | 201.17 (Ch$ 153b) | 242.5 (Ch$ 163b) | 2.1% |
| GDP | 81,557.36 (Ch$ 57,905b) | 116,690.63 (Ch$ 89,151b) | 221,809.36 (Ch$ 149,721b) | 173.0% |
| BERD as a % of GDP | 0.31% | 0.17% | 0.22% | |

Source: Data for 2004, Ministry of Economy; data for 2008, from Ministry of Economy.

BERD by performing sector provides a clear picture of the collaboration that the private sector has with other sectors. In 2010, BERD was performed almost entirely by the industry

itself, equalling 92.8% of all BERD. The Higher Education sector performed 5.5%, the private non-profit sector 1.6%, and public research organisations the minimal remaining. This shows that there is very limited interaction between the private sector and public research organisations; and that the main innovation partners for enterprises are other enterprises.

**Barriers and risks for attaining the national business R&D investment targets**

Overall, the business sector has a low rate of innovation. The research executed by the private sector is mainly intramural[13], and only 14.9% of privately executed R&D comes from the government. However, a distinction of the reasons for the lack of innovation activities can be made by sectors. Given the high return in the primary sector (i.e., processing and exports from natural resources), there is no real incentive to innovate more in this sector than the current low level. For the manufacturing sector, most R&D expenditure is due to purchase of equipment, expenditure in property rights, training and instalment of equipment, and market entry, while original R&D is low. Moreover, the most frequent type of innovation performed by the private sector in Chile is related to marketing and management. In order to overcome this lack, better science-industry linkages would be a means. In this line, the *2010-2020 Competitiveness and Innovation Agenda* adds that in order to bridge the gap between the private sector and the academic/research communities, it is necessary to reinforce the third mission of universities. However, the public and private sectors have different interests in R&D and both sectors are not linked. The constant changes in government priorities also create a dynamic inconsistency, as budget lines for R&D are constantly changed.

**Policy mixes towards increased private R&D investment**

The 2008 National Innovation Strategy of the CNIC aimed to leverage the private sector and increase its R&D activities. Although not officially promoted by the current government, the following objectives of the strategy are currently in place:

1. Incorporate new knowledge into the productive system; through tax incentives for business R&D, strengthen the protection and use of intellectual property, and increase the input of innovators into company management through training –all this mainly implemented through the *Applied R&D programme*, and the *Go-to-market Initiative*.
2. Establishing technology transfer programmes to increase the number of companies that innovate – notably through the *Programme for the Promotion and Innovation Management in Chilean Enterprises*, and the *Programme for the Attraction of International Centres of Excellence for Competitiveness*.
3. Support innovative entrepreneurship through programmes that track investment and entrepreneurs from abroad (i.e. through the *Global Start-up Entrepreneurs Programme*), to impulse seed capital from universities (i.e. *CORFO's business incubators*) and to continue tackling funds of risk capital jointly with foreign funds (i.e. through the *Risk Capital Fund*) in support of innovative businesses and projects.

The participation of businesses in the existing measures mentioned above is limited, including those initiatives promoting industry/academia linkages in the field of R&D, such as the *Fund for the promotion of science and technology development* (FONDEF).

The public sector funds research at universities and research centres. However, public funding for science lacks focus, and there is the need to enable the development of a co-ordinated and comprehensive system. The major weaknesses in the policy mix are the delay in the support for collaborative research and technology transfer. Some initial efforts have been done, however slow. For example, the Programme *Associative transfer between universities* in support of technology transfer was designed in 2009. CORFO, the agency supporting business innovation, began to train and prepare a few people in universities in specialised tasks of technology transfer, and then launched a call for proposals in order to support the creation of 15 technology transfer offices in universities focusing on licensing and patenting. These offices have been supported for a total of €3.3m (Ch$ 2,217m). Support for the private sector in the form of collaborative business networks has been increasing in the

[13] Survey of innovation 2004-2006, Council for Innovation and Competitiveness

last years. This initiative started in 2005 with the measure *Consortia*, of CONICYT, CORFO and FIA. Once the original funding expired, CORFO launched a call for projects supporting research consortia that had demonstrated positive results in the achievement of their original objectives. In 2012, only 2 Consortia were granted transitional financing, one focusing on cereal-based food products, and a second one on fruit production in the North of Chile.

**Innovation-oriented procurement policies**

Procurement has not been used as a way to promote R&D in firms and organisations. The current public purchasing system –*ChileCompra*- is only used to promote transparency and competition in public procurement.

**Other policies that affect R&D investment**

In terms of other policies that affect R&D investment, CORFO is developing a venture capital fund for renewable energies (not yet implemented by the end of 2012). The Committee for Clean Production has established agreements with industry in order to reduce their environmental footprint. These agreements have resulted in the definition of standards that industry is obliged to comply.

## 2.4 KNOWLEDGE DEMAND

The industrial structure of Chile is predominately specialised in mining, agriculture and alied sectors like forestry, logging and fishing. Fresh fruit, wine and salmon are success histories, and altogether account for about 50% of agricultural exports in Chile. As single commodity, copper is the most important. Chile has become the copper mining capital of the world, producing one third of the global copper output (AMCHAM, 2011), accounting for 55.6% of Chile's exports in 2006 and approximately 8% of GDP. Services are becoming progressively important, notably financial services, transport and tourism. Despite the government efforts, the Chilean economy is not diversified.

According to the fifth innovation survey (CNIC, 2008), the enterprises that innovate the most are in real estate (51% of all enterprises), followed by mining (37%), social services (35%) and electronics (34%). Regarding the future perspectives of innovation, about 46% of all Chilean enterprises considered their innovations to be considerably important and relevant for the future. Sectors above this average were mining (62%), real estate (59%), electronics (57%), manufacturing industries (54%), social services (50%), and agriculture (48%).

Over the past decade, Foreign Direct Investment (FDI) in Chile has represented an annual average of 6.5% of GDP, rising to an average of 8% in the period 2007-2009. Surprisingly from 2009-2010, it grew by 17%. Studies have however stated that the effect of FDI on the overall productivity of the country is very limited (Alvarez, 2002). Mining, financial services, and electricity, gas and water, are the sectors where foreign investors have invested predominantly in the period 2006-2010 (see Table 6). Moreover, Chile relies heavily on imported knowledge through R&D by foreign enterprises, royalties, patents, and machinery. R&D developed by universities is only poorly if at all absorbed by industry. The main source of foreign direct investment is the United States with a share of 26% of all FDI for the period 1974-2010, followed by Spain (19%), Canada (18%), the United Kingdom (8%), Australia (5%), and Japan (4%) (CIE, 2011).

In 2010, CORFO launched the programme 'Go to Market' supporting Chilean entrepreneurs (individuals or institutions –i.e. universities, private sector enterprises, and non-for-profit organisations) in finding foreign markets and investors demanding their knowledge products. In 2011, 50 sucessful applicants were granted a total of €1.3m (Ch$ 873.6m). The programme aims to bring R&D projects and technologies from ideas to the market, by linking them with technology brokers abroad. Up until now, the Standford Research Institutes (SRI) has acted as the main broker, by offering training tools in business planning, and organising meetings in Silicon Valley with enterprises, incubators and investors.

Additionally, the Ministry of Foreign Affairs, through its network ProChile, launched a pilot programme called ContactChile supporting entrepreneurs in understanding and penetrating international markets.

**Table 4: Foreign Direct Investment by economic sectors, Million Euros (2006-2010)**

| Industry | 2006 | 2007 | 2008 | 2009 | 2010 | Total | Share of total |
|---|---|---|---|---|---|---|---|
| Agriculture and fishing | -86 | 95 | 66 | 99 | 21 | 195 | 0.43 |
| Mining | 2,702 | 4,617 | 3,046 | 4,745 | 4,655 | 19,766 | 43.36 |
| Manufacturing | 920 | -480 | 1,073 | 236 | 257 | 2,006 | 4.40 |
| Electricity, gas and water | 842 | 66 | 943 | 1,398 | 750 | 3,999 | 8.77 |
| Construction | 36 | 49 | 107 | 12 | 83 | 286 | 0.63 |
| Commerce | 328 | 396 | 414 | 553 | 824 | 2,516 | 5.52 |
| Hotels and Restaurants | 26 | 32 | 24 | 5 | -2 | 86 | 0.19 |
| Transport | 2 | 102 | 374 | 41 | -6 | 512 | 1.12 |
| Communications | -112 | 262 | 801 | 95 | 908 | 1,953 | 4.28 |
| Financial services | 664 | 3,430 | 2,660 | 868 | 2,498 | 10,119 | 22.20 |
| Business services | 296 | 270 | 559 | 333 | 984 | 2,442 | 5.36 |
| Other services | 4 | 130 | 81 | 70 | 32 | 318 | 0.70 |
| Not assigned | 194 | 157 | 175 | 361 | 386 | 1,274 | 2.79 |
| **Total** | **5,816** | **9,161** | **10,352** | **8,862** | **11,397** | **45,588** | **100.00** |

Nota: Data is presented in the form of a balance of payments. A positive sign shows an increase of FDI in Chile, and a negative sign a decrease.

Source: Central Bank of Chile, 2011.

Data on Government budget appropriations for R&D (GBAORD) by socio-economic objective is not available for Chile.

Current developments in policies and programmes include the support to sectors through Consortia financing (i.e. Innova Chile's *Technology Business Consortia*), the Applied R&D programme, support for technology brokers, intermediaries and technology diffusion (i.e. the *Nodes Programme*), and Offices for technology transfer and licencing in universities. Although, cluster policy has not been financially supported in Chile since 2009, some clusters remain active (i.e. offshoring, milk, and agro-fisheries).

The government of Chile does not have any policies supporting knowledge and R&D in public procurement.

## 2.5 KNOWLEDGE PRODUCTION

### 2.5.1 Quality and excellence of knowledge production

The Chilean research and innovation system is characterised for having relatively low inputs in research (measured by the public funds for R&D and the availability of HRST and researchers in comparison to national targets), and an average-to-low scientific output (measured by the number of ISI publications and their impact factor). Research infrastructures have been an increasing government priority since 2004 (i.e. the Basal Programme and PIA). Regarding the availability of human resources in research (R&D personnel), Chile had about 5,441 FTE in 2010, compared to 240,000 in Brasil, 70,000 in Mexico, and 57,000 in Argentina- showing the small size of the market in comparison to other Latin countries.

The system underperforms in terms of outputs. Regarding performance of HEIs measured by the scientific production through the number of publications and citations, Chile is placed on

position 43 of the world rank for the period 1996-2007 (CEPAL, 2010), with more than 30,000 publications produced and 233,000 citations. This value is however behind the world ranks of Brazil (17), Mexico (28) and Argentina (34). In 2011, the number of scientific publications as included in the Web of Science (WoS) increased by 23% in comparison to 2010, reaching a total of 6,134 publications (América Economía, 2011). In some fields, particularly in astronomy and Antarctic research, Chilean researchers compare well internationally.

Regarding the citation rate of Chilean scientific publications (and despite the fact that this does not necessarily reflect the quality of the publications), this was equal to 4.1 in the period 2002-2006, which is slightly lower than the world average of 4.6, but above the levels of Argentina (3.3), Brazil (2.9) and Mexico (2.8) (CONICYT, 2006 –with World Bank data). Also, in Latin America, Chile has the highest number of publications per capita. Chilean scientific production is also highly concentrated at institutional level. As an average, universities have quite low levels of research, and the bulk of the activities is generated by only a few universities (about two-thirds of WoS publications are produced by three universities). Moreover, only a few universities perform most of the R&D and receive the majority of funding. For instance, in 2011, the University of Chile (28.2%), the Pontifical Catholic University (19.5%), and the regional University of Concepcion (9.3%) were the most significant recipients of FONDECYT funding.

Given the awareness of the government of the considerable gap between knowledge production and its exploitation, CORFO has implemented the *Applied R&D programme* supporting the process of obtaining patents, especially in precompetitive research. The Industrial Property Department of Chile granted 5,733 patents between 1994 and 2005: 16 to universities, 6 to research centres, 65 to firms and the rest to individuals. Less than 15% of patents granted correspond to Chilean residents. In 2008, a total of 1,398 patents were granted, out of which only 9,3% corresponded to Chilean residents. Although the levels increased continousy over the last years, they remain low.

The 2010 Innovation Survey, showed that 21.1% of innovative mining companies hold patents, compared to the trade sector with 5.8% and manufacturing with 5.5%. Thus, mining is not only the most important industrial sector in Chile, but it is also leads to the largest number of patents granted to nationals and foreigners from the Chilean Patent Office. Licensing over the last five years has been 0.5% of GDP, half of the level of more advanced knowledge economies with a strong natural resources base, such as New Zealand. A large share of the Chilean patents includes a foreign co-inventor. In many of the export industries, which have the most demand for R&D results, there is a large foreign ownership (e.g. mining, fishery).

### 2.5.2 Policy aiming at improving the quality and excellence of knowledge production

One of the weakest aspects of Chilean research and innovation policies is the lack of mechanisms for systematic evaluation and monitoring of institutions, agencies, programmes and policies. This does not mean that evaluations do not exist, but these are not periodic, and the results are not always public. In the last years CONICYT has only made public the results of one programme evaluation –the FONDEF, but it has not published the results of evaluations of its main programmes (i.e. FONDECYT and the *Associative Research Programme*), undertaken in 2011 and 2012. Between 2008 and March 2010, the CNIC performed some evaluations, whose results were made public. In 2009-2010, the CNIC was in charge of the Evaluation of the *National Innovation Strategy*, including all of its action lines (this was not however an evaluation to CNIC's programmes). Since 2010, and coinciding with the change of its Executive President named by the new government, no other evaluations have been made public. In January 2012, the CNIC launched a call for tenders for the "*Design and Management of a Digital Diffusion Strategy for the Review of the National*

*Innovation Strategy*". However, up to December 2012, there has been no dissemination of the results of the evaluation. The study should have been completed by October 2012.

Until now, there is no publicly available information indicating that the distribution of funds and budget is done as a consequence of evaluations. However, the National Directorate of Budget (DIPRES) evaluates some of the S&T programmes[14]. These evaluations are usually taken into account by the agencies managing the funds.

The performance of universities is not measured using publication outputs but by using the achieved degree of exploitability of the generated knowledge. Since 2008, the number of patent applications by universities is used as an indicator for excellence. There are neither specific indicators to measure the excellence of researchers, nor are university departments evaluated.

Additionally, the government aims to improve the quality of research through its "*Centres of Excellence*" initiative that started in 2004, and its initiative to attract International Centres of Excellence. These were implemented following a call for proposals on scientific needs by the CNIC in 2009 that showed the need to have internationally recognised centres, higher investment in public goods, and a greater critical mass in sciences. The initiative offers competitive funding (grants) linked to publications, citations and patents, and to support the development of human resources in sciences. The Centres of Excellence are selected through a peer-review process with a panel of international experts. There are currently 32 centres of excellence: 13 are Basal Centres, 12 are regional centres, and 7 are PIA centres (*Shared Major Scientific Equipment Programme*).

A second initiative, started in 1999, supporting centres of excellence is the *Millenium Science Initiative* (MSI), which currently is under the auspices of the Ministry of Economy[15], with the objective of promoting the development of cutting edge scientific and technological research. The MSI finances the creation of Centres of Research-Millenium Institutes, selected through public grant competitions for their scientific merits. They are evaluated based on the performance of researchers and their output, such as teaching activities, publications, citations, and the internationalisation of research.

## 2.6 KNOWLEDGE CIRCULATION

### 2.6.1 Knowledge circulation between the universities, PROs and business sectors

Knowledge circulation between universities, PROs and the business sector is a key problem in Chile. The OEDC 2007 report on Chilean Innovation Policy states that interaction between the key players within the national innovation system shows 'serious weaknesses'. The climate and framework conditions for improving the science-industry complex and the circulation of knowledge are not being supported. Universities have had very limited relationships with industry, perhaps (and arguably), mainly because of a lack of demand, but certainly due to the academic tradition of not emphasising industry needs. Also, mobility between the sectors is low (ERAWATCH, 2010). According to the 2010 Innovation Survey, only 2-3% of the innovating companies in Chile cooperate with universities or PROs. Cooperation among universities, public research centres and firms in Chile is very low (CNIC, 2010).

[14] Examples of evaluated programmes, funds and organisations are the FONTEC evaluated in 2005, the Innovation in Agriculture Programme in 2005, the FONDEF in 2006, the Postgraduate Scholarships Programme in 2006, the Regional Programmes of CONICYT in 2006, the Business Incubators Programme in 2007, and InnovaChile in 2009.

[15] The initiative was prior under the responsibility of the Ministry of Planning.

Government response to the weak interaction has been strong in the last years. The innovation strategy concerns for example 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 (World Bank, 2009). This perceived lack of effective technology transfer, as well as the inadequate institutional and financing mechanisms, hamper the creation of new technology-based firms. Privately commissioned research and mission-oriented research have been discussed publicly, however the debate – notably within the CNIC- did not reach a consensus on the fact that support for research should be mission-oriented. Currently, there are no policies oriented neither to supporting clusters nor for mission-oriented research. Policies supporting entrepreneurship, notably those promoted by the Interministerial Committee for Innovation of the Ministry of Economy, are mainly in charge of universities and business associations (i.e. *Business Incubators programme* and the *Start-up Programme*).

Universities have access to competitive funds to work with incubators. The latter exist since 2001. Nevertheless, CORFO supports the functioning of eight incubators since 2011. Four of these are universities and will receive funding for up to six years. In 2012, CORFO granted additional funds to four other incubators, out of which three are universities and one is part of the Chile Foundation. Since 2012, CORFO provides support to two types of incubators: to incubators-I, or those focusing on the creation of innovative enterprises with high growth potential, linked to high level knowledge and technologies; and to incubators-D, or those developing new businesses with medium-return, which are not necessarilty producing innovations and are not linked to frontier technologies.

The Programme to Attract International Centres of Excellence was launched by CORFO in 2009 in response to low performance levels in the transfer and commercialisation of scientific results produced in Chile. The objective of the programme was to attract renowned international research centres with a track record in creating business out of technology. In essence, Chile wants to transfer a culture of research and management from highly experienced and successful research organisations to the markets and society. The programme requires the foreign international centre of excellence to set up an entity in Chile and to generate high quality R&D activities in the country in collaboration with Chilean players (especially universities), in exchange for a subsidy of up to €14.2m (Ch$ 11,530m) over 10 years. More than a dozen research organisations responded to the call for projects. Receiving grants are the Fraunhofer Society (Germany), CSIRO (Australia), INRIA (France) and the Wageningen University and Research Centre (the Netherlands). The first three are already up and running, whereas the latter has started to operate in the last months 2012, and will finish its initial phase early 2013.

In relation to consortia financing, InnovaChile's instrument *Business Technology Consortia* (or Consorcios Tecnológicos Empresariales) funded several technological consortiums between companies and universities. In 2009 there were 22 supported consortiums with a total investment of approximately €95m (Ch$ 77,140m), of which 47% was private. FIA and CONICYT have also financed consortiums, the first providing sector-specific funding. Most of the consortia receiving public subsidies from CORFO, CONICYT and FIA stopped operating in 2011, when the programme was discontinued. However, CORFO launched a call for projects called "Transitioning Basal Funds for Technology Consortia", which aims to provide transitional funding to the original initiative, while a new programme is created. Funding is granted for up to 3 years (total budget €238k (Ch$ 193.2m)) under two modalities: 'Technology Consortia for Innovation', and 'Technological Associations for Competitiveness'.

### Cross-border knowledge circulation

Given the less-developed status of the Chilean innovation and research system, international knowledge access and transfer is considered as very important. The government, public research institutes, universities and enterprises view international cooperation as an opportunity to accelerate learning and to increase research capabilities more quickly. Following the example of more dynamic and innovative economies, the CNIC considers internationalisation of Chilean innovation activities to be a central point for policies. Like its

trade strategy, the country seeks bilateral and multilateral agreements in STI with the most dynamic countries in the world. As evidenced by CONICYT's programmes, there is a strong consensus that the best knowledge and technology transfer is done via 'inserting' foreign experts into Chilean research organisations and communities.

In September 2002 the EU and Chile signed an agreement on scientific and technological co-operation bilateral S&T Cooperation agreement. The objective of the agreement was to intensify scientific collaboration, notably in the context of the European Research Area. Chilean participation in the FP has considerably increased in the last years. In the period 1998-2002 there were 23 projects involving Chilean participants, a number that increased to 73 projects in the period 2002-2006. Chile also holds a vast number of other international agreements with research organisations in foreign countries. It also participates in multi-lateral cooperation agreements within Iberoamerica, notably the *Ibero-American Programme for Science Technology and Development* (CYTED) focusing on ICTs, health, sustainable development, energy, science and society, and industrial development (see also ERAWATCH Research Inventory Chile country presentation).

The Programme for the *Attraction of International Centres of Excellence* has been the priority of the last two governments, investing significant funds with the objective of facilitating knowledge and best practices from what are considered benchmark countries to Chile.

Chile has no initiatives involving inter-governmental research infrastructures. A case of shared infrastructures is the European Southern Observatory (ESO), where Chilean researchers can be hired as staff, but not at decision-making levels. Other observatories, such as the Atacama Large Millimeter Array (ALMA), formed by European, North American and East Asian organisations, has promoted the hiring of Chilean professionals at managerial levels. In all cases, Chile does not participate in the financing of the observatories, and simply provides the geographical location following the cooperation agreements between Chile and the research organisations.

Individual mobility of researchers is enabled particularly with the countries that have signed co-operation agreements with Chile. The main measure supporting the mobility of individual researchers (nationally and internationally) is the *Scholarship Chile* Programme. A total of 770 international scholarships were granted in 2011. The most popular destinations for Chilean Masters degree students receiving CONICYT scholarships in 2009 were the US (25.5%), Spain (24.2%), the United Kingdom (21.2%), France (15.1%), and Australia (14.6%); and at PhD levels, the US (29.8%), Spain (17.9%) and the UK (17%) (CONICYT, 2009).

The EU Framework Programme, through the *People* programme has supported 31 Chilean researchers in the period 2007-2010, 90% via the Marie Curie's International Research Staff Exchange Scheme (IRSES), the remaining ones via the International Outgoing Fellowships (IOF) and the International Incoming Fellowships (IIF) Programme.

### Main societal challenges

Chile has several national challenges, many related to natural resources and the peculiarities of geography. The country has quite severe and continuous energy crises, and struggles with water resources in some of the most copper-rich regions. Climate change is also affecting Chile critically, especially its vulnerable and important glaciers, which provide the only available water in several regions. During the past 20 years thematic priorities were defined in order to achieve a better quality of life for Chilean people.

From the international co-operation agreement that Chile has signed with the EU, some identified challenges are energy, water resources, and national research capabilities and development. Other co-operation priorities are agriculture and the energy market, technology intelligence for SMEs, health care, and plague control.

## 2.7 OVERALL ASSESSMENT

Public funding for R&D has been once again growing after the 2010 earthquake that deviated funds and resources to other national priorities. However, available funds still lack focus, and there is the need to enable the development of a co-ordinated and comprehensive system. There are several barriers that hinder the effective development of the RTDI system for achieving the expected outcomes, including barriers to R&D investment, lack of critical mass (i.e. relevant stakeholders in the RTDI system), lack of coordination and linkages between actors in the national RTDI system and the adequate use of public funds supporting R&D. There is limited support for collaborative research and technology transfer. The constant changes in government priorities have created a dynamic inconsistency, as budget lines for R&D are constantly changing. Moreover, there are limited mechanisms in place for the systematic evaluation and monitoring of institutions, agencies, and programmes.

Regarding human resources, the main weakness of the system is a low number of students enrolled in tertiary education, and consequently low rates of S&E graduates, On top of this, the human resources created are not being utilised most effectively Even though the Scholarships Chile programme is supporting Ph.D. and Master level students, there is a risk that many of the scholarship holders educated in foreign institutions do not return to Chile.

The Chilean economy is not diversified and the effect of FDI -and foreign-owned enterprises- on the overall productivity of the country is very limited. Moreover, R&D developed by universities is only poorly if at all absorbed by industry. Bureaucracy hampering the use of the tax benefits for R&D in enterprises has been tackled through changes to the Tax Exemption Law implemented in the second half of 2012, and whose resuls are not yet visible.

The interaction between key players in the national innovation system is very weak. However, framework conditions for improving the science-industry complex and the circulation of knowledge are starting to be supported in universities and industry.

# 3 National Policies for R&D&I

## 3.1 LABOUR MARKET FOR RESEARCHERS

### 3.1.1 Stocks of researchers

According to the R&D Survey of 2010 (Ministry of Economy, 2012), 17,910 people work as R&D personnel (researcher, technicians and administrative personnel) in Chile. The number of researchers per thousand of labour force was of 1,2 in 2010[16]. There are 9,453 researchers, out of which 3,947 are PhD holders. Researchers in Chile are working in the private sector, universities and private non-profit organisations (i.e. the Chile Foundation, the Life Sciences Foundation). From the PhD holders, 82% work at universities and 5% in enterprises (Ministry of Economy, 2010)[17]. There are no studies or analyses on the number of researchers needed in Chile.

As an estimation of the (outwards) mobility of researchers in Chile, the CONICYT granted a total of 852 scholarships through the *Scholarships Chile Programme* in 2011, out of which 439 were for PhDs, 360 for masters and 53 for postdoctorate degrees. Since its inception in 2006 and until 2009, the programme financed 1,729 PhD scholarships abroad, and between 2008-2009 a total of 1,645 scholarships at Masters level. There are no other available data on the inwards and outwards flow of researchers in Chile.

Although there have been programmes to attract foreign researchers (i.e. notably through institutional agreements targeting specific universities –mainly in the United States), this is not common practice in Chile. In the future, more inward foreign researchers are expected, notably through the Programme to Attract International Centres of Excellence.

### 3.1.2 Providing attractive employment and working conditions

There are no studies about the salaries of researchers. All universities are free to set the salaries of their researchers. All PTIs have salary scales/levels similar to those of civil servants. Some authors (de la Fuente, 2009) have signalled the existing disparities in salaries relative to affiliation and discipline. Researchers in private universities have higher salaries than researchers in public institutions. Researchers in the areas of business management and economics are better paid than those in medicine and other humanities disciplines. Additionally, the Catholic University of Chile (private-public), and the universities Adolfo Ibañez, Los Andes, and del Desarrollo (all three private), grant higher salaries to their researchers, together with those institutions teaching MBAs.

The work conditions are not different from other economic sectors. Research personnel can be hired under the Labour Code or as independent workers (full-time or part-time) -and the researchers themselves are responsible of paying their social security. Most research positions in universities are financed through projects won competitively by the researchers themselves.

As a preventive government action to brain drain, the programme for the *Insertion of human capital in academia and industry* of CONICYT promotes research careers and concerns the insertion of highly qualified personnel to the Chilean labour market.

[16] According to the Chilean Statistics Institute, the total labour force was equal to 7.98 million people in 2010. Total labour force includes all individuals that are 15 years old and older.
[17] The complementary 12.9% work in other sectors non-specified in the referenced study.

The maternity leave is paid if the researcher is under a Labour Contract. This is not the case of researchers working as independent/freelance workers. There are no policy actions in favour of equal gender representation of researchers at different levels in organisations.

### 3.1.3 Open recruitment and portability of grants

Open recruitment of researchers, through public calls, advertisement in newspapers and websites, is particularly common in the public sector and academia. The recruitment procedure is semi open because in practice anyone can apply and have access to the evaluation results. However, interviews or oral examinations are not open. There are no restrictions to research institutions for recruiting foreign researchers.

There are no procedures or a system in place for the recognition of professional qualifications. Researchers with a foreign doctoral or masters degree usually have their national grade recognised, notably with those countries with which Chile has signed agreements (since 1917, with Brazil, Colombia, Equator, Spain, Uruguay, Bolivia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Peru) (University of Chile, 2011).

Research grants can be handled and managed directly by the researchers, or indirectly by their institution of affiliation. However, if researchers change their institutional affiliation, the grants remain in the institution to which these were initially granted.

Researchers have social security as any other worker; there is no special pension scheme for researchers. Supplementary pension schemes do not exist in Chile. All pension funds are private, meaning that each person has to contribute for his/her own pension through personal savings. In the case of researchers with a labour contract, the employer contributes to the pension fund but the amount contributed is deducted from the researcher's gross salary. Independent freelance researchers contribute to their own pension through savings.

### 3.1.4 Enhancing the training, skills and experience of researchers

There are neither academic professionalisation policies nor academic training policies in Chile. Training is voluntary.

Regarding the mobility of researchers, the *Programme for the Development of Advanced Human Capital* –also called *Scholarship Chile*- of CONICYT, provides grants for postgraduate studies nationally and abroad. The objective of the programme is to increase significantly the quality and quantity of researchers in the country. In 2011 the programme *Scholarship Chile* -created in 2008-, was the biggest public programme in R&D in terms of budget and, in contrast with the rest of programmes for R&D and academia, it is continuously growing. Between 2005 and 2009 the number of scholarships for postgraduate studies abroad increased by nearly 900%[18].

Grants for studies inside Chile have been also growing, and the policy is now oriented to link national programmes with programmes abroad through Chilean graduate and doctoral students, or by bringing foreign professors to Chile. Also through *Scholarships Chile*, CONICYT funds internships for post-doctoral studies in Chile or abroad. Many universities (e.g. the Alberto Hurtado University, the University of Development, and the Adolfo Ibañez University) are also linked to foreign universities through institutional agreements in postgraduate programmes. Some of the local universities (e.g., the Federico Santa María Univesity) can send their students abroad for some weeks, via a university student loan that is self-financed by the student. Other universities give their students access to online courses in foreign universities.

[18] It is a prerequisite that the beneficiary has been accepted to the foreign university prior to applying to the scholarship.

Inter-sectoral mobility is mainly promoted through CONICYT's *Programme to introduce advanced human capital in research centres and enterprises*. The pilot programme was implemented between 2004-2008, granting 37 subsidies that financed 100% of the salaries of researchers in the first year, 86% of a full-time salary during the second year, and 71% for the third year. A survey study determined that 81% of researchers at Masters and PhD levels continued working at the universities and/or enterprises after the end of the programme. Additionally, a total of 11 innovations[19] emerged from the R&D projects in which the researchers participated. In 2010, 35 projects were financed, benefiting 46 young researchers, and attracting 32 international researchers for short-term research periods. In 2011-2012, two calls for projects were organised focusing on inserting international researchers in regional universities for a maximum period of 10 months, also open to Chilean researchers that have been working as researchers abroad for at least 7 years. The completion of the first call has been evaluated as a positive step towards increasing research in academia.

## 3.2 RESEARCH INFRASTRUCTURES

Chile does not have a national research infrastructures roadmap or national strategy. The CONICYT funds infrastructure investments through two programmes: the *Basal Programme*, started in 2004; and the funds for *Shared Major Scientific Equipment* (PIA)[20], which launches a call for proposals every year. The Basal Programme became a funding line of PIA in 2011. It provides long-term, five-year funding for centres of excellence in universities and PROs. It also finances research networks, associative research and training of researchers. PIA's 2010 call for proposals was for major equipment acquisition on the basis of shared use and to have a high occupancy rate and shared costs (critical mass), being accessibility between several players. The total budget of the PIA –including the Basal Programme- for 2011 is of €53.8m (Ch$ 36,153m). The Basal programme is currently being evaluated (i.e. in 2012), and new funds have been earmarked for launching a new call for proposals. A mid-term evaluation of the PIA has been announced (with no specific date) and the results will be critical for securing its continuity.

In addition, almost all of the CONICYT programmes can finance research equipment.

## 3.3 STRENGTHENING RESEARCH INSTITUTIONS

### 3.3.1 Quality of National Higher Education System

There are three different types of institutions considered to be HEIs, *universities, professional learning institutions, and technical training centres*. In total there are more than 300 HEIs in Chile, universities counting for a total of 61. As the only group of institutes producing tertiary graduates and postgraduates, universities are essentially the R&D performers within the Higher Education system. A total of 16 universities are public (i.e. called 'traditional' universities), 36 are private and autonomous, and 6 are private and non-autonomous. Public universities are the best in terms of quality, but the private are increasingly offering better quality programmes (Bruner, 2007). Funding budgets between private and public universities are radically different. Funds for public universities are scarce, whereas private universities obtain important funds from tuiton fees and other institutional sources. Universities performed €208m (Ch$ 140,140m) in R&D, and financed €70m (Ch$ 47,250m) in 2010, which is 20% lower in comparison to previous years.

[19] The survey study asked the beneficiaries whether they have introduced any type of innovation (product, service, management, design) during the duration of the programme. Eleven respondents declared they had.
[20] Or in Spanish, Concurso de Equipamiento Cientifico y Tecnologico Mayor de Uso Compartido - PIA.

The number of tertiary education graduates in the population aged 24-65 has increased in the last years, and in 2004 it was of 13% that corresponds to half the average of the OECD (OECD-World Bank, 2009). In 2010, the total number of tertiary level students in technical training centres, professional institutes and universities was almost one million. Women represented 51% of all students in universities, 48% of total in professional institutes, and 53% of total in technical training centres (Ministry of Finance, 2010).

The task of the HEIs is twofold: to train technicians, professionals, graduates and postgraduates; and to contribute to scientific and technological development. Beyond these tasks, the Ministry of Education has set the general, overall objectives and roles of universities as to: develop advanced human capital; provide learning opportunities beyond secondary education; create advanced information and knowledge; provide support for a reflective culture and public debate; and stimulate regional development.

Regarding research performance, Chile scores very well in comparison to the rest of Latin American countries. According to the Index of Talent Development Ranking of Heidrick & Struggled for 2011 -produced by *The Economist Intelligence Unit*-, Chile came out in second position. The ranking takes into account factors such as the number of enrolments, the placement of the universities in international rankings, and total expenditures in education as a percentage of GDP. With a ranking equal to 46.7 points, Chile is placed in rank 26, and is the highest in Latin America, followed by Argentina (rank 32), Mexico (36) and Brazil (38).

However, regarding the performance of Chilean HEIs, the QS University Rankings in Latin America 2012/2013 places only a few Chilean universities in the highest places (i.e. four out of the top ten ranked are Chilean universities). In this ranking, academic performance is measured through academic and employer reputation surveys in combination with data on research productivity and citations, student/faculty ratio, the proportion of staff with a PhD, and web presence. Chile is placed in rank 50 regarding the number of staff with a Ph.D. per student, and rank 30 in the student/faculty ratio. This could indicate that the academic level currently being offered in Chilean HEIs does not correspond to the amount of fees being charged to the students (QS Intelligence Unit, 2012).

Chile has the highest number of publications per capita in the Latin American region. However, the scientific community, across the board, is small and concentrated in a few universities, which also dominate in terms of citations of WoS publications; equalling 6,134 publications in 2011, compared to 5,661 in 2010 (see ERAWATCH Research Inventory Chile Country Fiche 2012).

Chilean universities are not found in international rankings (i.e. Shanghai Academic Ranking of World Universities, the Times Higher Education World University Rankings). However, the Business School of University Adolfo Ibañez was ranked first place for the second consecutive year (i.e. 2011-2012) for its MBA in the *América Economía* Magazine's Universities Ranking - evaluated using factors such as number of professors; degree of internationalisation; networks; production and diffusion of documents and publications; and business environment and enterpreneurship.

The quality of higher education has been a continous concern for the government. In 1999 two commissions were created in order to advice the Ministry of Education. On the one hand, the National Commission on Accreditation of Postgraduate Studies (CONAP) was tasked to continue the work begun in CONICYT consisting of accrediting master and doctoral programmes and to allocate resources for scholarships. On the other hand, the National Commission on Accreditation of Undergraduate Studies (CNAP) had to develop experimental procedures for the accreditation, and to develop a proposal for the establishment of a national quality assurance system in education. Both, CNAP and CONAP, generated tools and procedures for the evaluation of institutional accreditation of educational programmes for undergraduate and postgraduate courses, and HEIs participated voluntarily and actively in these processes. Representatives of the academic sector, the CONICYT, the business sector, and from the Division for Higher Education of the Ministry of Education form the CNAP. In order to obtain public funding from CONICYT, all PhD programmes need to be accredited at national level by accreditation agencies officially designated for this objective by the CNAP.

Both committees operated until the enactment of the Law 20.129 in 2006, which established a Quality Assurance System in Higher Education. This law reflected the experiences and proposals of the previous Commissions and created the National Accreditation Commission (CNA) as the only institution for the institutional accreditation for both undergraduate and postgraduate studies. Today, the country has 61 accredited universities, which represent 75% of all universities in Chile. Accreditation has also been granted to 24% of all professional institutes and 9% of the technical training centres.

Following the MECESUP programme set up in 1998 to improve the Quality of Higher Education, the second phase of the Programme – "MECESUP 2 -Tertiary Education for the Knowledge Society" aims at providing the necessary skills to increase global competitiveness, sustain economic and social development, and ensure that talents are not lost because of differences in learning opportunities. The objectives of the MECESUP 2 include support for government planning and monitoring in the tertiary education sector, strengthen policies and strategies for tertiary education, strengthen the national system of quality assurance, improving the national information system for tertiary education, providing funding for academic and innovative projects, and implement pilot performance agreements in public state-level universities. In 2012, MECESUP launched a call for proposals targeting universities in order to make them innovative, which is a novelty in the Chilean academic sector. The programme will work under a scheme of Performance Agreements integrating management and evaluation indicators. For a total budget of €12m (Ch$ 7,680m) for three years, the call will extend three grants to the best proposals.

### 3.3.2 Academic autonomy

The Chilean Constitution and the Chilean State initially guaranteed universities' autonomy in 1931. Since then, the system has changed from fully public, to a system with strong private participation. During the 1980's, the military government gave the opportunity to the civil society to start new universities with private funding and capital. The new Constitution of 1980, and the Law of 1990 (LOCE –or the Constitutional Organic Law on teaching), restrains the rights of granting Bachelors degrees to 18 professions. Currently, the General Education Law of 2009 regulates education in Chile, and also gives the possibility to private not-for-profit organisations to create new universities.

There are three governance models in Chilean universities: those of public universities, private laique universites, and private universities. Public universities are managed by a Board of Directors formed by government representatives; and an Academic Council with an advisory role, and composed by the Rector, a vice-rector, and renowned academics. The Board establishes all university policies, and decides upon financial issues, salaries of researchers, and the approval of study plans. Students and administrative staff do no participate in the Board. The university professors elect the Rector. Private universities elect their Rector through Corporate Councils that represent the interests of the owners and members of the private institution. The Rector appoints the Deans upon approval of the Councils and without consulting the university's professors. Private laique universities that are part of the CRUCH –or Rector's Council of Chilean Universities- have the same governance models as public universities. However, religious authorities, particularly the bishop, have influence in naming the Rector (OECD-World Bank, 2009). All governance models give the Board of Directors the autonomy to decide on the management of the institution, by assigning tasks and responsibilities to the Deans. All universities are autonomous in choosing and designing their research agendas.

Regarding financial autonomy, universities receive funds from the government, based on a mechanism under which only those universities (called *traditional*) that belong to the CRUCH receive direct financing. There are 25 members in the Council, the remaining 35 universities being private. The CRUCH universities receive direct fiscal support (AFD), depending on the number of students and courses. However, 95% of this is direct, and 5% on the basis of the university's performance, measured by the number of publications in

scientific journals, number of competitive-funded projects, and the number of human resources with a Masters and PhD levels. The AFD for 2012 will be approximately equal to €275m (Ch$ 176,000m).

In addition, the government helps finance all universities through indirect fiscal support (AFI), which will be approximately €37m (Ch$ 23,680m) in 2012. The AFI is allocated to those universities attracting the top 27,500 students based on their results on the *University Selection Test* (PSU) (Bruner, 2007). The dependence of CRUCH universities on the AFD is very high, which makes it difficult to improve in terms of efficiency. Universities are not obliged to report on the use of these funds, which makes it difficult to manage and monitor/evaluate.

As an initiative to encouraging strategies for restructuring and modernising Chilean univiersities, the Ministry of Education has introduced university "performance contracts" since 2006 –first as a pilot programme under MECESUP 2 (see section 3.3.1).

### 3.3.3 Academic funding

Public academic funding comes from four major sources: the AFD; the AFI (both of them were equal to 47% of total public funding to universities in 2008 (Cáceres et al., 2008)); tuiton fees paid by students, credit and scholarships (47% on average); and resources from other organisations and services (7%). However, the distribution of shares changes from case to case. Private universities receive more funding from organisations that support them (i.e. foundations, individuals, investors, private sector enterprises, trust funds). Funding dedicated explicitly for research comes from competitive funds of CONICYT and CORFO and each university can leverage them with its own funds. The large share of fees paid by students, student credits and scholarships, has created a university system that competes for attracting students. Moreover, several universities have specialised marketing strategies in TV and other media for the promotion of their institutions.

Other elements of academic funding, notably in relation to the allocation criteria of funds for research, and the financial autonomy of universities are discussed in section 3.3.2.

## 3.4 KNOWLEDGE TRANSFER

### 3.4.1 Intellectual Property Policies

Property Rights have been promoted more intensively in the last 7 years. The government was concerned about the low productivity of the national R&D centres and universities. Different studies undertaken by the Ministry of Economy through the Chile Foundation and CNIC in 2004 and 2008, and a diagnostic of IPRs in Chile by the World Bank in 2009, showed that the IP system was little used. Moreover, Chilean universities have not been very active in seeking to establish IPRs and, with a few exceptions, had little success in generating revenue from the exploitation of IP assets.

In support to this, the National Institute of Industrial and Intellectual Property Rights (INAPI) was created in 2009, as an institute depending of the Ministry of Economy. The INAPI is advocated to grant, register and diffuse property rights. INAPI acts together with CORFO and CONICYT to give potential IP users more facilities and easily available information. INAPI is incorporated to the Patents Cooperation Treaty (PCT) since its creation.

The government grants free access over the ownership from research outcomes financed by public funds. In particular, CONICYT has more barriers than CORFO in relation to ownership rights because universities and research centres –the main beneficiaries of CONICYT- are less concerned about IPs. There are no clear IP policies and rules developed

by public research organisations. In some cases, when using public research, a third of the revenues from the research outcomes can go to the researcher. There are no specific rules to "non-employees" such as students.

Universities have developed Offices for Technology Transfer (OTT) since many years, notably in the University of Concepcion and the University of Santiago. Despite this, the results are not promising, because R&D in Chile is usually done at the level of basic and fundamental research. Results are not transferred to brokers in order to continue their way to the market. The University of Chile has a manager in charge of IPRs but it is not frequently used nor demanded. Private universities normally seek advice from international IPR specialists abroad.

CORFO started to fund a holistic programme to bring science to the market by providing training in Licensing and Patenting Offices (OTLs) in universities, given the low qualifications in HEIs identified in an evaluation by the CNIC in 2010. In 2011, 15 University-based OTLs were funded. The overall objective is to expand the number of innovative companies in Chile, and to use the knowledge created in universities effectively in the market. The implemented model is similar to brokering, including technical advice.

Finally in 2012, within the framework of the MECESUP II Programme, a new call for proposals was launched called InES -"Innovation in Higher Education", with the objective of making universities innovate through science (see Section 3.3.1).

### 3.4.2 Other policy measures aiming to promote public-private knowledge transfer

**Spinoffs**

Spinoffs are not too common in Chile. There are however some successful cases financed through public funds (i.e. AFD, AFI) and coming out of universities (e.g., University of Santiago, University of Chile). In 2008, CORFO supported business spin-offs through its Support for Creation of Entrepreneurial Spin-offs programme. The objective of the support measure was to create new, high-growth potential business from non-core business areas. Companies, universities and public organisations could apply for funds, which could be used to cover up to 70% of the expenses of projects costing no more than €450.000(Ch$ 343.8m). The activities of the projects included evaluations, training, and incorporation of external experts. However, after a first call, the programme was discontinued.

The Government supports venture capital networks, also through CORFO. The Business Angels Networks programme provides up to 70% funding (of projects up to approximately €150k (Ch$ 100.8m)) for no more than six years. The networks can use the funds in several different types of activities, including investment opportunity searches, workshops, training and others. There are currently six existing networks funded by CORFO. Since 2010, there are also specialised offices to attract venture capital and business angels. Three of them are linked to universities, the Catholic University –*IncubaUC*-; the University of Chile together with the University of Los Lagos –*Angeles de Chile*-; and the University of Bío-Bió -*Angeles del Sur*. Three other offices are private: *Proyecta*, *Southern Angels*, and the *Women Entrepreneurs Club S.A.* These offices have been successful and are developing and spreading their business activities to more investors.

**Inter-sectoral mobility**

Researchers in Chile usually work in academia and some in the private sector working as consultants. According to the Innovation Survey 2008, from around 2,000 scientists, only 5.1% work in the private sector. There are no legal restrictions to inter-sectoral mobility; however, it is common that research centres make their employees sign a confidentiality agreement when hired. CONICYT's Programme to introduce advanced human capital in research centres and enterprises is the most important for inter-sectoral mobility.

**Promoting research institutions - SME interactions**

CORFO funds a total of 19 business incubators in the country (2010), which are considered intermediate players in the national system. The incubators are typically local or regional initiatives with the participation of universities, regional or local government, and companies. Activities between incubators vary, but most have very similar objectives of providing services that support new companies and facilitate technology transfer (see ERAWATCH Research Inventory Chile Country Fiche 2011, section 4.4). Incubators have many interactions with SMEs but they do not work directly with them (i.e. only as associates). The performance of services delivered to SMEs has been poor. Recent evaluations (CNIC, 2009) showed little effectiveness of the initiatives, notably in regards insufficient services offered to SMEs.

Research centres work with SMEs just in a few cases. SMEs' demand for services is also very low, most likely linked to the lack of innovation capabilities and culture in enterprises. The bureaucracy in research centres is another barrier that limits the interactions with SMEs (i.e., it hampers the purchase of services offered).

Some of the PTIs also offer services to SMEs. Following CNIC's recent recommendations, the governance system of the PTIs should be rethought in order to make them umbrella institutions that define strategic research agendas, and hence become able to respond and promote services for the private sector.

**Involvement of private sector in the governance bodies of HEIs and PROs**

Chile has public and private universities. Private universities have counsellors from the private sector in their governance bodies. The establishment of a research agenda in unverisities depends on several determinants and follows the university's vision and mission. Other organisations undertaking research close to public universities –such as foundations, or not-for-profit organisations- can have private-sector representatives in their governance bodies according to the organisation's mission. In these cases, the private sector acts as validator of the research and services delivered. The private sector has no involvement or influence in the governance bodies of public HEIs (see section 3.3.2).

**Regional Development policy**

The main instrument to promote RTDI in regions is the *Fund for Innovation and Competitiveness* (FIC). Until now this instrument has been used mainly for strengthening regional capacities. Only a few regions are active in knowledge transfer, notably the regions of Concepción and Valparaíso. Concepción has a Development Centre since 1983; and Valparaíso has a business incubator hosted by the University Federico Santa María. The Ministry of Finance will evaluate the FIC in 2011. There are no other policies or measures focusing on knowledge transfer in regions.

## 3.5 ASSESSMENT

The Chilean RTDI system has many weaknesses, the main being the shortage of advanced human resources in science and technology; lack of knowledge demand, especially from the private sector; and a low propensity to utilise Intellectual Property and technology transfer. The governance of the system has deteriorated with the CNIC having little capacity for giving a strategic long-term vision to the system. However, the system is dynamic and responds to the stimulus provided by the government, and notably those policy measures targeting the increase of R&D investments in the private sector, mainly managed by the Ministry of Economy.

Government funding has helped in increasing the number of PhDs, mainly through the availability of national and international scholarships through the *Scholarships Chile Programme*. However, the quality of HEIs remains low, and very few universities are in the

top ranks compared to other Latin American universities. One of the most notable improvements in the last year is the increase in the production of knowledge –measured by the amount of WoS publications-, which rose by 23%. This indicates that the international performance of Chilean researchers continues to increase, and the prospects for the future remain strong.

The Chilean labour market for researchers has not been analysed in detailed studies and hence there is little evidence of its characteristics and evolution. However, what is clear is that researchers do not have privileges or stable labour contracts, as it is the case in other sectors of the economy.

Regions lag behind in capabilities and infrastructure in comparison to the capital region of Santiago. However, seven of them have initiatited an ambitious process for the design of regional innovation strategies, with the financial support of the European Union. The results and long-term impacts of these processes rest pending, in particular with regards to the inclusion and importance of science and technology and the availability of advanced human resources for the actual implementation of these strategies.

# 4 International R&D&I Cooperation

## 4.1 MAIN FEATURES OF INTERNATIONAL COOPERATION POLICY

Chilean international cooperation policy is mainly focused on the Latin American region. The country's strategic objectives are to strengthen regional integration, and to contribute to the social, economic and S&T development of the region. Because it is considered as a middle-income country, Chile is not eligible as a net receptor of cooperation funds, but it has also to participate as a donor. The co-operation priorities are in fighting poverty, promoting social protection and cohesion, education, health, strengthen public institutions, support public policies, promote exports and trade, and support SMEs and competitiveness.

The Ministry of Foreign Affairs manages Chile's cooperation policy, and the Agency for International Cooperation (AGCI) is in charge of its execution. Technically, the AGCI is organised around thematic areas and groups of countries. It holds periodic international meetings and implements the actions that the Chilean government mandates, coordinating all other involved agencies, including CONICYT. Overall, cooperation policy is implemented through bilateral and trilateral cooperation agreements.

Chile is leader in the Latin American and the Caribean region in terms of growth and economic stability. It is hence common that the country receives through cooperation agreements, Latin American students to undertake postgraduate, Master degrees and Doctorate level studies, and to receive public sector civil servants to spend visiting periods on topics in which Chile is specialised.

Regarding the geographical focus, international cooperation is mainly with the neighbouring countries of Central America and the Carribeans. There is also intra-regional co-operation notably with Argentina, Brazil, Colombia, Cuba, Mexico, and Venezuela. Regarding non-Latin American countries, the main cooperators are Belgium, Canada, Denmark, Finland, Germany, France, Israel, Japan and Spain.

Bilateral RTDI cooperation with Germany is the most important in terms of funding. It has started twenty years ago and has grown over the years until reaching about €90m (Ch$ 60,750m) in 2010. It has helped to restore capacities (equipment, infrastructure and funding), particularly after the earthquake of 27 February 2010. Financial aid has been directed mainly to the environmental sector and economic infrastructure. The most important projects were on renewable energies and energy efficiency (AGCI, 2008 and OECD, 2007). Chile has also cooperation agreements with the German Academic Exchange Service (DAAD) regarding scholarships at PhD and postdoctoral levels, as well as internships. The objective is to increase scientific knowledge in scientific priority areas of Germany, with the exception of medical and clinical sciences, and veterinary. Chile also holds trilateral cooperation agreements with Germany jointly with other Latin American countries.

The second most important cooperation agreement of Chile is with the European Union. Support through scholarships to the EU (i.e. through the Marie Curie Actions of the EU FPs, and through bilateral co-operation agreements) has helped in building a base of researchers where national public funds are limited.

The most important multi-lateral cooperation agreement is the CYTED running since 1984 (see section 4.4.2).

Multilateral agreements have also been suscribed with the Organisation of American States, the Latin American Integration Association, and the United Nations System – including agencies such as the United Nations Children's Fund (UNICEF), the United Nations World Food Programme (WFP), the Food and Agriculture Organisation of the United Nations (FAO), the United Nations Development Programme (UNDP), and the Inter-American Institute for Cooperation on Agriculture (IICA).

Barriers limiting international cooperation are related to language (usage of foreign languages by project managers and researchers), bureaucracy in responding to international calls for proposals, and lack of linkages with foreign research teams.

## 4.2 NATIONAL PARTICIPATION IN INTERGOVERNMENTAL ORGANISATIONS AND SCHEMES

National participation in intergovernmental organisations and schemes is mainly done through public organisations and international co-operation agreements.

Chile has agreements with French institutions since 1992 for the training of researchers through scholarships for Masters, PhDs, and traineeships in French universities and S&T research institutes, such as the French National Center for Scientific Research (CNRS), the Research Institute for Development (IRD) and INRIA – a French public research body dedicated to digital science. The training focuses on the strategic research topics of the hosting institutions, as well as other issues including ICTs, earth sciences, health, applied mathematics, and modelling.

Cooperation with the Spanish National Research Council (CSIC) exists for the exchange of postgraduate students and young researchers, as well as for the exchange and dissemination of specialised publications.

The European Southern Observatory (ESO) works in Chile since 1966 and has an agreement with the Chilean government for the use of lands in the regions of Antofagasta and Coquimbo. Currently Paranal, La Silla, and other telescopes are functioning in Chile with a permanent flow of scientific and operational support from national services. The government holds an agreement of collaboration with ESO for Chilean researchers, regarding time for telescope observation.

In the last three years, the Atacama Large Millimeter Array (ALMA) established by astronomic research organisations from Europe, North America and East Asia, operating in the San Pedro Atacama region (Valley of Chajnantor, region II), has invested in the installation of 40 antennas that form the observation infrastructure for astronomers undertaking collaborative research. The Chilean government has secured a cooperation agreement under which national researchers are allowed to spend research time using the astronomical telescopes onsite.

## 4.3 COOPERATION WITH THE EU

After restoring political relations with Chile in 1990, the EU and Chile signed an association agreement in November 2002, which is in force since March 2005. In addition, since September 2002 both parties also signed an Agreement on scientific and technological co-operation. The Ministry of International Relations and its executing Agency for International Co-operation (AGCI) manage the implementation of the agreement. The agreement is based on the principles of mutual benefit. It supports each other's economic interests to reduce proverty and to achieve sustainable development. The two major sectors prioritised from 2007 onwards are social cohesion, and innovation and competitiveness. EU cooperation funds will be splitted between these sectors during the 2011-2013 implementation phase. This is partially funded by the EU (by 50%) for a total of €50.5m (Ch$ 33,936m). One of the action lines implemented in 2011 refers to the support for the design of regional innovation strategies in seven Chilean regions with the Subsecretary of Regional Development (SUBDERE and regional governments). Because of the cooperation agreement, Chile became a partner under the European Research and Development Framework Programmes (FPs).

Other multilateral cooperation agreements involving EU countries are Math-AMSUD and STIC-AMSUD with France, and Latin American countries including Argentina, Brazil,

Paraguay, Uruguay, and Peru. The STIC-AMSUD is a scientific and technological cooperation programme with the objective of strenghthening the creation of research networks and development in the area of ICTs, through joint research projects. The projects are selected according to their potential on innovation transfer in the region. At least two participant countries must be represented, as well as at least one French research team. The MATH-AMSUD programme is a similar initiative but with a focus on mathematics research. Both programmes, financed with French funds, launch a call for proposals every two years.

Among other cooperation instruments with the EU, there is the *Al-Invest* Regional Aid Programme and the Enterprise Europe Network (EEN) Initiative. The EuroChile Foundation acts as a co-operation network for both programmes. *Al-Invest* is an economic co-operation programme that aims to support the internationalisation of SMEs in Latin America through collaboration with European partners and in order to contribute to reinforce social cohesion in the region. Chilean beneficiaries are SMEs. The programme has a total funding of €2.25m (Ch$ 1,827m) for the period 2009-2012. The aim of the EEN is to provide services in support of business and innovation, including business co-operation, technology transfer and access to FP7. One of the main activities of the network is the diffusion of technology profiles and commercial requirements of enterprises through an Internet platform, in order to allow private counterparts to make business in a more efficient way (B2C). The network also helps local SMEs in accessing information on EU legislation and funding, and in increasing the chances of Chilean enterprises when applying to EU funding. The EuroChile Foundation hosts the EEN's Chilean contact point. The foundation also coordinates the exchange of experts, traineeships in the EU, Chilean participation in international fairs, and technological missions to the EU.

Chile has an important number of other bilateral agreements with European countries, including the United Kingdom (since 1975), Germany, Hungary, Italy (since 1990), Belgium, Denmark, Finland, France (since 1992), Poland, Portugal, and Spain (since 1997).

### 4.3.1 Participation in EU Framework Programmes

Considered as a third country for the European Union, Chile is not eligible for funding under the ERA-NETs, the European public-private partnerships, or Joint Programming Initiatives. Due to its co-operation agreement on S&T with the EU, the country can participate in some calls funded by the FP7.

Regarding Chilean participation in EU Framework Programmes, Chilean organisations have participated in 92 projects in FP7 for a total value of projects of €205.6m (Ch$ 138,163m). The most common thematic areas are the knowledge based bio-economy and environment and infrastructure; which are different from the FP6 priorities that were around sustainable development, health and ICTs. The success rate of Chilean applications in FP7 is 26%. There have been 488 applicants and 107 participations. The largest success rate (44.3%) is in the priority area '*People*'. Chilean participation in FP7 has grown vis-a-vis FP6 (see *ERAWATCH Research Inventory Chile Country Fiche 2012*), with primarily universities and research organisations as the main participants. The participation of enterprises has remained low throughout the implementation of the cooperation agreement (see Chilean European Portal, and the CONICYT Liaison Office for the EU-Chile cooperation).

Other cooperation initiatives within FP7 are CHIEP II –or the Chile-European Union Liasion Office- and Bio-Circle I and II. The CHIEP II supports networking between the EU and Chile by giving access to information (available programmes, application procedures, etc.) for potential FP7 beneficiaries. Bio-Circle is an initiative that looks for the insertion of researchers to the EU in issues related to food, agriculture, acquaculture and biotechnologies. The initiative organises training sessions for researchers from outside the EU, and provides information on the available funds and actions on these topics.

## 4.4 COOPERATION WITH NON EU COUNTRIES OR REGIONS

### 4.4.1 Main Countries

Chile has an important number of other bilateral agreements with non-EU countries. It holds cooperation agreements with almost all Latin American countries, including Argentina (1970), Brazil (1980), Colombia (1984), Costa Rica (1999), Cuba (2009), the Dominican Republic (2005), Equator (2005), Honduras (2009), Mexico (1991), Panama (1998), Peru (1999), Uruguay (2002), and Venezuela (1990). In addition, Chile has agreements with Australia, Canada, China, Japan, New Zealand, the Russian Federation, South Africa (since 1988), the United States (since 1974), and Vietnam.

There is also intra-regional co-operation notably with Argentina, Brazil, Colombia, Cuba, Mexico, and Venezuela. Regarding non-Latin American countries, the main non-European cooperations are with Canada, Israel and Japan.

Although Chile lacks science and technology co-operation programmes that finance research projects, the country has promoted short-term professional fellowships for Latin American and Caribbean researchers/professionals willing to learn more about the Chilean R&D institutional system.

### 4.4.2 Main Instruments

The most important multi-lateral cooperation agreement is the *Ibero-American Programme for Science Technology and Development* (CYTED) running since 1984. The CYTED is a successful multinational programme including European (Spain) and non-European countries. It promotes the dialogue between Ibero-American researchers and helps to extend the national knowledge base. The focus is on research, innovation and the exchange of knowledge and experiences. Research projects must include private sector enterprises involved in business networks –especially at Ibero-American and international levels.

## 4.5 OPENING UP OF NATIONAL R&D PROGRAMMES

There is no specific strategy or policy established in Chile on the opening of R&D programmes. So far, there have been no situations where R&D funded by the government has been conducted abroad. There are no discriminating eligibility criteria for foreigners who are residents in Chile, but neither are there incentives.

Bi-national R&D research is promoted through the Centres of Excellence (see section 2.6.1). Researchers can participate with other international research centres and decide to develop research in Chile or abroad.

## 4.6 RESEARCHER MOBILITY

### 4.6.1 Mobility schemes for researchers from abroad

Chile promotes the mobility of researchers from third countries since 2011. The initiative consists of supporting the insertion of foreign scientists and experts in national universities and research centres. The objective is to strengthen the training of highly qualified human resources, and increase the research productivity of Chilean universities, notably that of regional universities. The programme also promotes creating institutional linkages, and the development of research networks at national and international levels. Because of its recent implementation, it is too early to evaluate its effectiveness.

In addition, the Programme to Attract International Centres of Excellence focuses in attracting renowned international research centres with a track in technology transfer and commercialisation of research results (see Section 2.6.1).

The *Scholarships Programme for foreign researchers* started in 2011 with the objective of attracting foreign talent to regional universities. Up-to-date there have been three open calls that have been well received by the regional authorities and have received strong participation from regional and foreign researchers.

### 4.6.2 Mobility schemes for national researches

The most important instrument supporting the mobility of national researchers is the *Scholarships Chile Programme*. In addition, through CONICYT, the government is promoting the mobility of national researchers abroad through doctoral trainings, and technology traineeships in INRIA (France) and in Silicon Valley (USA). In 2012, calls for proposals were launched for traineeships abroad targeting medical doctors, English language professors, and researchers in mathematics and fundamental science (i.e. biology, chemistry, physics, and earth sciences).

Some Ministries award scholarships to civil servants, professionals and technical staff, but these are not part of specific mobility programmes. For example, the Ministry of Education gives scholarships for traineeships abroad focusing on learning the educations systems of Germany, Spain and other European countries.

# 5 CONCLUSIONS

The Chilean knowledge triangle is far from operating efficiently or effectively, despite the progress done particularly in the last 4 years. Increased focus is given to identified weaknesses such as the need to increase the knowledge base (i.e. number of researchers), promoting a better environment for enterpreneurship and innovation, and linking the national RTDI system to successful international initiatives. Governance, institutional and structural weaknesses hamper the RTDI system, notably in relation to the lack of co-ordination among stakeholders. Moreover, there is a decrease in the financing and administrative burdens in programmes supporting scientific infrastructure and research equipment.

Progress has been done for strengthening the framework conditions for improving the science-industry complex and knowledge circulation is better supported in universities and through the *Applied R&D* programme. Despite the increased innovation rate in the private sector, the overall performance is still very weak, and public R&D investments are low.

However, there seems to be an increasing political consensus for the importance of defining a long-term strategy for research and innovation, and some progress has been achieved in this direction. The supply and demand of knowledge is not yet well connected and efficiently articulated. The recently implemented pilot programme for the insertion of qualified human resources in industry and academia is a good sign of efforts for the better articulation of the knowledge triangle.

CORFO is currently undertaking a restructuration in order to diminish bureaucracy and increase accessibility to enterprises. However, one of the main problems of the restructuring is that concrete actions have not been taken regarding the linkages of CORFO with CONICYT and FIA, and preventing the duplication and overlapping of programmes implemented by the three agencies.

The new R&D tax exemption law should stimulate and increase private sector investments, and trigger the demand for knowledge workers. The reforms to the law aim to tackle SMEs' demand for business services, and their lack of innovation capabilities and culture. Innovation policies are now aiming to setting-up dedicated programmes that enrich the educational offer by matching the needs of the productive sectors of the economy.

In the last four years, the available funds in support of human resources have increased, including support for scholarships (i.e. the Scholarships Chile Programme) and some pilot programmes to attract talents and knowledge from abroad. However, the challenge remains on how to create the necessary framework conditions and local demand for hosting PhD graduates (national and foreign) and prevent brain drain. The new programmes and increased budgets are expected to prevent brain drain (e.g. through the programme for the Insertion of human capital in academia and industry). New programmes were created to attract researchers from abroad, with the objective of increasing the opportunities to accelerate learning and increase research capabilities. There is a lack of policy actions explicitly addressing the lower employability of women in the labour market for researchers. The support for scientific research through individual research projects has increased (i.e. National Fund for Scientific and Technological Development). However, collaborative research has not received much attention or focus.

The increase of international co-operation with the EU is a strategic element of the National Innovation Plan towards 2014 and a good way to pursue excellence.

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# 7 List of Abbreviations

| | |
|---|---|
| AFD | Direct Fiscal Support for Universities |
| AFI | Indirect Fiscal Support for Universities |
| ARDP | The Regional Development Agencies |
| BERD | Business Expenditures for Research and Development |
| CCHEN | Chilean Commission of Nuclear Energy |
| CIMM | Mining and Metallurgy Investigation Centre |
| CIREN | Natural Resources Information Center |
| CONICYT | National Commission for Science and Technology |
| CORFO | Chilean Economic Development Agency |
| CNIC | Chilean Innovation Council for Competitiveness |
| CRUCH | Council of University Rectors |
| ERDF | European Regional Development Fund |
| FIC | Chilean Innovation and Competiveness Fund |
| FONDAP | Centres of Excellence Funding Programme |
| FONDECYT | National Fund for Scientific and Technological Development |
| FNDR | National Fund for Regional Development |
| FP | European Framework Programme for Research and Technology Development |
| GORE | Chilean Regional Governments |
| HEI | Higher education institutions |
| HES | Higher education sector |
| IADP | Inter-American Development Bank |
| IFOP | Chile Foundation; Institute of Fisheries Development |
| IGM | Military Institute for Geography |
| INACH | Antarctic Institute of Chile |
| INFOR | Forestry Institute |
| INH | National Hydraulic Institute |
| INIA | National Institute of Farming Research |
| INN | National Standards Institute ( |
| ISI | International Science Index |
| MINEDCUC | Ministry of Education |
| PIA | Shared Major Scientific Equipment Programme |
| PRI | Public Research Institute |
| PRO | Public research organisations |
| R&D | Research and development |
| S&T | Science and technology |
| SAF | Air Survey Service |
| SERNAGEOMIN | National Service for Geology and Mining |
| SF | Structural funds |
| SHOA | Navy HydroTableic and OceanoTableic Service |
| SOFOFA | The Chilean Federation of Industry |
| STI | Science, technology and innovation |
| SUBDERE | Under-Secretary for Regional Development |