



# **EVALUATION REPORT OF NATIONAL INNOVATION STRATEGY FOR COMPETITIVENESS, CHILE**

**INTERNATIONAL EVALUATION PANEL**

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## **Evaluation panel**

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## PREFACE BY THE INTERNATIONAL PANEL

**Chile has an Urgent Needs for Higher Growth.** Returning to high levels of economic growth is a critical policy concern for Chile. Since 1998, growth rates have been only half of the seven point one percent (7.1%) achieved from 1984–97. Total Factor Productivity, arguably the most important measure of the quality and sustainability of growth, has dropped from an annual 2.8% in that period to only 0.4% annually from 1998–2005. Chile’s continued social progress depends on economic diversification, job creation, and increased competitiveness. Since the mid–1980’s, success in export markets –with significant concentration of production in a few sectors– and high commodity prices have laid the groundwork for sustained growth. Today, however, some of these once–dynamic sectors are faltering as lower cost competitors take market share, as Peru is doing in the fruit sector. Other sectors are teetering, such as salmon/aquaculture, which faced a collapse in production from failure to properly manage the environment for production. Copper prices have fluctuated with the global economic slowdown; new low cost producers (Argentina, South Africa) are threatening Chile’s market share for wine. At a time when Chile should be strengthening existing industries and diversifying as a top competitor into new ones, it finds its competitiveness eroding. The situation calls for coordinated policy actions.

**The CNIC Has Been A Key Player In Diagnosing Challenges For Sustaining Growth.** The National Council on Innovation for Competitiveness has continuously drawn attention to Chile’s current competitiveness challenges and the long–term path to innovation–driven prosperity. The Council has been at the centre or associated with a significant body of analysis and policy recommendations produced in the last few years. In fact, in the judgment of this Panel, the Council has played a key role in counteracting the perilous complacency that tends to affect growing economies.

**Significant Recent Analytical Work Points to A Way Forward.** Chile’s economic performance and policy environment has been thoroughly studied over the past few years. Major reports have been produced by the Council itself, by the OECD and the World Bank, “Growth Commission”, and by numerous domestic agencies and organisations, such as the Presidential Commission for Higher Education. While one finds minor variations in emphasis and conclusions, in general these reports point in similar directions. Observations and recommendations tend to emphasize that

Despite a favourable environment and significant investment, *Chile has not succeeded in diversifying its economy or becoming an innovation driven competitor.* Its competitiveness has stagnated recently.

*Improving business innovation in private sector firms* in the short and medium term is a central challenge. Policy options exist that could provide a significant stimulus to business innovation.

*Major government investments in innovative capacity* through such agencies as CORFO, CONICYT, and through the tertiary education sector have yielded some progress, but *are hampered by significant coordination failures and weaknesses in institutional capacity.*

**Conditions are Ripe for Vigorous Policy Engagement on Innovation.** Chile does not need another round of analytical studies; it needs policy engagement and political commitment to implementing changes that can vastly improve its environment for innovation. A strengthened Ministry of Economy and a strong Inter-Ministerial Council for Innovation will provide a good start. Similar institutional strengthening in the Ministry of Education (especially for the Division of Higher Education) is required and for CONICYT will bolster capacities in science and technology research and human capital formation. As Government becomes more effective in creating an enabling environment for innovation, the return to public investment for the creation of innovation capacity will increase. Most importantly, obstacles to increased business innovation will be mitigated and private sector expansion should drive rates of growth to accelerate.

**Central Role for a Strong CNIC, Going Forward.** The CNIC has made good use of its independent voice since its inception. In both analysis and advocacy, it has used its position to increase the evidence base for policy, to raise the standards for accountability of actors in the innovation system, and to speak out for timely and bold actions to promote growth. Chile's only path to high-income status is through innovation-driven growth, and the existence of a strong and agile CNIC provides a stimulus to swifter and better policy action. As part of a Government commitment to achieving higher growth rates, the CNIC should continue to exercise its mandate to analyse, propose, and advocate for policies to maximize Chile's innovative capacity for competitiveness.

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## Report Summary

### Context of the Strategy

Chile's economy has moved from high to low growth, largely because of low and falling productivity and low levels of innovative activity in major economic sectors. In recognition of the urgent need to re-energise the Chilean business sector, Government intervention has been necessary in order to effect the necessary changes in a time scale in which competitive market forces cannot be relied upon alone to restore growth.

The National Innovation Strategy presents an evidence-based, analytically coherent, and action oriented set of proposals for fostering increased economic growth. The strategy is based on three pillars – high quality life-long learning, a science and technology system oriented towards economic and social needs and a proactive and innovative business enterprise sector. The governance structure established for the Strategy involved the Consejo Nacional de Innovación para la Competitividad (CNIC) as strategic advisor to the Government, and the Committee of Ministers of Innovation (MCI) for to undertake policy design and implement the strategy.

### Context of this Report

CNIC has engaged a Panel of international experts to assess the relevance of its strategy to the needed objectives of the national innovation agenda. The panel examined both the design of the strategy and progress in its implementation. This report provides a summary of its conclusions and recommendations.

The Panel recognises that this intervention is complex and wide ranging, and that many of the initiatives are at an early stage. There are many issues to be addressed and many of the initiatives will not bear fruit for a number of years. The Panel therefore makes a number of recommendations which it has categorised as **short-term**, where urgent actions needs to be taken or where early successes can be achieved, and **medium to longer term**, where actions need to be put in place in order to have a cohesive strategic intervention and where major gains should be made over a longer timescale.

## Conclusions

### *The scope of the National Innovation Strategy*

The structure of the Innovation Strategy is coherent, its elements are appropriate in this situation, and it has coverage and sight of the main issues and strategies.

In relation to the three pillars of the Strategy –high quality life–long learning, a science and technology system oriented towards social needs, a proactive and innovative business enterprise sector– the panel believes the CNIC’s diagnosis of the issues is sound and that the policies it proposes are largely correct.

### *Governance and Policy*

The ongoing role of CNIC should continue to be that of independent advisor to the Government but its responsibilities should also include the monitoring of the implementation of the Strategy and the evaluation of the impact of and advances in the Strategy.

There is a need to establish clearly the institutional status and objectives for CNIC, which should have autonomy to recommend a National Innovation Strategy and responsibility for monitoring coordination across the activities that implement the Strategy.

### *Implementation of the Strategy*

Progress to date in implementing the strategy has been too slow, and has been hampered by the relative lack of conduction and empowerment of the Ministerial Committee of Innovation(MCI) With the division of labour, where CNIC acts as a strategic advisor to the Government and the MCI as the body responsible the implementation of the strategy, this weakness of the MCI causes lack of focus and coordination of the interventions.

Increased effort in publicising and promoting the innovation strategy and vision across the economy is needed so that all actors understand its purpose and goals.

There is insufficient cohesion and coordination of the programmes/instruments.

### *Business Innovation*

A clear part of the strategy should be to move established companies to the productive frontier through process improvement and product innovation. However there is a need to ensure the Strategy is focused on internationalisation of the Chilean innovative companies, rather just simply internalised improvement.

A number of legal and regulatory matters create rigidities in the system; and there seem to be few initiatives to address these issues.

The creation of clusters that largely reflect existing and potential strengths, based on a process of careful analysis by independent consultants, provided an initial action to set priorities. The effectiveness of the clusters has been variable, and a more detailed assessment of the success and failure factors needs to be undertaken to make this initiative more effective. Only limited resources are devoted to the creation of companies' internal technological and innovation capabilities and on encouraging them to use these resources for innovation. There needs to be more focus on endogenous innovation capacity of firms and the generation of 'pull' for technology to complement the 'push' of other policy measures. A greater scale of effort must be devoted to business innovation, generating the take-up needed to get critical mass and change innovation culture.

In particular, more effort needs to be devoted to the development of a critical mass of innovative SMEs to encourage development of a significant venture capital activity and to facilitate linking these SMEs to larger companies as core suppliers.

There needs to be increased focus on measures that induce learning and changed behaviour. There is a need to reduce bureaucratic barriers to service delivery.

There is a requirement for a systemic perspective in designing the intervention portfolio.

There is insufficient effort to stimulate the emergence of regional capacity for development, creating 'learning regions' that can more actively contribute to a more differentiated innovation strategy in future.

### *Science Base*

The initiative to increase funding of research in the knowledge infrastructure, so as to 'kick-start' the national research system across public and private sectors towards a level of input and output more typical of OECD countries is appropriate. However this additional investment needs to be focused on changing the structure of the scientific effort, rather than sustaining the existing structure.

The impact of increased investment in R&D on economic development will be maximised by closer alignment of research themes with socio-economic objectives – that is, a higher level of mission-orientation in publicly funded research. The R&D effort is less mission-oriented than most developed countries, and almost all developing countries and thus there is a need to increase the use of 'relevance' criteria in the selection processes for research funding.

There is a need to devote more focused resources to mission-oriented work and associated mission-orientated centres of excellence, while ensuring that these are adapted to Chilean circumstances; this should be seen in the context of sustaining excellence-based basic research. The process of changing the priorities of activities of the science capability towards industrial and societal needs has not been totally effective with investment being diffuse rather than focused.

The initiative to invest in world-class research infrastructure is appropriate, but there is an absence of strategic positioning to enhance and sustain this investment.

Coordination and linkages need to be improved among different parts of the innovation system – notably between Research and Higher Education and Business

A key need is to strengthen the links to the regions' autonomous capacity for development.

### ***Human Capital***

Chile lacks a holistic, integrated, quality–assured and accredited system of education stretching from primary school to PhD, in which credits are mutually recognised and transferable at the appropriate levels and which is consistent with international norms and accreditation where possible (eg the Bologna process)

More effort needs to be given to quality–assure and accredit all of education, producing a holistic and transparent system that offers equity of access and benefits in the form of improved education, labour markets and innovation capabilities in industry and the public sector

Considerable effort has been given to improving standards in schools and ensuring equitable access to education at all levels. Much further work needs to be undertaken fully to implement this strategy

There have been several initiatives to increase postgraduate education, especially where this is linked to international exposure. However there is an absence of strategies to integrate this increased capacity into the R&D sector and into industry

There is insufficient status and priority for these initiatives in the implementation process, suggesting the need to create a Subsecretariat for Higher Education and Research, headed by a Vice Minister, in the Education Ministry, in order to drive through needed reforms

### ***Transversal Platforms***

There needs to be more rapid progress in the development of plans and investments in critical transversal platforms such as information technology (particularly communications capacity), and transport.

## Recommendations

The Panel makes a number of recommendations in the Report. Of those recommendations, the following recommendations are considered critical to the successful implementation of the Strategy:

### *In the short term:*

- 1 Establish the institutional status and objectives for CNIC, which will provide for its autonomy to develop and oversee the implementation of the National Innovation Strategy and for its accountability for monitoring and ensuring coordination across the programmes of the Strategy.
- 2 Introduce programmes and instruments, which develop more focus on endogenous innovation capacity of firms and the generation of ‘pull’ for technology to complement the ‘push’ of other policy measures.
- 3 Develop programmes, which aim to develop a critical mass of innovative SMEs linked with larger organisations as core suppliers, including the provision of seed capital.
- 4 Extend the effort to quality–assure and accredit all of education, producing a holistic and transparent system that offers equity of access and benefits in the form of improved education, labour markets and innovation capabilities in industry and the public sector.
- 5 Increase the proportion of mission–orientated research activity by reforming funding processes to reflect a better alignment of research with national development needs.
- 6 Implement bottom–up processes in the clusters with the objectives of increasing the probability of short–term productivity gains while creating an environment that enhances collaboration among firms and with the Government within each cluster.
- 7 Rationalise programmes and improve the coordination and cohesion between programmes and instruments.

### *Over the medium to longer term*

- 1 Develop strategies to encourage a robust early stage venture capital sector around a critical mass of innovative SMEs.
- 2 Develop a framework that allows for cluster formation and diversification with evolving areas of industrial strength.
- 3 Analyse needs and develop strategies and policy and regulatory frameworks to encourage investment in, and development of, effective transversal platforms, particularly in respect of communications networks to link research institutions and businesses.
- 4 Further stimulate the emergence of regional capacity for development, creating ‘learning regions’ that can more actively contribute to a more differentiated innovation strategy in future.
- 5 Develop strategies and implement programmes to integrate the increased cohort of advanced human capital into the research and business sectors.



## 1 Introduction

This report presents an assessment by an independent international panel of the strategy of the National Council for Innovation for Competitiveness (CNIC) and its implementation.

The CNIC was originally set up by presidential decree in 2005 as an interim body. In response to the report of the interim Council, President Bachelet made it into a permanent body in 2006, with a mandate to advise the President on policies in the area of innovation including the education of specialised human resources and the development, transfer and diffusion of technology. The mandate of the Council set out in Decree No 505 is to

- Propose a national strategy for innovation for competitiveness

- Publish strategic proposals

- Establish mechanisms to consult and enter dialogue with relevant actors, especially the regions

- Propose how to allocate the FIC tax on mining companies

- Undertake studies

- Make proposals for institutional redesign

Based on this mandate, the CNIC produced Volume 1 of ‘Towards a National Innovation Strategy for competitiveness’ early in 2007 and Volume 2 at the start of 2008. The strategy contains a wide-ranging series of reforms and initiatives that aim to double Chilean income per head by 2020–25, matching the level of comparable resource-based developed countries.

The panel reviewed the CNIC’s strategy and further proposals, three background reports commissioned from independent consultants and interviewed key stakeholders during a week in Santiago in January 2010. It reconvened early in March to finalise its report. The Panel endorses the CNIC’s analysis of the stagnating state of the Chilean economy, it is singling out of the poor productivity and innovation performance of major sectors of the Chilean economy as the cause of this stagnation, and the urgency of implementing policies to catalyse and reenergise the performance of Chile’s private sector – the fundamental basis of economic activity.

The report is organised in five chapters. Following this introduction, it reviews the progress of Chile’s development and summarises key elements of the current crisis in development. It reviews the achievements of the CNIC overall and in establishing a Strategic Innovation Policy. It then discusses progress and continuing needs in the main blocks of the CNIC’s national strategy for innovation for competitiveness before drawing conclusions and making recommendations.

The Panel has been mindful of the need to harmonise and prioritise the longer-term policy and institutional changes contained in the CNIC reports with the pressing needs for near-term actions directed at stimulating increased firm and industry performance. The Panel also has been mindful of the historically unique evolution of Chile’s economic and governmental structures. Thus, its note of experiences, policies and programmes adopted in other developed countries are intended as examples of initiatives worthy of consideration and adaptation, not as prescriptions.

## 2 The Crisis in Development

The growth that doubled Chile's national income per head in the two decades to 2005 has faltered. The growth was enabled by the development of new resource-based industries and it has stopped because of a failure to use innovation to sustain growth in productivity and output. Chile is therefore at a dangerous point in its economic development. Re-establishing a high rate of growth will require significantly improved innovation performance. Because other countries are entering the same markets and innovating faster than Chilean industry, 'standing still' is not an option. If innovation and productivity in Chile continue to stagnate, national income per head will **decline** in relative terms. Rather than redoubling income per head, Chile will sink back into underdevelopment.

The problems that have led to stagnating performance have been clearly documented by, among others, the OECD<sup>1</sup>, the Growth Commission<sup>2</sup>, the World Bank<sup>3</sup> and the CNIC itself. The central problem is Chilean companies' poor innovation performance. It is companies that create wealth and jobs; their performance drives economic development. At the aggregate level, the international literature says that innovation alone accounts for about half of growth. The Chilean Innovation Surveys show that companies' innovation expenditures fell from 1.6% to 1.2% of GDP between 2004 and 2006 and the proportion of companies that had introduced innovations in the previous three years fell from 38% to 33%<sup>4</sup>. The learning effects of Chile's innovation expenditure are limited. 80–90% of Chilean firms' innovation spending is on importing machinery. In comparison, European companies typically devote half their innovation spending to internal R&D – aiming to master rather than merely acquire technology<sup>5</sup>.

At the level of overall economic policy, Chile has been among the 'best in the class' in conforming to international doctrine. The quality of public policy is high; government is regarded as stable, reliable and with a low level of corruption; Chile scores well in international comparisons of the ease of doing business; corporation tax is low; and property rights are secure. Reform is based on a broad consensus, so Chile has deservedly acquired a reputation for predictability and sustainability<sup>6</sup>. The Growth Commission rightly concluded

Most observers seem to believe that the challenge for Chile today is to design and implement a package of far-reaching microeconomic reforms. In contrast to the macro reforms successfully undertaken heretofore, micro reforms are seen to be more difficult: their effect can take time to

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<sup>1</sup> OECD Reviews of Innovation Policy: Chile, Paris: OECD, 2007

<sup>2</sup> Homi Kharas, Danny Leipziger, William Maloney, R Thillainathan and Heiko Hesse, *Chilean Growth Through East Asian Eyes*, Commission on Growth and Development Working Paper No 31, Washington DC: IBRD/World Bank, 2008

<sup>3</sup> World Bank, Project Information Document (PID) *Chile Promoting Innovation and Competitiveness*, Report No AB3180 (mimeo)

<sup>4</sup> CNIC, 2009. Innovation is here defined to include organisational, managerial and marketing innovations

<sup>5</sup> OECD (2007), p75

<sup>6</sup> Growth Commission (2008)

capture, their implementation cuts across ministerial responsibilities, and aspects of reform affect perceptions of the political and social compact that has governed Chile in past decades.

Historically, import–substitution was abandoned in the 1970s and export–led growth based on natural resources induced the growth spurt of 1985–97. The spurt extended the existing strength of copper mining and provided dramatic growth in fishing, aquaculture, fruit, wine and other food. Corfo, and from 1976 Fundación Chile, paved the way with finance and encouraged technology transfer. In line with the OECD ‘technology gap’ orthodoxy of the time, imported technologies were adopted but limited effort was made to develop domestic capability to unbundle, understand and further develop the technologies – in the companies the universities and institutes or indeed in the state. An early cost of this was inability to regulate fishing adequately and the collapse of some fisheries. A recent cost has been the crisis in salmon farming, also owing to inadequate regulation.

Studies of the development of Total Factor Productivity (TFP) confirm that most of the increase in TPF in the 80’s and 90’s was due to reallocation of resources from traditional industries to natural resource based sectors, with imported technologies that increased the productivity of new companies in these booming sectors. Thereafter, most of the intra firm productivity gain was realised through rationalisation and downsizing rather than through expansion, while later entrants often came in with weak technological capability and therefore with **lower** productivity than existing players. Chilean manufacturing productivity levels were still less than 40% of global best practice by the late 1990s<sup>7</sup>.

Fast–growing countries tend to have increasing diversity in their exports<sup>8</sup> but Chile’s diversification largely came to a halt by 1995. Growth in resource–based industries can provide opportunities to diversify into others. But the sectors in which Chile’s exports are specialised tend to have poor potential links of this kind<sup>9</sup>.

The response to the growth spurt should have been increased innovation activity, developing knowledge to lever the windfall provided by the exploitation of new raw materials into sustained competitive advantage. Instead, industry harvested the rents but failed to invest in knowledge, the physical and human capital needed to maintain an internationally competitive position.

### **Business innovation**

If industry is to innovate, it must have both the desire and the means to do so. Modern innovation processes are increasingly ‘open’ and involve networks (often whole supply chains), yet networking and clustering of Chilean firms is at an early stage. Companies’ links to the research system are weak, because of that system’s isolation and concentration and because firms have low absorptive capacity. Few research–capable people work in business and they are concentrated in a small number of firms. Chile’s ICT intensity is also very low by international comparison, limiting the ability of industry both to gather intelligence and to modernise.

At present, Chile’s business sector R&D spending (BERD) accounts for about 45% of Gross Expenditure on R&D (GERD). The most developed countries’ BERD tends to be two–thirds to three–quarters of GERD. The right policy is **not** to try to transfer state to private expenditure in order to achieve an OECD–like ratio of BERD to GERD. In Chile, the whole of GERD is simply

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<sup>7</sup> Crespi (2006)

<sup>8</sup> Growth Commission (2008)

<sup>9</sup> Hausmann and Klinger (2007)

too small to support a healthily innovating economy and generate growth. The needed policy in Chile is for the state to invest in R&D ahead of business. As industry's absorptive capabilities rise, so a virtuous circle of supply and demand for advanced human capital will be established, as it has in all the developed countries, leaving the balance of investment between the state and business to evolve towards developed-country proportions.

According to the OECD, there is a 'rent seeking' approach<sup>10</sup> in industry, which ignores the need constantly to reinvest profits in technological progress and therefore in the human and physical capital and knowledge needed for product innovations and improvements in productivity. So a key policy requirement is to increase **understanding** of the need for innovation as a driver of productivity growth and economic expansion. But understanding is not enough. The means must also be available. Chile's innovation system is clearly deficient in its ability to provide the levels and quality of human resources, knowledge infrastructure (of universities and technology institutes) and the policy support required for innovation that is provided to Chile's competitors.

### **Human capital**

Despite recent reforms, low levels of literacy and educational attainment undermine the ability of the work force continue to contribute to productivity and innovation. 37% of the potential student body is effectively illiterate while only 2% reach levels of education that would qualify them to be 'knowledge workers' able to assimilate and develop knowledge needed for technological innovation<sup>11</sup>. (This compares with rates of under 10% illiteracy in developed resource-based economies such as Australia, Canada, the dynamic SE Asian economies and China. Over 10% in China and leading OECD countries, and 20% in the fast-growing SE Asian countries, are educated to 'knowledge worker' levels.) A much smaller proportion of Chileans study abroad, building the networks that enable access to global developments in knowledge and technology. And the talents of many Chilean women are wasted: Chile has the lowest rate of female labour force participation in South America.

The weakness of the education and training system extends up through vocational training (so that the quality of middle-level labour is mixed and uncertain) to higher education, whose output of the needed graduates and postgraduates in science and engineering is limited. PhD output has been very low by international comparison and has only started to rise in recent years. Chile has made admirable progress in some areas of education, such as expanding tertiary coverage. Yet quality and relevance still lag below OECD levels, and will continue to constrain innovation capacity unless improved.

### **Science and science linkage**

Chile's scientific productivity is better than most countries in Latin America but remains low in world terms. As in many developing countries, the **pattern** of scientific spending is more biased towards basic research than in developed countries – a result of the scientific elite having a great deal of control over funding allocation combined with a low level of demand or signalling from companies and other social actors about needs.

In Chile, most R&D is financed by the government and carried out in the universities with few connections to the business sector. The system of Public Research Institutes that in other

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<sup>10</sup> In effect, the OECD is saying that much of Chilean business has failed to internalise the need to invest in industrial forms of knowledge and innovation

<sup>11</sup> Growth Commission (2009)

countries provides important support to innovation and development in the business sector is weak and ineffective in Chile. Scientific human resources are in short supply. Likewise, the system of IPR and the markets for knowledge-based services are underdeveloped.

### **Governance**

The problem is not only education and conditions for **technological** innovation. For example, the key limiting factors in moving further into tourism have been **organisational**: lack of coordination in infrastructure development; and failure to coordinate private sector development, so that investments become mutually supporting.

A more fundamental problem, which underpins part of the lack of coordination, is the absence of specific mechanisms for setting strategic priorities in the STE, training and Innovation areas. The OECD points to weak governance and coordination among the agencies responsible for research and economic development that has resulted both in ‘blind spots’ and in duplication of functions. There has been too much emphasis in policy on R&D (especially in the universities) and too little on technology absorption and diffusion<sup>12</sup>. Interventions have tended to be project- rather than programme-based, taking a fragmented view of needs. Fear of government failure and the desire to use ‘neutral’ instruments that do not differentiate among sectors of industry has meant that programmes have often failed to tackle the specificities of need in different sectors. Not least, the small scale of the effort to increase innovation has been insufficient to address the problems properly.

The CNIC represents a major step in the right direction – a perception that was reinforced in the OECD’s follow-up to the Innovation review that focused on the CNIC<sup>13</sup>. It provides an **arena** in which strategic intelligence can be collected and strategic policy capabilities accumulated, and national innovation policy discussed and coordinated. Its strategy provides a development agenda around which the key national actors can organise.

The effectiveness of CNIC naturally also depends on the other institutions of the new Innovation Policy System that is emerging in Chile. The Inter-Ministerial Committee, in charge of specific policies design and implementation comprising those ministers who sit on the CNIC, appears to have struggled with the task of implementation and delegation to the agencies. As a result, the CNIC has been involved in more specific debates about individual policies than is desirable in a governance system that makes good use of agency.

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<sup>12</sup> The report apparently misses weaknesses of direct support of industrial R&D and industrial innovation in firms, a major problem of Chile and of other developing economies.

<sup>13</sup> OECD, (2009)

### 3 Achievements of the CNIC

In this section we first summarise the history and strategic aims of the CNIC and then discuss its achievements.

#### 3.1 The Agenda of the CNIC

The CNIC mandate of setting strategic priorities and coordinating national research and innovation strategy is needed in all countries. Beyond CNIC with its *Vision and Strategic Priorities* function at the highest level of the State (or Government Structure), the *Innovation Policy System* also includes, a Ministerial Innovation Committee (MIC), individual Ministries, and the funding/implementation agencies like Corfo (including INNOVA Chile) and CONICYT. MIC decides what parts of CNIC's advice to implement. The Minister of Economy chairs the MIC but actors in the system are expected collectively to implement the strategy while at the same time no one can tell all the others what to do. Actors must therefore work together 'vertically' (between ministries and their agencies), 'horizontally' across administrative boundaries and at regional and national levels.

The first volume of the strategy says

Total Factor Productivity must rise, driven by greater knowledge–intensity, technological change, human capital and innovation

Average years of schooling must rise to 12 by 2010 and 14 by 2021, while the proportion of the cadre of 18–24 year olds entering higher education must rise from 43% today to nearly 80% by 2021; Chile should make significant progress in the results achieved in OECD's international PISA evaluations

GERD should rise from 0.68% of GDP in 2004 to some 2.3% by 2021 and the business share of this should rise from 37% to 50% of that total

Dependence upon a small number of economic sectors must be reduced. At the time, the 25 main items comprised 76% of exports. This should fall to below 50%

The country's position as measured by international innovation and economic indicators should improve<sup>14</sup>

The second volume<sup>15</sup> (2008) stresses the need to move towards a knowledge economy and points out that in a time of increasing global specialisation, Chile cannot afford to try to be good at everything and must therefore specialise. It proposes three major pillars

High–quality, life–long learning

A science and technology system orientated towards social needs

A proactive and innovative business enterprise sector

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<sup>14</sup> CNIC (2007)

<sup>15</sup> CNIC, (2008)

In its statement<sup>16</sup> to the government in 2009, the CNIC formulated more detailed proposals in a number of areas: Human Capital development e.g. proposing a national system of competence-based labour certification, overseen by a certifying body; Business Innovation e.g. strengthening clusters, both by providing support to the development of cluster strategies and by supporting capacity building at the regional level as well as more directly providing cluster management and funding for cluster-based innovation; and Science e.g. proposing increased funding for research infrastructure and areas of mission-oriented research relevant to national economic priorities.

### 3.2 Achievements of the CNIC

At the overall level, the CNIC has tackled all the five elements of Strategic Innovation Policy. It has established a **national vision** – in the form of two volumes of strategy and their continuation into updated sets of proposals in August 2009 and March 2010. This includes both overarching objectives like growth, moving into a knowledge economy, regional issues, ecology, equity, etc, and a view about where the country's present and future comparative and competitive advantages lie.

CNIC has also **articulated the vision into a set of priorities and helped to articulate these into policies**. Many of the actions triggered by the CNIC are 'horizontal'. A major achievement has been also to initiate a process of articulating thematic priorities for national 'clusters'. Other policy actions include

- Extending CONICYT funding towards centres of excellence, to reduce fragmentation and start to orient university research towards industrial needs

- Strong support for enhanced budgets oriented to direct support of innovation in firms, and related actions (a weak link in Chile's innovation system)

- University accreditation and funding reform of, to increase quality

- An early retirement programme at universities, to enable renewal and create career opportunities for young researchers

- A shift towards accredited, competence-based vocational training

- Changing the Industrial Property Department into the National Intellectual Property Institute (INAPI), enabling modernisation process of patents and IPR

- Establishing the need to reform and increase the capabilities of the research institute/technology centre sector, in order to support the needs of industry

It has **coordinated** policy formulation by acting as a policy **arena**. Coordination among sectors and agencies was improved, not only through the formal activities of the CNIC but also via the informal links established by individuals<sup>17</sup>. CNIC has partly collected and partly funded the strategic intelligence and capability development needed in order to understand and monitor systems performance. More effort is required to make Chilean indicators conform to OECD norms and in monitoring and evaluation, but CNIC is already a reference point for the national innovation system. Another important facet of coordination is the increased public visibility the CNIC has brought to innovation. Given the cultural problems of adjusting to the centrality of innovation in modern economic development, this work with the public at large is very important. The existence of the CNIC triggered the creation of the MIC inter-ministerial committee, giving Chile a policy

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<sup>16</sup> CNIC (2009)

<sup>17</sup> Note that insiders view such links as a critical success factor for the Finnish Research and Innovation Council, which is considered the archetype for such bodies

implementation mechanism that spans several ministries, creating opportunities to implement more holistic policies.

The CNIC has started work to **evaluate the National Innovation System and associated policies** by commissioning and cooperating on a series of evaluations at the programmatic level and by defining an evaluation architecture and methodologies through which it can – in cooperation with the other stakeholders – organise systemic evaluation.

It has **influenced the budgets for science, technology and innovation** in several ways (i) suggesting areas that are weak and need public support (ii) by revising a final draft of the proposed budget that will be discussed in parliament (iii) being asked by some MPs about the consistency of the budget during parliamentary investigations. Direct public expenditure on science, technology and innovation has grown from 0.26% of GDP in 2007 to 0.32% in 2008 and is estimated to reach 0.36% in 2009<sup>18</sup>. This is still considerably less than OECD countries spend but shows the state making the kind of ‘kick-starting’ investments that should help initiate growth in BERD.

Clearly, it is still too soon to expect to be able to see signs in economic statistics that CNIC has had an effect on the economy. However, all these achievements make it reasonable to expect such effects in the medium and longer term.

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<sup>18</sup> CNIC, (2009)

## 4 The Strategy for Innovation for Competitiveness

In this section, we review progress in the Strategy, following the three major pillars of the strategy and the cluster policy, noting at the start of each section how the CNIC viewed each in its proposals of August 2009.

### 4.1 Business Innovation

The CNIC notes that funding for business innovation has grown less rapidly than that for the other two pillars. Universities' Technology Transfer Office (TTO) and IPR management functions remain underdeveloped. The number of consortia between academia and industry has increased but remains modest. The amount of direct innovation support to companies has remained static for some time. The R & D tax credit was itself misconceived in that it rewarded links with the knowledge infrastructure rather than endogenous innovation. Also bureaucracy contributed to reduce the limited success of R&D tax break scheme for industry. The needed reform of the research institutes has been delayed, so the upgraded technology support infrastructure companies need is still largely absent. The volume of spending on innovation support programmes delivered to industry is small and its administration bureaucratic. The programmes are fragmented, so it is hard for beneficiaries to obtain an overview.

The CNIC's proposals for remedying deficiencies in business innovation were

- Large-scale provision of extension services to modernise technology in companies and to encourage increased innovation

- A significant increase in innovation subsidies, focusing on grants for SMEs and guarantees and tax credits for larger companies and organisations and projects

- Significantly expanded schemes to inject University graduates, including PhD-holders, into industry

- Promoting the creation of a portfolio of types of risk capital from the seed stage onwards and encouraging 'business angels' by giving them tax breaks

- Reforming bankruptcy laws and funding regulations that discriminate against former bankrupts, in order to promote US-style 'serial entrepreneurship'

- Encouraging companies to engage in collaborative research consortia with each other and with universities, while strengthening universities' ability and desire to deliver the 'third mission' of supporting economic and social development

In the view of the Panel, the most urgent and difficult problem to tackle is to change firms' innovation behaviour and increase their innovation capacity. This involves not only technological but also management, marketing, networking and other capabilities. These determine both endogenous innovativeness and companies' ability to operate within supply chains and clusters – configurations known to increase the rate of innovation through supplier-user interaction. The benefits of all the other measures proposed to improve the innovation system cannot be realised in the form of growth unless firms' innovation behaviour and resources improve.

Companies differ in their capacities for innovation. Many low–technology firms with no engineering or scientific personnel are barely able to make technological innovations and depend on external sources of technology. Once the first engineer or scientist is in place, firms acquire some ability to explore external options and not only adopt but also start to adapt technologies. As the number of engineers increases, so endogenous change is increasingly possible. Companies become less dependent upon external sources of innovation and increasingly able to make use of research as well as to do their own. An important goal of innovation support policy is to help companies pass through these developmental stages. This implies using different support measures at different stages, and aiming to induce the learning and changes in innovation behaviour that come with increasing sophistication. That often means using an intervention to initiate the process of learning and then leaving companies to draw the consequences via changed behaviour – another example of the ‘kick–starting’ role of the state.

The Chilean innovation support system has hitherto done strikingly little to address the early stages of developing company technological capabilities, where other countries use technology audits, advisory and extension services and programmes to ‘inject’ qualified scientists and engineers into companies in order to create absorptive capacity. The CNIC wisely proposes the use of schemes such as these, which will launch a virtuous circle of learning in the companies – teaching them the virtues of endogenous innovation. Schemes to insert or otherwise provides incentives for the hiring of qualified manpower are especially powerful but need to be matched with company needs: less capable firms initially need BSc/MScs; more sophisticated companies need MSc/PhDs.

The innovation–in–firms support system should comprise a mix of horizontal (functionally orientated) schemes with vertically specialised innovation schemes that tackle the specificities of individual branches or clusters. A well functioning, horizontal programme, which subsidises innovation by individual firms, is important for countries like Chile<sup>19</sup> in order to provide ‘demonstration effects’ of the importance of innovation and change company culture from traditional ‘rentism’ towards the longer–term perspective of modern capitalism, based on investment and endogenous innovation. An important part of the process is collective learning (about technology, marketing, management etc). *High programme uptake is a major factor in assuring success*, creating the critical mass required for collective learning and a behavioural change in favour of increased innovative activity<sup>20</sup>. Given sufficient levels of uptake, innovation support creates a **disequilibrating** force, leading to imitation and therefore to spillover of behavioural change from the beneficiaries to their competitors. As behaviour changes, so the need for state intervention declines. Thus enhancing program take–up today may lead both to sharp increases in business innovation and to relatively (and maybe absolutely) lower subsidies in the future. Policy needs to go beyond formal R&D, to include also Design, Engineering, Technology Transfer, advice from consultants, etc, and the provision through other programmes of complementary Business Services related to commercialisation, management.

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<sup>19</sup> Teubal, (2008)

<sup>20</sup> See Teubal (1996,19977), Much of the econometric work on the impact of government subsidies on business innovation has not yet considered either the learning effects mentioned above (which go far beyond learning from R&D, which to some extent has been considered in some of the work) on the existence and especially, the eventual appearance of private sources of innovation finance in firms e.g. Venture Capital (this could be the major impact of Government subsidies to innovation). There are a few. See : Benavente J.M.; Crespi G. y A. Maffioli (2007) “Public Support to Firm´s Innovation : The Chilean Fontec Experience”. OVE Working Paper WP 05/07. Banco Interamericano de Desarrollo. Washington DC.

Horizontal programmes need to be complemented by others whose designs adequately consider sectoral specificities.<sup>21</sup> Here the cluster priorities provide a good basis for organising programmes that will simultaneously stimulate the development and extension of supply chains – themselves creating arenas for innovation.

A critical consideration in programme implementation is adopting *a learning approach* whereby a major objective of support (depending probably on companies and sectors or technologies) is to generate innovation capabilities at the firm level. Success in innovation is highly skewed, so it is not reasonable to expect every beneficiary to produce short-term innovation successes from capability-improving programmes.

A **systemic** perspective is important in designing a portfolio of interventions. First, this reduces gaps and overlaps. Second, it identifies complementarities. Third – and perhaps most important – it should enable the beneficiaries to navigate the support system. Many European innovation agencies have an ‘account management’ function that guides beneficiaries through a sequence of interventions that develop their capabilities over time, but also – by helping them learn – discourages them from becoming ‘repeat customers’ for individual subsidies.

At present, Chile’s innovation support schemes are fragmented and administered in an extremely bureaucratic fashion, as a result of fear of fraud and corruption. The R&D tax credit (which we argue was itself misconceived in that it rewarded links with the knowledge infrastructure rather than endogenous innovation) was so bureaucratic that it attracted only seven participations. Innovation project approval times of 180 days can be a major disincentive to take-up. Leading European agencies can turn around equivalent funding decisions in a few weeks so it is possible to implement an efficient process where funding decisions are taken low down in the organisation while at the same time having sufficient monitoring and auditing to keep the opportunities for fraud to an acceptably low level. The requirement that firms put their money into projects co-financed by the State, tend in any case to minimise ‘moral hazard’ and ensure that only *bona fide* projects are submitted.

A notable omission from the policy repertoire is the use of government procurement (or demand aggregation involving the private sector) as a way to induce innovation. Chile’s strong anti-corruption administrative culture makes it hard to implement this type of measure, but it is noteworthy that other OECD countries are increasingly exploring and using this option.

University–Industry links have three important dimensions for business innovation: human capital; R&D collaboration; and formal technology transfer. The first is probably the most important, so a combination of analysis of labour markets with direct university cooperation between universities and ‘consumers’ of manpower including business and the public sector is needed to keep the supply of graduates in balance with present and future societal needs.

University–industry cooperation becomes possible at the later stages of developing company technological capabilities. It not only can produce useful knowledge but, crucially, provides signals to the university system about what areas of research and education are needed by society and therefore fore funding opportunities will concentrate. Chile has tried to jump straight to current international practice here, funding collaborative consortia and this is useful in the pockets where there are clusters of firms with high absorptive capacity. European experience has been that in other areas can be useful to go through a more developmental period of binary university–industry collaboration (eg the LINK programme in the UK) that not only produces useful

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<sup>21</sup> Some specific programmes of direct support of company innovation may already be implemented through the various Cluster programs.

technology outcomes but also demonstrates the virtues of cooperation. Thereafter it becomes easier to move on to more highly leveraged forms of network R&D that involve less subsidy per participant.

More formal technology transfer through the sale of intellectual property or creating spin-offs can also be useful but requires significant reform within the Universities. A study<sup>22</sup> of Interlink Biotechnologies concludes that there was/were

- 1 No links between Academics and the unit in charge of technology transfer
- 2 Lack of IP policies which consider conflicts of interest among the various parties
- 3 No policies to appropriate the benefits from commercialisation of technology
- 4 Lack of specialised personnel
- 5 Fragmented instruments, lack of continuity and a commercial approach
- 6 Absence of critical mass of research

Professionalising the TTO function will take many years because it involves culture change within the universities. The experience of countries such as Sweden is that this can require a sustained effort of up to 10 years. A complementary need is for all kinds of capital markets to work well. Conventional banking in Chile does so, but bankruptcy laws work against the kind of serial entrepreneurship that has proved an important growth driver in the USA. Domestic innovation-related capital markets are weak. Foreign capital suffers tax disadvantages and operating restrictions, limiting the opportunities to import money (and, more important, know-how) for running seed and venture capital operations. As in the Israeli case, there is a strong argument for using state money to kick-start these markets, where supply can induce demand.

However, universities almost always lack the skills and industrial understanding needed to support firms at the earlier stages on developing technological capacity. Chile needs to activate its failing applied institute sector to fill this gap, initially focusing on lower-capability firms and shifting increasingly from technology services to research over time as development raises the absorptive capacity of industry.

Chile's political centralisation means that the regions need to develop the skills and resources to play a more effective part in economic development. Economic power and research resources concentrate in Santiago, and tend therefore to be disconnected from the growth sectors of the economy (except services). Whether conceived of as 'industrial districts', 'clusters' or 'learning regions', the spatial dimension is under-developed in the CNIC strategy. The regions themselves need to become more engaged in the regional dimension of development. So far, progress on creating regional capacity is fairly slow. Once the pace is increased, the regions can contribute a more dynamic and bottom up' dimension to strategy development. A key element will be to anchor the clusters promoted by CNIC in regional<sup>23</sup> institutions, including applied institutes physically co-located with the spatial concentration of the clusters.

### *Summary of Major Points*

The ultimate means through which the strategy can lead to increased prosperity is increasing firms' capabilities and propensity to innovate. All other policies should support this, and tackling this directly deserves greater financial priority than has been the case so far

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<sup>22</sup> Biotechnology assessment and strategic recommendations. Interlink Biotechnologies, LLC. December 2008

<sup>23</sup> In the sense of economic geography, not administrative regions

The scale of provision and take-up of innovation supports so far is too low and should be increased

For this, strong attempts should be made to reduce bureaucracy and to assure the continued growth of budgets

The capacities and behaviours needed stretch well beyond R&D into other aspects of innovation. These should also be stimulated by the innovation measures

A combination of ‘horizontal’ and ‘vertical’ programmes, tuned to specific sector and cluster needs, is required

Knowledge infrastructure must be provided and tuned to industry needs

- Applied institutes or technology centres, implying major reform in the applied institute sector

- Professionalised Industrial Liaison and Technology Transfer management must be introduced by the universities

- Bilateral and consortium university–industry collaborative R&D programmes

The opportunities to use demand – via procurement or demand aggregation – to stimulate business innovation should be explored

A systemic perspective should be applied to the design of the intervention portfolio

- To ensure simplicity, efficiency and transparency

- To provide a basis for guiding firms about how to use programmes cumulatively to build capabilities

Existing efforts to develop regional capacity for development should be strengthened, in order better to integrate the regions into delivering the desired results of the innovation strategy

#### 4.2 Cluster Policies<sup>24</sup>

Clusters are a major focus in CNIC’s strategy, part of the Business Innovation Pillar. Targeting is appropriate because of the need to provide industry specific public goods such as phytosanitary regulations, specialised skills and infrastructure, which government lacks the knowledge directly to identify even if (as in the case of regulations) it is effectively a monopoly supplier. The provision of these goods requires coordination among different ministries or agencies of government. There are also other reasons for focusing resources on clusters. In many cases, these are the parts of the economy where TFP has stagnated, urgently requiring intervention. The act of clustering itself provides important stimuli to innovation<sup>25</sup>.

The explicit articulation of cluster priorities and policies represents an important advance in the policy portfolio of Chile. Many advanced countries e.g in Europe are and have been doing this for some time, e.g Italy, Spain, France, Denmark, Israel etc. In order to avoid the risk of capture, CNIC used external independent consultants in the prioritisation process. The MIC took on the task of implementation and set up a number of public–private Strategic Councils for the clusters. Each has an Executive Secretary<sup>26</sup> in charge of advancing the agenda of the clusters and their ‘emblematic’ projects and programs.

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<sup>24</sup> Much of the material here came from CNIC (2007, 2008, 2010); INAP Consultores (2010)

<sup>25</sup> Porter (1998)

<sup>26</sup> And Corfo has an Assistant Manager for the Cluster National Programme which gives support to the executive secretaries.

In some cases, this involved a shift from a bottom–up definition of clusters (based essentially on membership of supply chains) to a top–down, administrative definition – so that, for example, several distinct ‘natural’ clusters were grouped together into a cluster under the Minister of Agriculture – who then found he was in the strange position of reporting to himself. Links to the spatial dimension of clustering and therefore to local actors have not been strongly enough established, so that it had been difficult to launch major cluster activities. These problems were compounded by the budgetary process, which undercut the MIC’s effort to integrate projects by encouraging distinct and often fragmented budgetary submissions by individual ministries and agencies.

The Panel’s view is that cluster policies must nonetheless continue but be based on a careful learning process, empowering supply chains and regions to self–organise in patterns that make sense to the participants and that allow them to connect to the provision of public goods, ranging from regulation through research to education.

In effect, there are two types of cluster policies. One is orientated to reinforcement or transformation of an existing cluster or sector; the other to the emergence of new clusters. Most of the important clusters prioritised by CNIC the Ministerial Innovation Council are established and of obvious economic significance. This kind of Weak Targeting correction of market and systemic failures in the presence of rather reliable signals that these are clusters that matter.

The second type of cluster policies is aimed at triggering and sustaining the emergence of a new sector, market or cluster. For simplicity we can call this Strong Targeting. This is inherently more risky, not least because there is no theoretical perspective that gives a satisfactory basis for deciding which potential clusters to target. It is necessary to rely on traditional business analysis. But if Hausmann’s argument that Chilean diversification is limited by existing industrial structure is valid, then there may be a need for the state to take such risks, since the market is unlikely to provide a solution. This should not, in our opinion, deter the Chilean Authorities from attempting to undertake Policy Targeting as many countries are now attempting in sectors/clusters where there are favourable pre–emergence conditions e.g operating firms, but no pre–existing industry as with some services areas proposed by the CNIC.

Cluster Policies should therefore continue to be a significant component of the overall Innovation Policy mix. While this should focus mainly on existing sectors/cluster, it should also include a measure of Strong Targeting as well i.e oriented to the emergence or creation of *new* clusters. The extent to which the early stages of building an offshoring cluster for Chile have been successful signal that this is possible, even if it is clear that – in policy as in business – not every bet one places will lead to a win<sup>27</sup>. The approach followed by the CNIC of identifying sophisticated derived demands from natural resources sectors, that have common capability and technology requirements is an interesting approach to select new emerging industries of high growth potential, based on some market signals<sup>28</sup>.

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<sup>27</sup> Strong Policy Targeting should include an explicit policy for generating options for targeting (beyond those areas where the country already has strong competitive advantages). For a discussion of these issues see Avnimelech and Teubal (2008)

<sup>28</sup> For example the identification of a potential for mechatronic services for underground mining, precision agriculture, Astronomy and remote salmon production is a promising example.

#### 4.3 Human capital

According to the CNIC, the entire human capital system needs further improvement and the addition of a system of Life Long Learning. The new SNCCL regulation aims to create a unified skill and certification system based on competences that will not only improve the operation of national labour markets but eventually connect to international norms. Quality, pertinence, coverage and accreditation are also needed at university level to make credits transferable and the entire system flexible and recognisably providing quality at an international level. A number of other issues must also be resolved, such as the creation of regional capacity in vocational and higher education, creating strategic intelligence to steer provision of training and ensuring equitable access to the system.

Going forward, the CNIC proposes to

- Connect education and training to production needs, by consolidating the National System of Occupational Competency (SNCCL) and leading the consolidation of a life-long learning system, focused through the creation of a qualification framework.

- Improve the supply of education and training through a competences-based approach that connects to international levels

- Enhancing the development of general skills via technical and vocational training

- Ensuring quality at the university level through university reforms and connecting education to international standards

- Ensuring the provision of quality training and the targeting of public support towards lower-income workers and smaller companies

- Making access to the education system more equitable, aiming at 60% coverage of the population by 2015 with training that is relevant to societal needs

Chileans value education as a human right and for increased prosperity. Public policy has sought to overcome past failures and inequities in educational attainment and quality that constrain productivity and competitiveness. The CNIC has successfully sought to accelerate and to influence the content of education and human capital policy reforms. But reforms need to speed up.

Chile's human capital challenges for innovation and competitiveness are

- Providing a solid educational base onto which Chileans can add specific career skills

- Putting in place an effective, quality-assured 'signalling system' about labour competencies to make the labour market work better

- Creating an effective system of life-long learning

- Maximizing the effectiveness of enterprise-based and other non-formal training

- Promoting high-quality, relevant tertiary education, accessible to all Chileans and articulated to permit progression among different degree programmes and types

Chile's scores in international comparisons of scholastic performance such as PISA are among the best in Latin America but poor in global terms. The Ministry of Education has launched many schools initiatives but reducing the de facto segregation of students into different types of schools based on by socio-economic background so as to provide opportunities for all is a continuing policy need.

Chile sends a substantial proportion of high school aged students to TVET<sup>29</sup> schools but these suffer from poor quality and curricular obsolescence. The Chile Califica program has

<sup>29</sup> Technical and Vocational Education and Training

championed four interventions aimed at improving the quality, their relevance, and the ability of graduates to continue to higher levels of study and employment.

Study “itineraries” to help students choose effective pathways from lower to higher skill levels—through experience and education—for technical careers

Networks of TVET educators to enhance quality by sharing information and experience

Training TVET teachers

Promoting ‘dual mode’ vocational education—where students learn both in school and through placement and internships in firms

At this early stage, success has been limited but the reasons are not completely evident. While TVET needs improvement, few clear short- and medium-term options exist. The most promising option is to raise the general skills of students and facilitate their continuation to tertiary technical training centres (Centros de Formación Técnica, or CFTs). This is consistent with the CNIC’s general recommendations in this field.

The second challenge has been creating a national system for the certification to certify labour competencies. This—and the related theme of a national qualifications framework—united concerns about

The ability of individuals to signal to employers the extent and quality of skills

The relevance of training and the ability of training providers to offer programmes that serve the specific needs of employers

The articulation of different aspects of the education system so that individuals can build skills through progressively higher formal degrees or other means

The creation of the National Commission for the Certification of Labour Competencies (SNCCCL) is a key milestone, building on the pilot experiences with certification promoted by Chile Califica with the Fundación Chile and involving over 30,000 workers.

The third and fourth challenges listed above are closely related. A ‘narrow’ life-long learning system comprises: (i) “second-chance” general education for adults who left school early; (ii) a comprehensive employment training and re-training system that permits workers to maintain and upgrade career-related skills. With respect to (i), the Chile Califica program has been successful in attracting adults who dropped out of school back into education. Such programmes should continue. As regards (ii), Chile’s employers can claim tax credits up to 1% of payroll when they purchase employee training from registered Technical Training Organisations (OTECs). While many training offers exist, their quality and relevance are mixed. Coordination between certifiers and the SENCE—the coordinator of the enterprise-based training system—has been robust but further reform is necessary to make the system reliable and effective.

A ‘broad’ system of Life Long Learning s needs: (i) recognised degrees granted by the formal education system; (ii) certificates from short-course training; (iii) skills gained through experience. Such a system requires coordination across different policy domains and a comprehensive national qualifications framework. It is particularly important to integrate with the tertiary system, despite resistance from the proponents of elite education. CNIC has done well to keep the spotlight on those activities while seeking to upgrade its quality, relevance, and coverage.

The fifth challenge is tertiary education. Credits from the technical colleges (CFTs) must become acceptable to the universities, opening the higher education system to more people. A second major issue is strengthening the incentives for improved quality and relevance in tertiary education. Significant progress was made instituting accreditation in the university system in the second half of the last decade. Most institutions accredit at least some courses. Means should be

found to ensure that accreditation “reaches down” to teaching and learning practices in the classroom. The accreditation process should encourage a diverse set of institutional missions, and not push institutions toward only a single model, such as the large, research intensive university.

Strategic intelligence is needed about human capital. Chile should redouble its efforts to analyse the Chile Califica experience with the certification of labour competencies, and extend the analysis to include the results from the upcoming participation in the OECD’s Program for the International Assessment of Adult Competencies (PIAAC) and the international Tuning Project.

Tertiary education funding needs to shift from a historical to a performance contract basis. Pilot performance contracts with four institutions are being tested through the MECESUP Programme. They should be intensively evaluated and expanded and MECESUP should be made permanent.

The Becas Chile Programme will sponsor 30,000 Chileans – including teachers and professors of CFT – to undertake high quality postgraduate training abroad in priority fields. Together with other actions, the Becas Chile Programme will contribute to the goal of a critical mass of highly trained human capital working in industry, academia, and research. Nevertheless, coordination mechanisms should be encouraged, for example while developing domestic graduate programs. For instance, by double awarding degrees systems (local and foreign universities). Also a more systemic approach is required in terms of generating options for insertion into academia and businesses /or business sector for those who are returning.

A major effort is needed to reduce the high dropout rate of students from poorer families, who are left with a large debt but no qualification. Extending the State Guaranteed Loan (CAE) to students attending CFTs is a significant step, as is the requirement for accreditation of CFTs whose students receive CAE loans. Additional work is needed to ensure that the accreditation process is appropriate to the CFTs and that students complete their degrees.

The CNIC has argued for the changes for tertiary education described above. However, the Division of Higher Education of the Ministry of Education has neither the mandate nor the capacity to coordinate the work and agencies involved. The Panel agrees with the CNIC, the World Bank and the OECD that a Subsecretariat for Higher Education and Research, headed by a Vice Minister should be created as a pre-condition to success for the human capital policy agenda.

Key issues for the further development of the strategy are therefore

- The strategy should promote the development of a holistic human capital policy, covering and integrating all educational levels

- Better use of strategic intelligence on labour markets

- Continued efforts are needed in the schools to raise standards to OECD levels

- The TVET system needs further quality improvement and more effective accreditation

- Chile should build on SNCCL to create a national system of certification for labour competences that extends from school to PhD level

- Existing ‘second chance’ educational programmes play an important role and should continue

- OTEC courses should be more effectively accredited and better linked to needs

- Accreditation and funding (including performance contracts) mechanisms should continue to be used to make the universities more open and better integrated with the rest of the education system

There is continuing need to boost postgraduate production (especially PhDs) via mechanisms such as Becas Chile which should cover formation in credited local PHD, in top international ones and combinations of both.

Further adaptations in student finance, combined with better measures for pastoral care within the colleges, are needed to reduce the high tertiary education dropout rate

A Subsecretariat for Higher Education and Research should be created, headed by a Vice Minister

#### 4.4 Science for Development

CNIC points out that, recent years have seen greatly increased funding for university research and the launch of a programme of investment in research infrastructure as well as the creation of a number of centres of excellence and a start on strengthening regional research capabilities. However, incentives are needed to align research better with national needs, improve science communications and to build more international links. More needs to be done to programme resources and reduce fragmentation in research. Core as well as project funding, is needed and measures are required to create scientific careers.

The CNIC sees four broad lines of development for the coming period

- Growing and strengthening fundamental research, providing incentives to encourage its development in areas of relevance to national priorities

- Creating a comprehensive national system for funding science

- Building the human advanced capital needed to supply the needs both of industry and of the research system, especially in the areas of national priority

- Strengthening the part of the education ministry concerned with Higher Education and the role of CONICYT as the agency responsible for developing research in Chile

- Changing the institutional mandate of CONICYT from the creation of knowledge and human capital to the promotion of prosperity through the creation and application of knowledge and the formation of human capital

The Chilean science system is rightly criticised for its limited size, modest productivity (by global standards) and poor links with industry. The CNIC strategy tackles the first two problems through increased CONICYT funding – using peer reviewed, project-based money to raise both volume and quality. Industrial linkage cannot be tackled without developing technological capabilities in industry. Once that is achieved, CONICYT can build on it by funding industrial-academic consortia. These provide information to the research community about what research areas have societal interest – and are will be fundable also in the future. Many developed countries have found that that this leads to co-evolution between business, research and higher education, with industrial needs acting as ‘focusing devices’ for research and education activities. Thus, with development and appropriate support, over time the science system becomes increasingly attuned to social needs.

A number of studies show positive correlation between R&D intensity and innovation outcomes<sup>30</sup>. **Strengthening research in the knowledge infrastructure** is an essential precondition for driving up business R&D and hence innovation, so the CNIC is right to target increased

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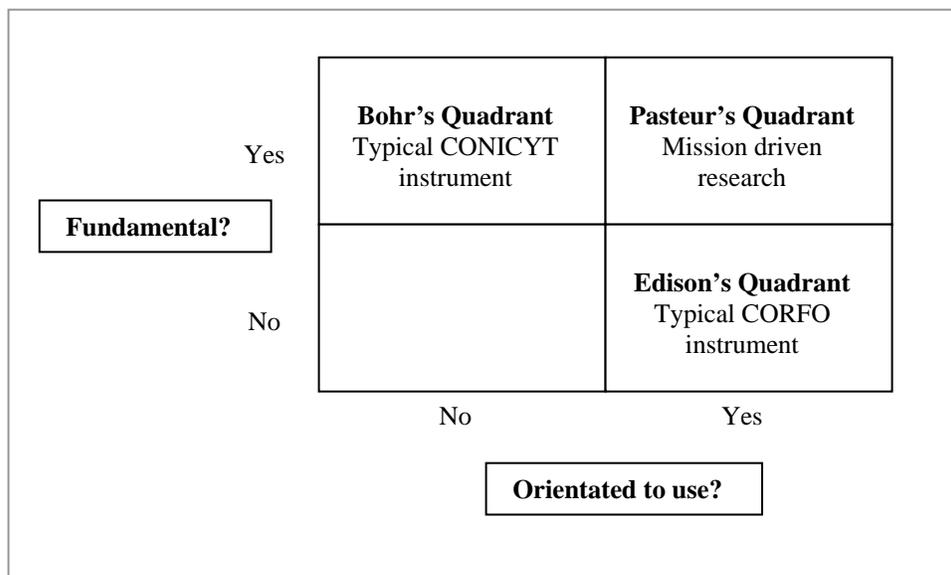
<sup>30</sup> Mairesse, Jacques, The Importance of R&D for Innovation: A Reassessment Using French Survey Data (2005). *Journal of Technology Transfer*, Vol. 30, Issue 1-2, p. 183-197 2005.

fundamental research in its strategy. Increased research outputs will, of course, result, but a key effect comes via manpower – including increased national ability to make use of advances in knowledge generated worldwide. By producing a (very) small part of the world’s knowledge, Chile trains the manpower it needs to make use of the rest.

In Chile, as elsewhere, the process of allocating project-based research funds is ‘captured’ by the scientific community, which provides the peer reviewers and populates the committees at CONICYT. Research indicates that the strategic orientation of expenditure strongly influences innovation performance<sup>31</sup>. Hence, CONICYT assessment criteria should address not only scientific quality but also likely impacts on society and industry (as is done, for example, by the US NSF and the UK research councils).

A subsequent reform should be the use of **Full Economic Cost in institutional funding** for universities and institutes research, eliminating the distorting effects of cross-subsidies from education to research<sup>32</sup>.

**Figure 1 Stokes' Quadrant Model of Scientific Research (Modified)**



*Adapted from "Pasteur's Quadrant – Basic Science and Technology Innovation". Donald E Stokes, Brookings Institution Press 1997*

The standard definition of ‘basic research’ is, essentially, that it is ‘curiosity-driven’. This definition reinforces the role of the scientific community in distributing research funding. In fact, a large part of fundamental research – what Stokes called “Pasteur’s Quadrant” – is use-orientated (Figure 1). There is often a perception<sup>33</sup> that orientation to such mission-oriented work will reduce

<sup>31</sup> L.Himanen, et al (2009)

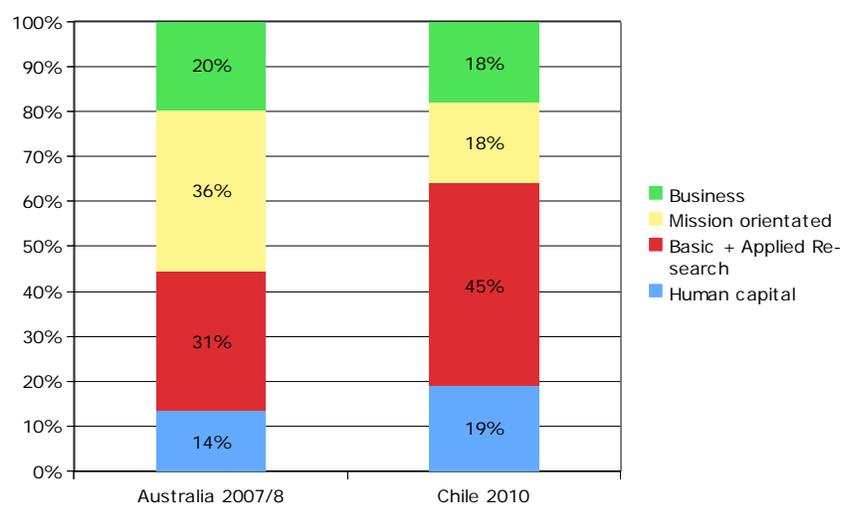
<sup>32</sup> Overhead cost for R&D funding is well below international standards.

<sup>33</sup> INAP Consultores, (2010)

the quality of research. However the experience of Japan, Australia and USA indicates clearly that this is not true – for example, in Australia the increased focus on mission-oriented research has increased Australia’s ranking as one of the leading source of intellectual property.

Many countries recognised as innovative (eg Finland, Japan, Korea, USA, Australia) are increasing the proportion of spending on **mission-oriented R&D** as a key driver of socio-economic growth. Chile has an R&D profile which is quite different from those of these innovative countries (see next diagram which compares Chile and Australia):

**Figure 2 State R&D Spending by Mission: Australia and Chile**



Increasing the role of mission-oriented research is a key part of the development process. This should be achieved partly by using research funding related to the missions of ministries such as transport, energy and so on and partly through strategic influence on project funding decisions.

In many fields, the nature of research has changed via a shift from discipline-based to multi-disciplinary research, increasingly focused on team-based and collaborative actions, the increasing importance of (large) data collections and the use of modelling and visualisation. Responding to these trends requires

- Establishing centres of research excellence, to bring together teams of critical mass to address larger, multi-disciplinary problems
- Establishing centres of collaborative research activity between universities and business
- Provision of advanced research infrastructure to support key research areas
- Provision of advanced ICT capability to underpin the use of large data sets

**Academic-industrial partnerships in centres of excellence** (sometimes called ‘competence centres’) use social and industrial needs as ‘focusing devices’ that signal about what research questions are socially interesting and therefore what kinds of research theme will become especially fundable. They also play a role in reorientating universities’ research culture and in

reducing the fragmentation of research within universities normally caused by the dominance of researcher-initiated research.

Many of these are being implemented in Chile, but are in the early stages of evolution and too broadly distributed to attain critical mass. Australia with a research effort more than ten times the size of Chile's has 30 Centres of Excellence/Special Research Centres (most with a high level of mission-orientation) and 48 Cooperative Research Centres linking business and universities. This compares with some 30 centres in Chile.

Chile's stage of development means that Chilean centres should place more emphasis on building firms' absorptive capacity than those in more research-intensive economies. (Norway, Austria and Sweden involve applied research institutes in their programmes to improve cooperation with less sophisticated industries.) The limited extent of existing clustering in Chilean industry means that policy is needed to encourage the formation of industrial consortia, so there is a natural role for the national clusters to play. FDI and links to foreign-based firms and universities can provide access to partners with high technological capabilities, so Chilean centres should seek to include such partners<sup>34</sup>.

A modern research effort is heavily based on access to modern research **infrastructure** whose costs are beyond the means of individual institutions and which therefore requires national coordination and financing. The Associative Research Program for Scientific and Technological Equipment Service Centres is key to the Chilean research effort, and its structure and conditions conform to best modern practice. The need for continuous development and renewal of infrastructure means that such a programme is needed permanently.

The Strategy envisages a number of **transversal platforms**. While their nature will depend on the work of the clusters, the issue of ICT platforms for both research and business innovation needs urgent attention. Most research-oriented countries have made significant investment in research and education networks as a foundation for data access and collaborative activities, and in research data centres and high capacity modelling centres. As with the ARPANET/Internet, high-capacity facilities have tended to spill into the business sector and form a strong basis for innovation. CNIC should encourage as a matter of priority the development of a strategy covering both aspects, which may include (de)regulation to remove blockages in the commercial sector.

Key issues in the further development of the strategy are therefore

- Increasing research funding to the knowledge infrastructure, so as to support the development of business R&D and a sustainable innovation system

- Make greater use of 'relevance' criteria in allocating research funding; this will require governance reforms at CONICYT

- Allocate a greater proportion of national R&D funding to mission-orientated work

- Focus a proportion of research funding into centres of excellence and 'competence centres'

- Ensure the design of these centres is adapted to Chilean circumstances, not simply copied from countries with high industrial technological capability

- Provide continuous funding for research infrastructure and platforms – while being mindful of the commercial opportunities they may induce

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<sup>34</sup> The standard objection that foreign participation caused 'leakage' of knowledge should not be ignored, but the main point of the centres is capacity building rather than making IPR

## 5 Conclusions and Recommendations for the Strategy

### 5.1 Conclusions

Chile is at a turning point in its development. Growth and the growth in productivity necessary to drive it have faltered. Competitor countries are encroaching on the new markets and industries that enabled Chile's growth spurt. Chile therefore faces a stark choice: to find a way to rekindle growth – most probably by increasing the rate of innovation – or to accept falling incomes per head, with all that implies for social and economic welfare and stability.

Chile's economic performance and innovation system have been intensively studied recently. The unanimous conclusion is that, despite good macroeconomic policy, microeconomic performance is unsatisfactory and therefore that significant reforms are needed in business innovation, human capital, research and innovation system governance. These have largely been documented by the CNIC in its Strategy.

The central problem is poor business innovation performance, so there is a need for action both within firms and in the other parts of the innovation system that enable firms to perform well. Well-functioning innovation systems comprise many sub-systems where demand and supply interact. At early stages of development, 'Catch-22' situations arise in parts of the innovation system where both supply and demand are weak. The state can often intervene to kick-start these sub-systems and then reduce its role. This can appear paradoxical if we take a static view, with the state at once playing interventionist and non-interventionist roles, but is comprehensible if we take an evolutionary perspective.

A key achievement of the CNIC has been to provide an arena to discuss the national development challenges and generate consensus for tackling them. It has generated a range of interventions, which support the intentions of a Strategic Innovation Policy

- Generating a national vision, with associated strategic priorities

- Helping articulate the priorities into a set of policies, together with other actors such as ministries and agencies, which will be involved in implementation

- Coordinating certain policies among different parts of the innovation system

- Evaluation of the National Innovation System and associated policies

It has successfully started to set priorities about clusters that largely reflect existing and potential strengths, based on a process of careful analysis by independent consultants. This initiates processes of coordination and signalling that will enable a more effective organisation and improvement of existing advantages. Strong priority setting, in the sense of trying to establish more or less new activities, has also been practised but on a scale that poses little risk. A key need is to strengthen the links to the regions' autonomous capacity for development.

In relation about the governance of the policy system at as whole and in order to address the implementation problems and assure the most effective hearing for its proposals, three conditions should be met.

First, CNIC should be independent from the government and the members should be selected from among the most qualified candidates in the relevant sectors – public, private, academic – both in Chile and abroad. The formal condition of this independence should correspond

to the best practices in Chile for ensuring the autonomy of relevant state organisations, for example, the antitrust authority or Central Bank.

Second, the commission should engage in regular diagnostic monitoring of the implementation of the national strategy. The goal of this monitoring should not be the evaluation of the impact of specific programmes but rather to insure that the relevant authorities are collecting the kind of information that enables them and oversight authorities to detect and correct errors in the design or implementation of programs. The goal is facilitate continuous and informed discussion of programmes whose initial conception will inevitably require improvement.

Third, to address the problem of coordination across ministries necessary to implement innovation policies and effectively to deliver many services in a complex society, a study group or commission should be created to review in detail the functioning of the inter-ministerial committee and the disjunction between its efforts and the budget process, and to propose appropriated remedies.

In relation to the Strategy, the panel believes the CNIC's diagnosis is sound and that the policies it proposes are largely correct.

### ***The scope of the National Innovation Strategy***

The structure of the Innovation Strategy is coherent, its elements are appropriate in this situation, and it has coverage and sight of the main issues and strategies.

In relation to the three pillars of the Strategy – high quality life-long learning, a science and technology system oriented towards social needs, a proactive and innovative business enterprise sector – the panel believes the CNIC's diagnosis of the issues is sound and that the policies it proposes are largely correct.

### ***Governance and Policy***

The ongoing role of CNIC should continue to be that of independent advisor to the Government but its responsibilities should also include the monitoring of the implementation of the Strategy and the evaluation of the impact of and advances in the Strategy.

There is a need to establish clearly the institutional status and objectives for CNIC, which should have autonomy to recommend a National Innovation Strategy and responsibility for monitoring coordination across the activities that implement the Strategy.

### ***Implementation of the Strategy***

Progress to date in implementing the strategy has been too slow, and has been hampered by the relative weakness of the Ministerial Committee of Innovation (MCI) with lack of conduction and little empowerment.

With the division of labour, where CNIC acts as a strategic advisor to the Government and the MCI as the body responsible the implementation of the strategy, this weakness causes lack of focus and coordination of the interventions.

Increased effort in publicising and promoting the innovation strategy and vision across the economy is needed so that all actors understand its purpose and goals.

There is insufficient cohesion and coordination of the programmes/instruments.

### ***Business Innovation***

A clear part of the strategy should be to move established companies to the productive frontier through process improvement and product innovation. However there is a need to ensure the Strategy is focused on internationalisation of the Chilean innovative companies, rather just simply internalised improvement.

A number of legal and regulatory matters create rigidities in the system; and there seem to be few initiatives to address these issues.

The creation of clusters that largely reflect existing and potential strengths, based on a process of careful analysis by independent consultants, provided an initial action to set priorities.

The effectiveness of the clusters has been variable, and a more detailed assessment of the success and failure factors needs to be undertaken to make this initiative more effective.

Only limited resources are devoted to the creation of companies' internal technological and innovation capabilities and on encouraging them to use these resources for innovation. There needs to be more focus on endogenous innovation capacity of firms and the generation of 'pull' for technology to complement the 'push' of other policy measures. A greater scale of effort must be devoted to business innovation, generating the take-up needed to get critical mass and change innovation culture.

In particular, more effort needs to be devoted to the development of a critical mass of innovative SMEs to encourage development of a significant venture capital activity and to facilitate linking these SMEs to larger companies as core suppliers.

There needs to be increased focus on measures that induce learning and changed behaviour.

There is a need to reduce bureaucratic barriers to service delivery.

There is a requirement for a systemic perspective in designing the intervention portfolio.

There is insufficient effort to stimulate the emergence of regional capacity for development, creating 'learning regions' that can more actively contribute to a more differentiated innovation strategy in future.

### ***Science Base***

The initiative to increase funding of research in the knowledge infrastructure, so as to 'kick-start' the national research system across public and private sectors towards a level of input and output more typical of OECD countries is appropriate. However this additional investment needs to be focused on changing the structure of the scientific effort, rather than sustaining the existing structure.

The impact of increased investment in R&D on economic development will be maximised by closer alignment of research themes with socio-economic objectives – that is, a higher level of mission-orientation in publicly funded research. The R&D effort is less mission-oriented than most developed countries, and almost all developing countries and thus there is a need to increase the use of 'relevance' criteria in the selection processes for research funding.

There is a need to devote more focused resources to mission-oriented work and associated mission-orientated centres of excellence, while ensuring that these are adapted to Chilean circumstances; this should be seen in the context of sustaining excellence-based basic research.

The process of changing the priorities of activities of the science capability towards industrial and societal needs has not been totally effective with investment being diffuse rather than focused.

The initiative to invest in world-class research infrastructure is appropriate, but there is an absence of strategic positioning to enhance and sustain this investment.

Coordination and linkages need to be improved among different parts of the innovation system – notably between Research and Higher Education and Business

A key need is to strengthen the links to the regions' autonomous capacity for development.

### ***Human Capital***

Chile lacks a holistic, integrated, quality-assured and accredited system of education stretching from primary school to PhD, in which credits are mutually recognised and transferable at the appropriate levels and which is consistent with international norms and accreditation where possible (eg the Bologna process)

More effort needs to be given to quality-assure and accredit all of education, producing a holistic and transparent system that offers equity of access and benefits in the form of improved education, labour markets and innovation capabilities in industry and the public sector

Considerable effort has been given to improving standards in schools and ensuring equitable access to education at all levels. Much further work needs to be undertaken fully to implement this strategy

There have been several initiatives to increase postgraduate education, especially where this is linked to international exposure. However there is an absence of strategies to integrate this increased capacity into the R&D sector and into industry

There is insufficient status and priority for these initiatives in the implementation process, suggesting the need to create a Subsecretariat for Higher Education and Research, headed by a Vice Minister, in the Education Ministry, in order to drive through needed reforms

### ***Transversal Platforms***

There needs to be more rapid progress in the development of plans and investments in critical transversal platforms such as information technology (particularly communications capacity), and transport.

## 5.2 Recommendations

### ***In the short term:***

- 1 Establish the institutional status and objectives for CNIC, which will provide for its autonomy to develop and oversee the implementation of the National Innovation Strategy and for its accountability for monitoring and ensuring coordination across the programmes of the Strategy.

- 2 Introduce programmes and instruments, which develop more focus on endogenous innovation capacity of firms and the generation of ‘pull’ for technology to complement the ‘push’ of other policy measures.
- 3 Develop programmes, which aim to develop a critical mass of innovative SMEs linked with larger organisations as core suppliers, including the provision of seed capital.
- 4 Extend the effort to quality–assure and accredit all of education, producing a holistic and transparent system that offers equity of access and benefits in the form of improved education, labour markets and innovation capabilities in industry and the public sector.
- 5 Increase the proportion of mission–orientated research activity by reforming funding processes to reflect a better alignment of research with national development needs.
- 6 Implement bottom–up processes in the clusters with the objectives of increasing the probability of short–term productivity gains while creating an environment that enhances collaboration between firms and with the Government within each cluster.
- 7 Rationalise programmes and improve the coordination and cohesion between programmes and instruments.

***Over the medium to longer term***

- 1 Develop strategies to encourage a robust early stage venture capital sector around a critical mass of innovative SMEs.
- 2 Develop a framework that allows for cluster formation and diversification with evolving areas of industrial strength.
- 3 Analyse needs and develop strategies and policy and regulatory frameworks to encourage investment in, and development of, effective transversal platforms, particularly in respect of communications networks to link research institutions and businesses.
- 4 Further stimulate the emergence of regional capacity for development, creating ‘learning regions’ that can more actively contribute to a more differentiated innovation strategy in future.
- 5 Develop strategies and implement programmes to integrate the increased cohort of advanced human capital into the research and business sectors.

## BIBLIOGRAPHY

Avnimelech, G. and M. & Teubal (2008b): “Evolutionary Targeting” **Journal of Evolutionary Economics**, special issue.

Avnimelech, G. and M. Teubal (2005), “Evolutionary Innovation and High Tech Policy: What can we Learn from Israel’s Targeting of Venture Capital?”, Technology and The Economy Program Working Paper Series STE–WP–25–2005, Samuel Neaman Institute, Science

Avnimelech, G. and M. Teubal (2006), “Creating VC industries which co–evolve with High Tech: Insights from an Extended Industry Life Cycle (ILC) perspective to the Israeli Experience”, **Research Policy**, 35(10), pp. 1477–1498. A version of the paper appeared in P. Braunerhjelm and M. Feldman (eds) **Cluster Genesis: Technology Based Industrial Development**, Oxford University Press

**Benavente J.M.** (2006) “The Role of Research and Innovation in Promoting Productivity in Chile”. *Economics of Innovation and New Technology* 15 (4–5) : 301–315. June

Bresnahan, T.; and A. Gambardella (2004): **Building High Tech Clusters**, Cambridge University Press, New York

Consejo Nacional de Innovación para la Competitividad, (2007) **Hacia una Estrategia Nacional de Innovación para la Competitividad”, Volume I**

Consejo Nacional de Innovación para la Competitividad, (2008) **Hacia una Estrategia Nacional de Innovación para la Competitividad”, Volume II**

Consejo Nacional de Innovación para la Competitividad, (2010): “**Avances y Desafíos: Agenda 2010–2020**”, typescript

Crespi, G. (2006). **Productivity and Firm Heterogeneity in Chile**, University of Sussex. Unpublished.

Fagerberg, J.; Guerrieri, P.; and B. Verspagen (1999): **The Economic Challenge to Europe: Adapting to Innovation Based Economic Growth**, Edgar Elgar Cheltenham, UK and Northampton, MA, US

Gana Quiroz, Juanita (2010), **Assessment of National Innovation Strategy: Background Report – Institutional Component**, Santiago

Gassler, H.; W. Polt; J. Schindler; M. Weber, S. Mahroum, K. Kuberczko and M. Keenan (2004), *Priorities in Science and Technology Policy – an International Comparison*, Joanneum Research, Project Nr. RTW.2003.AF.014–01, Commissioned by the Austrian Council for Research and Technology Development

Hausmann, R.; and B. Klinger (2007), **Structural Transformation in Chile**, Quantum Advisory Group, June

Himanen, L. et al, (2009), ‘Influence Of Research Funding And Science Policy On University Research Performance: A Comparison Of Five Countries’, **Science And Public Policy**, 36,: 419–430

Hurvitz, H.; and D. Brodet (eds), (2008): **Israel 2028: Vision and Economic–Social Strategy in a Global World**, US–Israel Science and Technology Commission, March

INAP Consultores (2010): “**Generation and Systematisation of Support for Evaluating the National Innovation Strategy in the Areas of Business Innovation**”, typescript, January

Interlink Biotechnologies, LLC (2008): “ **Biotechnology assessment and strategic recommendations**”.

Justman, M. and M. Teubal (1991), “Structuralist Perspective on the role of Technology in Growth and Economic Development”, **World Development**, 19 (9), pp. 1167–1183

Kharas, Homi, Danny Leipziger, William Maloney, R Thillainathan and Heiko Hesse, Commission on Growth and Development, (2008): **Chilean Growth Through East Asian Eyes**, Washington DC: World Bank

Kuznets, S. (1971), **Economic Growth of Nations: Total Output and Production Structure**, Cambridge, MA: Harvard University Press

Kuznets, S. (1973) “Modern Economic Growth: Findings and Reflections”, **American Economic Review**, 63:247–258

OECD (2007), **Reviews of Innovation Policy: Chile**, Paris: OECD

OECD, *Chile’s National Innovation Council for Competitiveness: Interim Assessment and Outlook*, Paris OECD: 2009  
Rodrik D. (2007), **One Economics, Many Recipes: Globalisation, Institutions and Economic Growth**, Princeton University Press, Princeton and Oxford

Porter, M (2008), ‘Clusters and the New Economics of Competition’, *Harvard Business Review*, November–December 1998

Saviotti, P. (1996) **Technological Evolution, Variety and the Economy**, Edgar Elgar, Cheltenham

Saviotti, P. and A. Pyka (2004), **“Economic Development by the Creation of New Sectors”**, *Journal of Evolutionary Economics* 14(1), pp. 1–35

Sercovich, R.; and M. Teubal (2009), **“Strategic Innovation Policy: A Systems–Evolutionary Perspective”**, submitted to **Science and Public Policy**

SYN (2010), **Generation and Systemisation of Base for the Evaluation of the National Innovation Strategy in the Areas of Science and Human Capital**, Santiago

Teubal (1996), **“A Catalytic and Evolutionary Approach to Horizontal Technology Policies (HTPs)”**, *Research Policy*, 25(8):1161–1188

Teubal (1997), **“R&D and Technology Policy in NICs as Learning Processes”**, *World Development*, 24(3):449–60

Teubal, M. (2008), **“Direct promotion of ‘Commercial’ Innovation in Least Developed Countries: A Systems Evolutionary Perspective”**, paper prepared for UNCTAD, April

