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Foreword

This study is part of a series of OECD country reviews of innovation policy devoted to member as well as non-member countries.* It was requested by the Peruvian authorities, represented by the Ministry of Economy and Finance, and was carried out under the auspices of the OECD Committee for Scientific and Technological Policy (CSTP) with the collaboration and support of the Inter-American Development Bank (IDB).

The review draws on a background report commissioned by the Ministry of Economy and Finance and prepared by the Peruvian consulting firm GRADE and on information collected during two field missions conducted by the OECD review team in August-September 2010 and in March 2011. During the missions interviews were conducted at central and regional levels with stakeholders in Peru's science, technology and innovation (STI) system: high-level government officials from the Presidency of the Ministerial Council and the Ministry of Economy and Finance as well as sectoral ministries responsible for policies in the areas of science, technological development, innovation and competitiveness, and for the oversight of institutions in charge of policy implementation; high-level managers of institutions in charge of policy development and implementation; officials responsible for the management of innovation funds; representatives of the enterprise sector, public research institutions (universities and research centres) and technological centres; non-governmental organisations and independent experts. The review also benefited from comments made during the presentation of preliminary results in meetings in Lima in March 2011.

The report was drafted by Daniel Malkin, consultant to the OECD. It benefited from contributions from Jean-Jacques Duhart (former Vice-Minister of Economy, Chile), Tarmo Lemola (Director, Advansis Oy, Finland) and Sungchul Chung (Senior Fellow, STEPI, Korea, and former Vice Chair of the OECD's CSTP). The review was initiated by Jean Guinet (former Head, Country Studies and Outlook Division, DSTI, OECD). Gernot Hutschenreiter (Country Studies and Outlook Division, DSTI, OECD) supervised and contributed to the preparation of this report.

The review owes much to officials from Peru's Ministry of Economy and Finance, particularly Javier Roca and José La Rosa, as well as to Flora Painter and Juan Carlos Navarro (S&T Division, IDB, Washington) and Claudia Suaznabar (IDB office in Lima) who provided valuable assistance to the OECD team throughout the preparation of the report.

**www.oecd.org/sti/innovation/reviews*

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Acronyms

ACT	*Actividades de Ciencia y Tecnología* Science and Technology Activities
ANR	*Asamblea Nacional de Rectores* National Assembly of Rectors
APEM	*Asociación Peruana de Productores de Mango* Peruvian Association of Mango Producers
BCRP	*Banco Central de Reserva del Perú* Central Reserve bank of Peru
BID	*Banco Interamericano de Desarrollo* Inter-American Development Bank
CAS	*Contrato Administrativo de Servicios* Administrative Service Contract
CIES	*Consorcio de Investigación Económica y Social* Consortium for Economic and Social Research
CITE	*Centro de Innovacíon Tecnológica* Technological Innovation Centre
CNC	*Consejo Nacional de la Competitividad* National Competitiveness Council
CNIC	*Consejo Nacional de la Innovación para la Competitividad (Chile)* National Council of Innovation for Competitiveness (Chile)
COFIDE	*Corporación Financiera de Desarrollo* Financial Corporation for Development
CONACYT	*Consejo Nacional de Ciencia y Tecnología (México)* Mexico's National Council for Science and Technology
CONCYTEC	*Consejo Nacional de Ciencia, Tecnología e Innovación Tecnológica* National Council for Science, Technology and Technological Innovation
CONI	*Consejo Nacional de Investigaciones* National Research Council
CONICYT	*Comisión Nacional de Investigación Científica y Tecnológica (Chile)* Chile's National Commission for Scientific and Technological Research
CONIDA	*Comisión Nacional de Investigación y Desarrollo Aeroespacial* National Aerospace Research Institute
CORCYTEC	*Consejo Regional de Ciencia Tecnología e Innovación* Regional Council for Science, Technology and Innovation

ENAHO	*Encuesta Nacional de Hogares* National Household Survey
ENCYT	*Encuesta Nacional de Ciencia, Tecnología e Innovación Tecnológica* National STI Survey
ENGEMMET	*Instituto Nacional de Geología, Minería y Metalurgia* National Institute of Geology, Mining and Metallurgy
FDI	Foreign direct investment
FIDECOM	*Fondo de Investigación y Desarrollo para la Competitividad* R&D Fund for Competitiveness
FINCYT	*Financiamiento para la Innovación, la Ciencia y la Tecnología* Financing of Innovation, Science and Technology (Fund)
FONDECYT	*Fondo Nacional de Desarrollo de la Ciencia, Tecnología e Innovación* National Fund for the Development of Science, Technology and Innovation
GRADE	*Grupo de Análisis para el Desarrollo* Group for Development Analysis
HEI	Higher education institution
IDI	*Red de Investigación, Desarrollo e Innovación* R&D and Innovation Network
IEP	*Instituto de Estudios Peruanos* Institute of Peruvian Studies
IGP	*Instituto Geofisico del Perú* Geophysics Institute of Peru
IIAP	*Instituto de Investigaciones de la Amazonía Peruana* Research Institute of on the Peruvian Amazon
IMARPE	*Instituto del Mar del Perú* Oceanic Research Institute of Peru
INCAGRO	*Innovación y Competitividad para el Agro Peruano* Innovation and Competitiveness of Peru's Agro sector (Fund)
INCITEMI	*Instituto Tecnológico y Científico Minero del Perú* Mining S&T Institute of Peru
INDECOPI	*Instituto Nacional de Defensa de la Competencia y de la Propiedad Intelectual* National Institute for Competition and Intellectual Property
INEI	*Instituto Nacional de Estadística e Informática* National Institute for Statistics and Informatics
INIA	*Instituto Nacional de Innovación Agraria* National Institute for Agricultural Innovation
INICTEL	*Instituto Nacional de Investigación y Capacitación en Telecomunicaciones* National Institute for Research and Training in Telecommunications
INRENA	*Instituto Nacional de Recursos Naturales* National Institute for Natural Resources

INS	*Instituto Nacional de Salud* National Health Institute
IPEH	*Instituto Peruano de Espárrago y Hortalizas* Peruvian Asparagus and Vegetables Institute
IPEN	*Instituto Peruano de Energía Nuclear* Nuclear Energy Institute of Peru
IPR	Intellectual property rights
IST	*Institutos Superiores Tecnológicos* High Technology Institutes
ITINTEC	*Instituto Tecnológico Industrial y de Normas Técnicas* Institute for Industrial Technology and Technical Norms
ITP	*Instituto Tecnológico Pesquero* Fisheries Technological Institute
MEF	*Ministerio de Economía y Finanzas* Ministry of Economy and Finance
MINAG	*Ministerio de Agricultura* Ministry of Agriculture
MINCETUR	*Ministerio de Comercio Exterior y Turismo*
MINEDU	*Ministerio de Educación*
OECD	Organisation for Economic Co-operation and Development
OTCIT	*Oficina Técnica de Centros de Innovación Tecnológica* Technological Innovation Centres Technical Office
PCM	*Presidencia del Consejo de Ministros* Presidency of the Council of Ministers
PIBAP	*Proyecto de Investigación Básica, Aplicada y Precompetitiva* Basis, Applied and Precompetitive Research Project
PIN	*Proyecto de Interés Nacional* National interest project
PISA	Programme for International Student Assessment
PITEA	*Proyectos de Innovación en Empresas Asociadas* Enterprises Innovation Project (in collaboration)
PITEI	*Proyectos de Innovación en Empresas Individuales* Enterprise Innovation Project (individual enterprise)
PRI	Public research institute
PROCOM	*Proyectos de Innovación Tecnológica para la Competitividad*
PROCYT	*Proyectos de Investigación en Ciencia y Tecnología* S&T research projects
PRODUCE	*Ministerio de la Producción* Ministry of Production

PROINVERSIÓN	*Agencia de Promoción de la Inversión Privada* Foreign Investment Promotion Agency
PROMPERÚ	*Comisión para la Promoción del Perú para la Exportación y el Turismo* Commission for the Promotion of Peru's Exports and Tourism
PROTEC	*Proyectos de Transferencia e Innovación Tecnológica* technological innovation and transfer projects
RICYT	*Red Iberoamericana de Indicadores de Ciencia y Tecnología* Iberoamerican S&T Indicators Network
SINACYT	*Sistema Nacional de Ciencia, Tecnología e Innovación Tecnológica* National Science, Technology and Technological Innovation System
SNIP	*Sistema Nacional de Inversión Pública* National Public Investment System
STI	Science, technology and innovation
WIPO	World Intellectual Property Organisation

OECD Review of Innovation Policy: Peru
Overall assessment and recommendations

Sustaining the recovery: towards a stronger role for innovation in Peru's economic development

A strong recovery in the last decade …

Peru has achieved outstanding economic growth over the last decade. With average annual growth of GDP and GDP per capita of 6.3% and 4.5%, respectively, it has been among Latin America's top economic performers. It weathered the recent financial and economic crisis well and picked up vigorously in 2010. Underpinning this excellent performance are sound macroeconomic policies, structural reforms to improve the functioning of product and labour markets, and the openness of the economy to international trade and foreign investment. These policies have fostered investment, productivity and job creation. They have allowed Peru to exploit its comparative advantages in natural resource-based sectors and traditional industries and reap the benefits of increased demand from both developed and emerging economies. They have also begun to have positive, albeit moderate, effects on living standards and poverty reduction.

… should not lead to complacency

However, Peru still lags behind most Latin American countries in terms of per capita income and investment in human capital and knowledge. Its economy remains relatively undiversified. Income disparities are high and informal jobs still account for a large share of total employment. Although labour productivity has increased since 2003, it still lags behind other Latin American middle-income countries. Growth in total factor productivity (TFP), which reflects more efficient use of factor inputs, including through innovation, has played only a marginal role. While the more efficient allocation of resources as a result of structural reforms has had positive effects, economic growth has been mainly due to capital formation and increased labour input.

While Peru's exports more than quadrupled in the last decade, its export specialisation and international competitiveness still rely essentially on its comparative advantages in natural resource-related commodities and on relatively low labour costs; the share of non-traditional products in total exports declined from 29% in 2002 to 21% in 2010. In the future, Peru is likely to face greater competition from countries with similar comparative advantages. For its natural resource-based exports, it faces the uncertainty of world demand and the price volatility of commodities.

To combat weaknesses that threaten sustainability…

Improving productivity throughout the economy and diversifying economic activities towards higher value-added production and exports are two major challenges for the medium- to long-term sustainability of Peru's growth and development. They are also necessary to ensure inclusiveness, notably through the creation of more qualified jobs, the reduction of informal employment and poverty alleviation. This calls for strategies and policies based on a close examination of potential sources and patterns of growth in a changing global environment. Lagging labour productivity indicates that there is much scope for improvement, while increased investment in knowledge assets to raise Peru's innovation capacity can help sustain growth. As returns to such investment take time and help determine the future competitiveness of the business sector, this is an urgent task for public policy.

In Peru, as in many developing countries, a preference for imported technology over the development of domestic innovation capacities has thwarted the development of absorptive capacity and limited technology diffusion via international trade and foreign investment. There is little technology diffusion from the more technologically advanced export-oriented mining and agro-industrial sectors, and the lack of variety in the country's production and exports hampers the emergence of technology-based value chains and reduces opportunities for learning.

Unlike developed countries such as Australia and Norway or emerging economies such as Brazil and South Africa – where natural resources also contribute significantly to export and income growth – Peru has been relatively unable to leverage its resource base to diversify in upstream and downstream industries or to develop services that increase the efficiency and sustainability of exploitation of its natural resource-based sectors. This is partly due to weak incentives for the business sector to invest in such activities but also to the scarcity of qualified human resources for developing medium to high technology in upstream and downstream activities linked to the mining and energy sectors, or for the sustainable exploitation of the country's large biodiversity resources.

…requires innovation as a driver of growth

The experience of successful developed and emerging countries indicates that a more proactive role by government in fostering innovation can help Peru develop new competitive advantages and alleviate constraints that hinder this process. Measures that encourage innovation and help respond to social challenges complement stable macroeconomic policy and sound framework conditions and can lead to a more sustainable growth path which is less affected by external shocks. Such a path can foster growth and inclusiveness through productivity gains from innovation-related investment, including in human capital, through technology diffusion and through the competitive advantages of a more diversified economy. Countries with resource endowments as different as Finland, Korea and Norway and, more recently, emerging economies such as China, Brazil and Chile have followed such a path, some of them very successfully. Unlike Peru, these countries have increased public and private investment in science, technology and innovation (STI) in the last decade. There has of course been some diversification in Peru in recent years, notably in the non-traditional agricultural sector where exports grew from USD 0.39 billion in 2000 to USD 1.9 billion in 2010. At least part of this success can be attributed to public policies that support innovation and technology transfer in that sector. To make better use of new sources of growth requires continued institutional and policy reforms.

Peru's innovation system: Main weaknesses and policy challenges

Unlike other Latin American countries, and despite a well-established academic tradition, Peru largely missed the opportunity to develop a strong public science and technology (S&T) infrastructure in its university system or public research institutes (PRIs) in the 1960s and 1970s. As a result, its S&T "supply side" has been insufficient. The resource endowments of these institutions and their performance in terms of knowledge generation and diffusion were often extremely weak. Peru continues to suffer from this situation, which is often aggravated by poor governance of PRIs.

In addition, changes in economic policy over successive political cycles were accompanied by sometimes drastic shifts in the role and orientation of S&T policy, thus hindering the emergence of a strong political consensus on the importance of investment in S&T for sustained and inclusive development and competitiveness. This led to low levels of resources for S&T and allocation conflicts and undermined the emergence of a coherent and articulated innovation system in which actors are more prone to engage in co-operation than to defend vested interests. A legalistic approach to institution building also led to layers of institutions whose responsibilities for policy design and implementation rarely correspond to their legislative mandates and to overlapping responsibilities and conflicts over scarce resources.

The role of support instruments in leveraging demand for scientific and technological knowledge from the private sector and building S&T capacity is also underestimated. This is compounded by institutional obstacles to the transfer of public resources to the private sector. Peru has been slow to realise the importance of intermediary institutions for the development of S&T infrastructure and technology diffusion.

Insufficient resources for S&T: A partial explanation of poor innovation performance

Compared to emerging economies and Latin American countries with similar levels of development or endowments, Peru devotes very few public or private resources to research and development (R&D). In 2004, the last year for which statistics – of uncertain reliability – are available, the R&D intensity of the Peruvian economy (the ratio of R&D expenditures to GDP) was only 0.15% against 0.90% in Brazil, 0.65% in Chile, 0.43% in Mexico and 0.86% in South Africa. Since then R&D intensity has risen in these other countries, and quite strongly in Brazil and South Africa, but has likely stagnated or increased only marginally in Peru. It is estimated that the share of the total budget to S&T institutions or innovation funds in fact decreased from 1.72% in 2003 to 1.59% in 2009. Peru's weak performance in terms of innovation outputs, as measured by patents or productivity, reflects to some extent the low level of investment in physical and intangible knowledge assets as well as inefficiencies in the innovation system that result in inadequate returns to S&T-related investment.

While resources that help to enhance STI capacity, especially R&D and S&T infrastructure, are certainly needed, concomitant development of absorptive capacity, notably in terms of (skilled) human resources, is also necessary. As the experience of the most successful countries indicates, the performance of innovation systems also depends on qualitative factors that foster the generation, acquisition, diffusion and application of knowledge and technology and ensure efficient leverage of public resources on private innovation-related investment in existing or new ventures. These factors include:

- Institutional and governance settings that shape policy orientation, design and implementation, allow for adaptive policy responses, and limit duplication of support programmes.
- Conditions favourable to the performance of public research and technology transfer institutions.
- Absence of legal or regulatory restrictions that negatively affect the leverage of public resources on private investment in S&T or the development of public-private partnerships for research and innovation.
- A policy mix that generates a virtuous circle of supply and demand in developing S&T capacity.
- Public support instruments and incentives that address market or systemic failures such as underinvestment in knowledge activities and knowledge interactions among agents, in particular those that affect collaborative activities and technology diffusion.
- The effect of framework conditions and regulatory regimes on business investment behaviour and their incentives to innovate and on the efficiency of public S&T institutions.

Major improvements are needed in all these areas to ensure that the increase in resources for S&T activities is effective and helps to raise Peru's innovative capacity and to meet social challenges.

Recent policy initiatives: Positive but limited results in a fragmented institutional setting

In the past decade the Peruvian government has taken various policy initiatives, some of an institutional nature, others to establish support programmes, to promote the development of S&T supply and demand capacities and to foster interaction among private and public actors in the innovation system. Recently, some success has been achieved through new S&T and innovation funds, some of them supported by multilateral financing institutions, through technology transfer and R&D support schemes, and through still modest measures to develop human capital in S&T.

The 2004 S&T and Technological Innovation Framework Law entrusted the National Council for Science, Technology and Technological Innovation (CONCYTEC) with responsibility for steering STI policy, notably through development of the National STI Plan and co-ordination of the so called National System of S&T and Technological Innovation (SINACYT). CONCYTEC was also entrusted with policy implementation functions through FONDECYT, its operational arm, which manages programmes to support basic and applied knowledge, technology transfer and diffusion, and development of highly skilled human resources in S&T.

The development of technological innovation centres (CITEs) by the Ministry of Production started in 2000. With funding from the ministry and from private sources or foreign co-operation agencies, the centres were designed to provide technological services to small and medium-sized enterprises (SMEs) or producers' associations in order to fill an important gap in technology transfer.

Two well-endowed competitive STI funds, co-financed by the Peruvian government and loans from multilateral financing organisations, were established. INCAGRO was launched in 2001 with an initial endowment of USD 20 million, raised to USD 45 million in a second phase, to promote innovation and technology transfer and public-private collaboration in the agricultural sector. FINCYT was launched in 2007 with an endowment of USD 36 million to promote a wide range of programmes, the most important of which aimed at strengthening the research and innovation capacity of enterprises, universities and public research centres and promoting collaboration among them. These funds have more efficient operating rules and better overall management evaluation records than previous programmes of a similar nature or with similar objectives.

In 2006, the Ministry of Economy and Finance created FIDECOM, a fund endowed with about USD 65 million, whose objective is to promote productive innovation. In 2007, by Law 29152, the Ministry of Production was charged with the operation of a competitive fund using FIDECOM's resources. USD 1.9 million was disbursed in 2010 to support innovation projects in the enterprise sector with an emphasis on collaborative projects.

In 2004 the Canon Law was amended to allocate part of the resources transferred to regional governments[1] to finance investment projects aimed at developing the research capacity of regional public universities.

These initiatives have helped expand business investment in innovation, albeit moderately. Research institutions, including universities, have used marginal increases in institutional funding to expand their knowledge base and, to a lesser extent, their knowledge transfer activities. Following the 2004 amendment to the Canon Law, universities received substantial additional resources for R&D investment (although strict conditions are imposed on the use of the proceeds). Technology transfer institutions have helped to raise the productivity and international competitiveness of some industries in the non-traditional manufacturing, agricultural and agro-industrial sectors, thus opening new opportunities for diversification.

Overall, these initiatives have only concerned a relatively small number of firms, research institutions and professional associations and have not led to sustained productivity growth. They have not catalysed a process of systematic technological upgrading in existing activities through inter-institution market and non-market transactions in knowledge or inter-industry knowledge spillovers, *e.g.* in value chains. With rare exceptions they have not served to jump-start a technology-based diversification process, and their scope is too limited to allow for using or appropriating new technologies to facilitate upskilling and address the problem of social inclusion. Moreover, there are major unresolved issues of policy governance. Institutional reforms are needed to clarify the confused landscape of policy design and address the latent conflicts in policy implementation that too often result in duplication of support programmes, absence of critical mass and waste of public resources.

In particular, CONCYTEC has not been in a position to steer STI policy for reasons having to do with lack of political backing, poor management and difficulties in forging a consensus among institutions that seek to protect their responsibilities and resources. Conflicts of interest also arise as a result of unclear distinctions between functional and operational responsibilities. In addition, there is a significant overlap in programmes that support S&T and innovation managed by different institutions (*e.g.* CONCYTEC and FINCYT); this leads to duplication of management costs and proliferation of projects with low eligibility ceilings in terms of project costs.

However, lessons can be drawn from these initiatives to develop an innovation policy that can pave the way for a more sustainable development path and create a virtuous circle of demand for and supply and diffusion of knowledge. Such a policy would require governance, institutional and regulatory reforms of an innovation system that has evolved in an incremental and often disarticulated way over the last 40 years.

Shortcomings in higher education institutions and human resources development

Owing to efforts over more than three decades Peru has achieved high enrolment rates in primary and secondary education and has an adult literacy rate of over 90%, among the highest in Latin America. However, this has been accomplished at the cost of secondary students' achievements in reading and science literacy; they are below those of comparable Latin American countries, as manifested in Peru's very low rank in international comparisons such as the OECD PISA programme.

In the higher education sector strong demand for education, fostered by sustained economic growth, has led to the creation of some public and many private universities and technological institutes. The number of university students increased from over 346 000 in 1996, date at which the creation of private for-profit universities became possible, to more than 839 000 in 2010, with private universities accounting for most of the increase. As many, if not most, of the private universities lacked any form of accreditation, quantitative expansion came at the cost of students' academic achievement. In most public universities, rapid growth in enrolments also had a negative effect on achievements as crowding compounded the effects of low salaries. Overall the same is true of the higher technological institutes. As a result, relatively few graduates have the qualifications to enter accredited postgraduate programmes in S&T and engineering. Moreover, by international standards there are very few scholarships available to qualified students to complete postgraduate programmes.

Universities are autonomous and, for practical purposes, accountability to supervisory bodies is minimal. As a result they have developed internal governance systems that overwhelmingly respond to criteria other than excellence in teaching and research or the so-called "third mission" of promoting knowledge interaction with the productive sector. The relative lack of resources for research activities and incentives has led many qualified researchers to emigrate. Other countries faced with similar problems have used repatriation incentives or schemes to attract foreign scientists through special forms of compensation in conjunction with other measures to upgrade universities and improve incentives for highly qualified scientists.

Available statistics indicate that the higher education sector performs close to 40% of R&D. These activities are carried out by a handful of universities; it is estimated that six (of which two are private) account for around 80% of total academic R&D, which is essentially financed by institutional funding, CONCYTEC competitive support pro-

grammes and FINCYT, as well as foreign sources of co-operation and funding, *e.g.* in the case of IIAP, IGP and Universidad Cayetano Heredia). Although these universities still rank rather low in international or Latin American rankings they serve as islands of excellence in Peru's research system.

The additional funding derived from the amendment to the Canon Law and allocated to regional public universities is in principle quite sizeable. However, a large part of these resources remains frozen owing to rigid regulations that constrain their use and to universities' insufficient absorptive capacities. Despite recent initiatives by the most R&D-intensive universities and a premium for collaborative activities in funds such as FINCYT, research and innovation-related interactions between higher education institutions (HEIs) and the productive sector remain rather weak.

Recent initiatives aimed at strengthening the research potential of universities, such as the CONCYTEC chairs and scholarship programmes, respond efficiently to real needs but are small in scope and reach. Such programmes should complement other, perhaps even more effective ways to secure a highly qualified body of researchers. Finally, the academic sector lacks sufficient means and funding mechanisms to develop and maintain S&T infrastructure equipment.

Public research institutes: A heterogeneous group with poor overall performance

Most of Peru's PRIs were created in the 1970s as decentralised agencies attached to sectoral ministries. They are more heterogeneous than in most countries. They can be roughly grouped into three categories according to their mandate or portfolio of activities:

- Those whose main mission is to carry out basic and applied research and technological development activities in areas deemed useful for specific sectors and to ensure technology transfers to these sectors' enterprises.
- Those that carry out "public good" scientific activities that benefit society at large, contribute to better use of the country's endowment in natural and social resources, and undertake technology transfer activities to the productive sector.
- Those whose mission relates to the definition of norms and standards and the provision of technology information and infrastructure services.

With few exceptions, the performance of PRIs engaged in science and technology development and transfer activities, as measured by scientific output, patents or collaboration with the productive sector, is rather low. This is mainly due to their governance, the modes of financing of their activities, and internal management procedures. The performance of the last category, which does not involve S&T activities *stricto sensu*, is generally up to international standards although some could benefit from better management in the delivery of technological services.

PRIs' relationships with the sectoral ministries to which they are institutionally attached are often restricted to discussions of budgetary requirements. Their research agendas are most often determined by inertia rather than co-ordinated with stakeholders and responsible ministries.

PRI governance is weak. It generally only entails formal accountability procedures that are not performance-based. Since the overwhelming share of PRIs' resources is institutional funding and revenue from sales of services is minimal there are no real incentives to improve performance. At the same time, PRIs do not enjoy true autonomy in

internal management matters, notably as regards the management of human resources. In many PRIs, the nature of resource appropriations, the lack of accountability and management constraints have had detrimental effects on performance. This has led to a vicious circle in which the S&T potential suffers from biases in favour of management personnel at the expense of human resources for S&T.

Potentially, PRIs are an important element of the Peruvian innovation system. To play their role efficiently to the benefit of both the private sector and society at large, will require major reforms in terms of *i)* governance and accountability; *ii)* diversification of the sources of financing, with a better balance between institutional funding and competitive project funding; and *iii)* proceeds from collaboration with and provision of services to the business enterprise sector.

Little investment in innovation by the enterprise sector

As a whole, Peru's business enterprise sector is very heterogeneous and has a low propensity to invest in R&D and innovation. It has been estimated that no more than 2% of all enterprises carry out S&T activities; the distribution is highly skewed by size and is concentrated in a small number of sectors.[2] A very small share of large firms are well connected to international sources of technology and engage in incremental process innovation, mainly through imports of know-how and advanced capital equipment. A larger, but still small, percentage of firms in the manufacturing and agro-industrial sectors have built some STI capacities, mainly through technology transfer and human capital formation, and are able to engage in product and process innovation. The overwhelming majority of firms do not engage in any innovation activity apart from the occasional replacement of machinery and equipment.

The low propensity of the business sector to engage in innovation activities observed in the 2004 innovation survey can be explained by a number of factors. Among the most important are:

- An aversion to risk, rooted in part in traumatic experiences due to changes in the economic environment in the wake of political changes and the effects on interest and inflation rates.
- Weak competitive pressures and prevalence of rent-seeking strategies among conservative entrepreneurs.
- Underdevelopment of value chains in which suppliers and contractors exert pressure or provide other incentives for innovation.
- Weak interaction between enterprises and domestic sources of knowledge in research institutes and universities, largely due to mismatches in the supply of and demand for knowledge and technological services and the absence of technology brokers to foster this interaction.
- Relative scarcity of highly skilled S&T and managerial personnel to design and implement innovation projects.
- Absence of capital markets and scarcity of financial institutions responsive to the financial requirements for innovative ventures in SMEs and the development of technology-based firms.
- Lack of efficient public support schemes to foster private investment in R&D and innovation.

Confronted with this adverse environment the Peruvian government has taken initiatives to improve the innovation climate, leverage private investment in innovation and promote better articulation of public research institutes and the enterprise sector. Competition and intellectual property rights (IPR) regimes have been strengthened. Support programmes for the competitive funding of firms' innovation projects on a cost-sharing basis, such as PROCOM/FONDECYT, were established, followed, on a larger scale and in a more efficient manner, by the FINCYT and FIDECOM technological innovation programmes. The success of such programmes shows that incentives that reduce the risks and costs involved in innovation projects reveal the existence of latent demand for S&T knowledge and the capacity to undertake such projects. It also shows that such incentives widen opportunities for development, diversification and productivity increases. As these support programmes are relatively new, there are still important questions concerning the social returns to public resources, the lasting impact on the propensity of firms to invest in knowledge assets, and the impact on strengthening interaction among innovation actors and on technology diffusion.

Insufficient technology transfer and diffusion

In many OECD countries technology and innovation centres play an important role in carrying out applied research, engaging in co-operation with, and providing technological services to, private enterprises and in fostering technology diffusion within or across sectoral boundaries. In many cases they are also involved in training activities. Various models have evolved depending on the nature of their status and form of governance (public, private or mixed); the mix of financial resources (grants, competitive funding of S&T projects); and the scope of their S&T activities (sectoral, multi-sectoral, or S&T field).

In developing countries, the vast majority of enterprises in low- and medium-technology sectors not only lack endogenous S&T capacity but also suffer from problems related to poor access to information and the application of norms and standards. This hampers their ability to innovate, to improve their production processes and to diversify their activities towards more sophisticated products and markets. In many of these countries, technology transfer institutions have been created to address these problems and develop S&T capabilities.

Peru, a relative latecomer in this area, created its network of technological innovation centres (CITEs) in 2000 under the aegis of the Ministry of Production which grants accreditation to individual centres. CITEs are organised along sectoral lines and can be either private or public. They sell their services and only the public centres are entitled to institutional funding. At present there are 14 CITEs in operation (eleven private and three public) in manufacturing industries, services, agro-industry, forestry and agriculture. CITEs are mostly demand-driven, but they generally operate in close connection with producers' associations, have good ability to identify potential demand in order to customise technological services, including training programmes, and have a good performance track record. However, while the number of enterprises assisted has grown significantly over the last five years CITEs' outreach remains limited given the magnitude of the problem of capacity building in Peru. At present they have neither the means nor a mission to engage in R&D although the development of such activities could broaden the services they provide, not only to sectors in which they are already present, but also to others, more technologically advanced. This would require more resources for S&T infrastructure and recruitment of more highly qualified resources in S&T.[3]

Possibly because of lack of *intra muros* R&D capacities, CITEs are not in a good position to benefit from FINCYT and FIDECOM, programmes that would boost innovative capacities in the networks of enterprises they service, or to involve PRIs in the development of their own technology transfer activities. However, CITEs have managed to promote a number of projects with SMEs which have been submitted to FIDECOM.

Institutions of a more regulatory nature play an active role in technology diffusion or in strengthening firms' capacity to ensure that technology upgrading actually opens new market opportunities. To give but two examples that are particularly important in developing countries, industrial property offices can facilitate the dissemination of technological information through open access platforms that provide knowledge on advanced technologies and certification agencies that provide information about international standards and related technological services both for current production and the development of new products.

INDECOPI, the agency in charge of intellectual property, has by and large a satisfactory record in the management of this area, which has improved in recent years. However, probably because of a broad portfolio that includes other missions, notably related to the promotion and enforcement of competition regimes, it has not been able to devote sufficient resources to promoting access to and dissemination of technological information.

SENASA, under the Ministry of Agriculture, is responsible for the promotion and certification of international standards for the processing and export of agricultural and agro-industrial products. It has contributed significantly to the adoption of more efficient production practices and innovative product diversification in the agricultural and agro-industrial sectors. SENASA also has a good track record of collaboration with technology transfer institutions in these sectors.

Regulatory obstacles to innovation

Apart from a number of legal regulations that result in inefficient governance structures in the Peruvian innovation system and hinder a move towards consolidation, some specific legal and/or regulatory obstacles diminish the efficiency of public support to innovation, hinder interactions among agents, and negatively affect the performance of research institutions.

- *Restrictions to the transfer of public funds to private-sector institutions.* In all OECD countries legal and regulatory provisions define the basis for and the conditions under which such transfers can occur. This is notably the case for public support for R&D. As a general rule, Peru forbids public transfers to the private sector. The provision of financing support to R&D and innovation activities is therefore hindered by legal and administrative obstacles and is very difficult to introduce. Rules to facilitate the enactment and implementation of support instruments may involve long delays and complex administrative procedures.
- *The SNIP procedures* that regulate and validate public expenditures for investment purposes by public institutions. These procedures were conceived for physical investment and it has proven difficult to apply the criteria to R&D and innovation-related intangible investment. For FINCYT and INCAGRO projects proposed by the private sector SNIP regulations compound the restrictions. Finding a way out of this complex situation requires defining the projects as services contracted to the government.[4] In practically all other countries once a fund is established its

operational rules are set; they entrust the managing agency with full responsibility for selecting and approving individual projects and disbursing the grants in accordance with accounting rules.

- *Labour laws applicable to civil servants* negatively affect public university researchers' ability to engage in collaborative projects with other institutions because of restrictions to inter-institutional mobility or the difficulty – if not impossibility – to receive payments for services rendered to another institution while on the university payroll.
- *Lack of autonomy of personnel management in public research institutes*. Rigidities in the labour laws render personnel turnover difficult and lead to the need to recruit better qualified personnel as temporary workers under the so-called Service Administrative Contract (CAS) applied to the public sector.
- *The tax regime* is unfavourable to investment in R&D and innovation in that it is not clear whether such investment qualifies as expenditure that can be written off against profits.[5]

Shortfalls in the scientific and technological infrastructure

The development and maintenance of scientific and technological infrastructure is important for the performance of the public research sector. It facilitates collaboration with the private sector and is necessary to compete successfully for national and international grants. In Peru the funding of S&T infrastructure has long suffered from neglect. Budgetary lines for S&T infrastructure rarely appear as such in the institutional funding of public research institutes and even less in that of universities. Moreover, as public investment it would be subject to SNIP procedures. Resources granted through competitive projects in the framework of CONCYTEC or FINCYT usually do not cover the overhead that would be needed to develop and maintain S&T infrastructure. Funding of S&T equipment is of course now available through CONCYTEC and FINCYT programmes but it is still rather limited.

Weak S&T linkages among institutions

Peru's innovation system suffers from a lack of knowledge interactions among institutions both in terms of co-operation by PRIs or between these and universities. There is a reluctance to share infrastructure equipment and engage in medium- to long-term commitments on collaborative research. Vested interests are strong and a lack of trust or uncertainties related to financial and human resources blur the perception of benefits to be gained from co-operation. The absence of performance-based incentives strengthens that perception.

The situation is not much better for S&T collaboration between research institutes and enterprises or for the provision of S&T services. On the demand side a preference for imported technology and low S&T absorptive capacity hinders demand for technological services. On the supply side public research institutes have little incentive to engage in collaboration or the provision of services as their resources proceed overwhelmingly from institutional funding, which does not apply performance criteria to collaborative activities. Also, as noted above, there are regulatory obstacles to such activities.

This problem of lack of articulation has begun to be addressed in FINCYT support programmes that place a premium on enterprises' innovation projects involving collaboration with a public research institute. However it is too early to know whether collaboration prompted by financial incentives will give rise to a dynamics of collaboration built on mutual interests and whether support programmes will have a "behavioural additionality" effect on enterprises' knowledge sourcing.

Need for a comprehensive STI policy and effective governance

Peru does not have an explicit STI policy with agreed strategic orientations. Rather, it has a multilayered body of largely uncoordinated, more or less independently designed and implemented policies of various ministries and public institutions. With relatively few resources devoted to STI overall and weak integration of the innovation system, institutions pursue their individual goals. While some efficiently managed policy initiatives have had some positive results, those that have created some coherence seem to have mostly "bypassed" the national legal, institutional and regulatory frameworks because their design and implementation modalities were largely defined in the context of loans involving multilateral financial institutions.[6] However, while such results can initiate a virtuous process and provide useful lessons, they cannot replace a revamping of the policy-making framework.

A country's STI policy mix is strongly shaped by the institutional setting in which priorities are defined and funded through the budgetary process, by the balance of power among stakeholders, as well as by framework and regulatory conditions that impinge upon the performance of the innovation system. Policies also evolve as the domestic and international environment changes. In Peru, the process that should lead to an effective policy mix is hindered by an inability to address the main weaknesses of the innovation system in an integrated manner and "kick-start" a virtuous dynamics in which public investment fosters private innovation performance.

The main reasons are: *i)* confusion of the functions of policy design and programme funding and management (*e.g.* CONCYTEC), and sometimes programme implementation (in some public research institutes) which can create conflicts of interest regarding the use of resources (*e.g.* for internal management rather than for funding of projects); *ii)* the excessively broad missions of some funds and institutions which cover the whole range of S&T policy areas (generation of knowledge and human capital development, private-sector R&D and innovation, technological development, diffusion and transfer);[7] and *iii)* institutional rigidities and a legalistic culture that hinder the development or the effectiveness of new policy instruments within the existing institutional architecture (*e.g.* Canon Law for regional universities, SNIP procedures, governance system of universities).

Lack of co-ordination can have adverse effects. In Peru it has led to overlapping responsibilities and duplication of support programmes by institutions or funds that operate in similar policy areas. This aggravates the chronic problem of critical mass and reduces the efficiency of support programmes. It has also resulted in blind spots in policy design: failure to develop policies or support programmes that depend on collaborative approaches between – and possibly funding by – several institutions. In Peru this is notably the case of mission-oriented programmes, cluster policies and innovation-led procurement policies. Better co-ordination requires information and data on STI activities and resources that allow for evidence-based decisions. Peru still has a long way to go to build an adequate, reliable and up-to-date information base. A related area of weakness is

the lack of a structure that creates the conditions needed for effective governance. There is ample evidence that, for a given volume of resources devoted to STI, innovation performance depends on the quality of the governance of STI systems, that is, the set of largely publicly determined institutional arrangements that shape policy design, implementation (agencies and instruments), delivery and evaluation and determine how the various public and private actors interact in allocating and managing resources devoted to STI.

Because most of the components of Peru's innovation system are weak and poorly articulated, it lacks a functioning governance system based on a comprehensive vision that is able to engage effectively in priority setting and co-ordinate policy orientations across ministerial departments, budgetary appropriations and policy implementation. The result is a fragmentation of programmes that lack critical mass, synergies and complementarities. In fact the dilution of governance responsibilities and the gap between the formal responsibilities entrusted to CONCYTEC by the 2004 S&T Law and its ability to carry them out call for a new institutional framework and possibly new legislation. The reform process should not jeopardise efficiently managed support programmes.

Strategic tasks and guiding principles

Despite the economy's impressive performance and its resilience in the aftermath of the 2008 financial crisis, Peru's low level of productivity puts the long-term sustainability of its growth pattern at risk. Given the potential volatility of revenues derived from its traditional exports in an increasingly global competitive environment, an overarching objective for Peru should be to lose no time in moving towards a more innovation-led sustainable growth path in order to increase productivity and competitiveness across a wider spectrum of activities, alleviate poverty and better address social needs.

To achieve this, the sound macroeconomic policies and favourable framework conditions that have underpinned the recovery since the turn of the century must be maintained. In addition, however, to harness the potential of science and technology and climb the innovation ladder, more public resources need to be devoted to the generation, diffusion and use of knowledge and technology; institutional reforms in S&T governance, policy design and implementation need to be continued and stepped up as they affect the efficiency of instruments.

Reaping the economic and social benefits of investment in science and technology takes time and continuity. *Sustained political commitment*, consensus building among stakeholders in determining national priorities and social visibility of the benefits to the economy and society as a whole are essential to a successful S&T and innovation policy. This requires oversight processes to ensure that priorities are effectively addressed in the design of innovation policies and reflected both in budgetary appropriations and institutional arrangements for policy implementation. Scientific, economic and social outcomes of increased public investment should be highlighted in the public debate, hence the importance of accountability.

A *qualified human resource base* is a cornerstone of any innovation-based strategy for socio-economic development. Peru suffers from serious weaknesses in this area and should not delay quantitative and qualitative efforts to strengthen the entire chain of education and training from primary school to postgraduate studies, and, more specifically, the development of knowledge and skills in science, mathematics and technology. The supply problems are compounded by problems of demand. The bulk of the labour

force is largely unskilled or low-skilled, and the lack of managerial skills in a large majority of firms hinders their capacity to absorb technology. It also makes them unwilling to take the risks associated with innovation. This implies wide-ranging efforts to develop training programmes and incentives to encourage the private sector to buy into them.

Peru's innovation policy should facilitate and foster *structural change and diversification* away from dependence on resource-based industries and towards more knowledge-intensive production in clusters of activities in which Peru has or can develop comparative or competitive advantages, based on its natural resources or upstream and downstream linkages with the mining and energy sector, including in service industries, as has been done in countries such as Chile and South Africa.

Emphasis should be placed on selected *mission-oriented R&D and innovation* programmes developed in partnership or collaboration by public research institutes and the private sector. Given the limitations on resources and capacity, the programmes should be circumscribed and focus on areas in which Peru has competitive advantages owing to its natural resources (*e.g.* biotechnologies for the preservation and sustainable exploitation of biodiversity, cleaner mining exploitation) or can address social needs (*e.g.* in health, water remediation and environment). International co-operation should be actively sought for the development of such programmes.

Innovation cannot thrive without both an adequate level of *modern physical infrastructures* in communication, logistics and transport and an easily accessible technological infrastructure that provides services in areas such as metrology, certification, normalisation and intellectual property management. These infrastructures have to be strengthened in Peru, in the former with the possible participation of the private sector, and in the latter by giving more means to institutions and ensuring better access to SMEs.

In line with these orientations, government policy should follow some *key guiding principles*.

First, because of the broad scope of issues that impinge upon innovation performance and cut across ministerial competencies, a "whole-of-government" approach should increasingly be adopted in shaping innovation policy. Such an approach has important consequences for the efficiency of governance arrangements.

Second, it is important to avoid institutional and regulatory conditions that hinder innovation-related investment, transfers of public resources to the private sector and public-private collaboration. Institutional and regulatory frameworks should be revisited in the light of innovation policies.

Third, effective governance must be assured. In Peru, this will depend on certain conditions that do not presently exist:

- *Political commitment* at the highest executive levels of government to ensure adequate budgetary appropriations for STI activities and their allocation to ministerial department and/or autonomous public agencies.
- *Efficient consensus-building processes* encompassing relevant ministerial departments, major stakeholder institutions for the setting of broad S&T and innovation orientations and priorities, and interdepartmental co-ordination on implementation.

- *Co-ordination of policies.* A lack of policy co-ordination and institutional inertia can hinder the translation of policy orientations into a policy mix that responds adequately to new challenges and the evolving needs of the actors of the innovation system and their interplay.
- *Clear delineation of institutional functions.* The distinction between policy formulation and policy implementation functions should be clear. They require different types of competencies and are subject to different accountability requirements. Confusion of functions can generate conflicts of interest.
- *Accountability and evaluation.* Regular evaluation of support programmes and institutions receiving public support should be the norm, with practical consequences for further rounds of support. However, a balance must be struck between the need for periodic adjustments based on evaluation and stability of support programmes to ensure their long-term impact on the behaviour of beneficiaries.
- *Monitoring of the performance of the innovation system*. At a broader level, good governance implies a system of information that produces internationally comparable statistics and indicators on a regular basis. This makes it possible to monitor the performance of the innovation system and benchmark it against quantitative policy objectives and other countries' performance. In this area Peru lags well behind OECD countries but also most other Latin American economies.

Efficient use of public funds to meet economic and social challenges is a principle of sound budgetary management. Public resources for scientific and technological development compete with other current or investment expenditures in areas that are often perceived as having higher or more immediate priority, especially in developing countries where the need to alleviate poverty and develop social and economic infrastructure puts strong pressure on the budget. The opportunity costs of public resources devoted to S&T policies and their legitimacy for addressing market and systemic failures must be justified by appropriate accounting of expected economic and social returns and *ex post* evaluations. The leverage effects of public investment on private investment can provide important signals.

Areas of high importance for sound *policy implementation* include:

- *Operational functionality: consolidation of the support system.* This involves the reduction of unwarranted overlaps among implementing agencies in the scope of support programmes to ensure that they concentrate on their core competencies, reduce management and transaction costs, and avoid duplication of programmes of less than critical mass. This may be a pervasive problem in Peru.
- *Funding instruments.* Programmes and projects can be supported in diverse ways. For innovation funds to private-sector projects, matching funds should be the preferred mechanism. It could be complemented by means such as guarantees which can leverage contributions from financial institutions. Subsidy rates should take due account of possible crowding out and windfall profits. In the rules governing the financing of programmes or projects the possibility of a premium (priority or higher rate of subsidy) for collaborative ventures should be systematically considered. For public research institutes performance-based evaluation should provide the criteria for the volume of institutional funding. This is not yet the case in Peru.

- *Management and delivery*. Eligibility criteria for innovation-related expenditures should be clear and restrictive. Sound, professional and timely evaluation procedures need to be established for the selection of projects presented in the framework of support programmes. This requires lean delivery processes that avoid unnecessary red tape, as well as the availability of panels that include experts able to assess the scientific or technological relevance of projects but also their business viability. Panels should include foreign experts. Assessment of support programmes should be an integral part of their design and performance evaluation of implementing agencies should be regularly carried out.

Recommendations

Improving governance and institutional reforms

The *de facto* absence of an effective governance structure accentuates the fragmented nature of Peru's innovation system and gives rise to inefficient use of public resources. The establishment of appropriate governance arrangements is an absolute necessity. It may require legislative and institutional reforms. Several options inspired by practices in various countries could be adapted to Peru by taking into account national specificities, but none would achieve the expected improvement if certain particularly important prerequisites are not met. These are: compliance with the good governance principles outlined above, in particular political commitment, formal interdepartmental co-ordination processes and institutional functionality; and the safeguarding of the efficient support programmes already in place.

Three design options for an overarching governance structure are as follows.

a) A new Ministry of Science, Technology and Innovation

In Peru the creation of such a ministry has been advocated by CONCYTEC and by a large fraction of the academic community, essentially on two grounds:

- A ministerial status would imply direct participation in budget discussions and would provide better opportunities to obtain increased budgetary appropriations for S&T institutions, support programmes and activities.
- A ministry could effectively assume the steering of the STI system that CONCYTEC was not in a position to fulfil. In principle, it would be better placed to ensure policy co-ordination and coherence and to reduce fragmentation.

These arguments are well taken but in the Peruvian context they appear somewhat shaky for two reasons. First, it cannot be assumed that the mere existence of an STI ministry will ensure a net increase in total resources for STI. Second, experience indicates that the ministry option is most effective when the ministry is involved (sometimes as *primus inter pares*) in an interdepartmental co-ordination body with other ministerial departments. Such a body oversees policies that can affect innovation performance, and the distinction between policy design and policy implementation functions is clear. This is hardly the case in Peru as only the Presidency of the Council of Ministers (PCM) and the Ministry of Economy and Finance (MEF) have the authority to steer inter-ministerial co-ordination and budget appropriations.

If the government were to consider this option it would have make certain that the new ministry is in a position to perform its steering, co-ordination and integrative functions in an effective manner.

b) Horizontal policy design with a principal implementation agency

In this option a decentralised government agency is the executive arm of a high-level government body with inter-ministerial co-ordination responsibilities for policy design and implementation. To some extent, this option is formally similar to the one envisaged by the Peruvian 2004 S&T Law when CONCYTEC was placed under the aegis of the PCM.[8] However, to be effective, new governance arrangements would be needed to avoid the failure due to the *de facto* inapplicability of the 2004 Law. This would imply:

- Effective leadership by PCM or MEF in steering the inter-ministerial co-ordination body, notably as regards the definition of policy priorities and their translation into budgetary appropriations.
- A revamping of CONCYTEC to enable it to become the executive arm of the inter-ministerial body entrusted with responsibilities for policy design and evaluation.
- Effective involvement in the co-ordination of sectoral ministries such as PRODUCE and those in charge of agriculture, health, education, environment, energy and mines, transport and communications. These ministries would be responsible for support programmes and/or sectoral institutions in charge of policy implementation, including their funding and assessment.
- Workable co-operation between CONCYTEC and sectoral ministries in the design and funding of sectoral programmes.
- The "new" CONCYTEC's proven capacity to manage support programmes with the same efficiency as FINCYT and termination of CONCYTEC programmes that currently duplicate those of FINCYT.

In principle, this option could be workable. In practice, however, its success would strongly depend on the ability of institutions to overcome the legacies of conflicts over competences and resources. In the Peruvian context, it may prove difficult to revamp CONCYTEC to give it as "new" a mission it failed to fulfil in the framework of the 2004 S&T Law.

c) A co-ordinated policy design with a distributed landscape of implementation agencies

This third option is inspired by the governance structures that have been successfully implemented in Chile. In this option the inter-ministerial body steering the governance process is directly in charge of priority setting, defining strategic policy orientations and budgetary appropriations. In this scheme, there is no principal implementation agency. Sectoral ministries involved in the co-ordination process are responsible for the oversight and funding of decentralised agencies tasked with policy delivery. In the case of Peru this would imply:

- The establishment by law of an Inter-ministerial Committee for Science, Technology and Innovation. This committee could include the PCM, and the Ministries of Economy and Finance, Production, Education, Agriculture, Health, Energy and Mines, Transport and Communications. Given their inter-ministerial responsibilities either PCM or MEF could chair or steer this committee. Given MEF's role in budgetary allocation, oversight of public investment as well as in regulatory frameworks, it may be better placed to chair the committee.
- CONCYTEC would remain under the Ministry of Education. With increased means and improved managerial capacity its competence would be similar to Chile's CONICYT in supporting scientific research and technological development (including infrastructure) through institutional and competitive funding, human resource development and the assessment of public research institutes.
- MEF and PRODUCE would share responsibility for innovation funds focused on private-sector innovation and technology diffusion and transfer.
- Public research institutes would continue to operate under their respective ministries with a representative of CONCYTEC on their boards. Boards would be entrusted with the design and monitoring of their respective institutions' performance agreement.

As in Chile, the committee could be supported by a small S&T advisory council with a limited number of representatives from public research institutes, public and private universities, and the business enterprise sector. This body would be entrusted with proposing strategic policy orientations, the introduction of new policy instruments, the consolidation of support programmes, and reform of regulations that impinge upon innovation performance. It could also be entrusted with policy evaluation and an information system to monitor the performance of the innovation system.

This option seems best attuned to Peru's present needs as it: *i)* confirms the high-level political commitment to S&T by entrusting an inter-ministerial body with governance responsibility and thus avoids the risk of capture by a principal implementation agency; *ii)* ensures a reduction of overlap of implementation agencies' responsibilities; and *iii)* fosters inter-institutional complementarities and co-operation on policy design and implementation.

Whatever option is followed, the establishment of new governance arrangements raises transition issues related to the management of existing support programmes. They concern in particular those funded by multilateral financing institutions, given their importance in the present architecture of S&T policy and their good overall performance. The setting up of a new governance framework should not jeopardise relevant and efficient programmes. In the case of INCAGRO, the programme has already been placed under the National Institute for Agricultural Innovation (INIA). If management quality is kept to the previous standards, which is far from ensured, this move is in line with the proposed governance arrangements. For FINCYT this report recommends extending it for additional phases under the aegis of the MEF, maintaining its present management and monitoring procedures or improving them if regulatory obstacles are removed or alleviated. Eventually, FINCYT should mainly focus on programmes in support of private innovation and be merged with FIDECOM.

Specific recommendations

Various policy recommendations proposed in this report and others that are implicit in the assessment of Peru's innovation system and the policy and institutional challenges it faces are summarised below.

Higher education and human resources

- Speed up the establishment of an accreditation process in line with internationally recognised standards throughout the higher education system (universities and high technology institutes).
- Initiate a reform of university governance that promotes excellence in research and facilitates retaining and promoting the most qualified personnel. Use the institutional financing of public universities to carry out this reform and move towards the performance-based funding models implemented in many OECD countries. These models tie institutional funding to criteria of excellence and an increasing share of resources for S&T activities comes from competitive grants and provision of research and technological development services.
- Foster participation in international research networks through fellowships awarded in the framework of international co-operation agreements in Peru's priority areas.
- With the participation of INDECOPI promote the development of IPR management practices in the higher education sector, focusing in priority on institutions with the highest S&T potential.
- Reform the Canon Law to extend the notion of public investment to human capital. Facilitate regional universities' possibilities to use Canon Law resources for collaborative R&D projects with other universities or private enterprises or other expenditures that increase their S&T capacities (*e.g.* doctoral and post-doctoral scholarships; repatriation of researchers).
- Eliminate university barriers (credit equivalence) that hinder the pursuit of graduate studies in the university system by students of higher technology institutes.
- Consider a considerable increase in postgraduate scholarships for domestic and foreign universities.
- Provide incentives to the private sector to hire S&T postgraduates, with sunset clauses.
- Alleviate regulations that impede the participation or contribution of public university researchers to private enterprises' S&T activities or projects and, more generally, inter-institutional mobility.
- Develop programmes that are likely to attract foreign or expatriate scientists, taking into account the experience of other countries.

Public research institutes

- Define qualifying criteria for public research institute status (*e.g.* proportion of S&T personnel in total staff); adapt their legal status in line with practices in other Latin American or OECD countries as far as permitted by Peru's institutions and laws in order to increase their management autonomy, notably as regards human resources, and reduce the perverse effects of rigid labour rules and short-term contracts for qualified researchers.
- Reform the governance of PRIs to ensure that they fulfil their core missions of research, technological development and diffusion efficiently. Broaden their boards to include representatives of their major stakeholders. Enforce accountability and institute performance agreements with effects on the volume of resources from institutional funding and set objectives for the share of funding from competitive grants, contracts and sales of technological services. Performance agreements should include prospects or tentative commitments regarding expected returns to collaborative ventures and sales of services as well as, when appropriate, indications of prospects for international collaboration.
- Develop IPR managerial capacities in collaboration with INDECOPI.
- Consider the possibility of streamlining the PRI system through dissolution, merger or partial privatisation of institutes depending on fulfilment of performance agreements over a few years and economies of scale or scope.
- Encourage the development of a formal consortium of PRIs aimed at promoting multidisciplinary research programmes or projects and facilitating staff mobility.
- Consider the possible use of Canon Law resources in collaboration with universities that benefit from them.
- Provide incentives for the mobility of PRI S&T staff to the private sector and *vice versa* and facilitate or amplify the contracting of postgraduate students through CONCYTEC scholarships and fellowships.
- Encourage the participation of PRIs in international research networks, in particular through targeted co-operation with research institutions of other countries in the region and beyond.

Promotion of innovation in the business sector

- Give the business sector a more prominent role in the governance of the innovation system and the definition of strategic orientations and policy priorities.
- Give more attention to impediments to innovation related to physical infrastructure bottlenecks or deficiencies (transport, information and communication technology, logistics) that affect all sectors as well as to S&T infrastructure (metrology, standards, IPRs) that mostly affects SMEs.
- Enhance INDECOPI's capacity to improve enforcement of IPR protection and competition laws, to diffuse an IP culture and to upgrade IPR management capabilities in the business sector.
- Maintain the value-chain-based programmes developed by PRODUCE and MINCETUR.

- Address obstacles to the creation and early development of new technology-based firms (NTBFs). Consider specific support schemes in existing innovation funds; conduct an assessment of barriers to entrepreneurship and engage reforms in line with its conclusions.
- Initiate a public procurement policy to support innovation in sectors with strong social demand (health, energy, transport, environment, education).
- Review regulatory regimes governing transfer of public resources to the private sector in light of the legitimacy of such transfers to foster private S&T and innovation activities.
- Continue to give a premium to public-private collaboration projects in grants from innovation funds (bottom-up projects).
- Consider mission-oriented or sectoral support programmes (top-down) predicated upon collaborative arrangements between the private and the public sectors under conditions of matching resources from firms, PRIs and possibly regional governments. Use this instrument for the development of clusters. Select programmes on the basis of criteria related to national interest and natural resource endowments which can lead to competitive advantages (*e.g.* biodiversity).
- Eliminate or reduce legal obstacles to collaboration between public research institutes and the private sector; facilitate contractual agreements.

Intermediary institutions

- Consider a significant expansion of CITEs in terms of: sectoral coverage; strengthened S&T capacity in applied research to better address firms with innovation potential; raising the technology demand capacity of a larger portfolio of firms or organisations with low technological capacity; and provision of training services to those firms.
- Strengthen institutions that provide intangible S&T infrastructure (technological information, IPRs, metrology, certification, standards) and facilitate access to their services and IPRs).

Legal and regulatory reform

- Revise the tax code to set clear rules allowing investment in R&D activities to be written off against profits.
- In the Public Career Law and the rules that govern CAS contracts consider including provisions adapted to the specific nature of S&T activities.
- Revise labour laws that block institutional mobility of public researchers and, more generally, laws and regulations that impose restrictions on public-private collaborative arrangements.
- Review and revise the SNIP procedures that apply to public investment in R&D and innovation activities (or public support to such activities). As regards the application of SNIP procedures to innovation fund projects, the rules that apply to FINCYT should be generalised.

Transition issues

The future of innovation funds or programmes benefiting from loans from multilateral financing institutions such as INCAGRO and FINCYT are a significant issue. Their importance in the promotion of Peru's S&T capacities and innovation performance is clear. The reasons for their success are various but the main ones are:

- First, they catalysed latent demand for research and technological development and are effectively contributing to an increase in S&T capacity across the economy in both the public and private sector that had not been achieved with other types of programmes.
- Second, there has been a good fit between their design and focus and the recognised weaknesses of Peru's innovation system.
- Finally, there is their efficiency in management and delivery, notwithstanding the many regulatory (and at times institutional) obstacles encountered.

As mentioned both FINCYT and INCAGRO should be extended for additional phases under the same institutional settings and the same management and monitoring procedures, or even improved ones if some regulatory obstacles are removed or alleviated. In a more distant future, such funds and programmes will eventually have to be financed by the Peruvian Treasury. In that case their design and focus and management may be subject to changes in accordance with the evolving forms of governance suggested above.

Summary table: SWOT (strengths, weaknesses, opportunities, threats) analysis of Peru's innovation system

Strengths	Weaknesses
• Sound and stable macroeconomic environment • Strong export-oriented resource-based industries • Existence of some well-designed and managed matching funds support programmes (funds) that highlight the existence of latent R&D, S&T and innovation potential and catalyse the development of research, development and innovation (RDI) activities • Performing technology transfer institutions (CITEs) • Pockets of excellence in scientific research • Existence of leading enterprises with innovative business models • Sound performance of some vocational and professional training institutions	• Very low record of public and private investment in RDI activities • Absence of effective governance mechanisms gives rise to institutional conflicts over competencies and resources • Absence of connection between planning exercises and budgetary allocations • Poor system of information, monitoring and evaluation, lack of data on STI activities and resources • Perverse effects of laws and regulations governing public investment on STI activities • Significant red tape in administrative procedures • Weak R&D performance and poor governance of most institutions in the public research and academic systems • Weak articulation between business sector and public research institutions • Weak IP culture and IP management capabilities in the public, private and higher education sectors • Limited supply and low mobility of human resources for science and technology • Overall lack of absorption capacity in majority of SMEs and importance of informal sector • Poor performance of education system and bias towards non-S&T studies at graduate level • Limited variety in production structure hindering technology spillover effects • Shallow development of natural resource-based clusters • High level of formality and low efficiency in central/regional co-ordination of RDI investment and support programmes • Financial markets ill adapted to innovation-related investment • Lagging infrastructure investment
Opportunities	**Threats**
• Greater political awareness of the role of government in fostering innovation • Raising the consciousness of the private sector about the importance of innovation investment • Continuous support of multilateral financing institutions for the funding of R&D and innovation support programmes • Increased technological spillovers of foreign direct investment • Wider exploitation of agro-industry and biodiversity resources through innovation • Deeper cluster development and engagement of SMEs in the supply chain	• Possible volatility of traditional resource-based export markets • Low technological spillovers in the production structure in the absence of proactive support programmes • Institutional rigidities hindering experimentation in policy design and implementation or leading to capture by inefficient institutions • Possible conflicts over endogeneisation of support programmes partially funded by multilateral financing institutions • Shortages of highly skilled S&T personnel

Notes

1. These are comprised of a share of the corporate tax and royalties collected from mining, gas, oil, hydroelectric, forestry and fishing firms.
2. Inferences based on the 2004 ENCYT Survey for enterprises with a turnover of USD 30 000 or more (CONCYTEC, 2010).
3. In most advanced and developing countries technology centres have developed *intra muros* R&D capacities and have thus broadened their services portfolio. This is also true of Colombia.
4. The scheme proved more complicated to implement for INCAGRO than for FINCYT.
5. Article 37 of the tax law (*Ley de Impuesto a la Renta*) defines the expenditures that can be written off against profits. In the case of innovation-related costs the enterprise should provide evidence that these expenditures are "necessary to produce and maintain the source of profits". The risk of possible fines if the evidence is not accepted by tax auditors leads enterprises not to write off such expenditures.
6. INCAGRO played a positive role in steering the "agricultural innovation system" and FINCYT did the same for the overall innovation system. Despite their success, these programmes lacked institutional legitimacy to engage in a participatory steering process.
7. However, in the case of FINCYT the decision to give it a broad scope was the most appropriate one and a second best solution.
8. This governance model is essentially the one applied in Mexico with CONACYT as a decentralised agency under the Presidency of the Republic. However, apart from CONACYT, several sectoral ministries have important responsibilities in S&T policy development and the funding of S&T-related institutions and support programmes.

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Examen de l'OCDE de la politique d'innovation du Pérou : Evaluation globale et recommandations

Soutenir la reprise : vers un rôle plus puissant de l'innovation dans le développement économique du Pérou

La forte reprise au cours de la dernière décennie …

Le Pérou a affiché une croissance économique exceptionnelle au cours de la dernière décennie. Avec une croissance annuelle moyenne du PIB de 6.3 % et du PIB par habitant de 4.5 %, ce pays s'est classé parmi les tous premiers sur le plan des performances économiques en Amérique latine. Il a traversé sans trop de difficultés la récente crise financière et économique et a connu une vigoureuse reprise en 2010. A la base de cette excellente performance, on trouve des politiques macroéconomiques saines, des réformes structurelles pour améliorer le fonctionnement des marchés des produits et du travail, ainsi que l'ouverture de l'économie aux échanges internationaux et à l'investissement étranger. Ces politiques ont favorisé l'investissement, la productivité et la création d'emplois. Elles ont permis au Pérou d'exploiter ses avantages comparatifs dans les secteurs fondés sur les ressources naturelles et les branches d'activité traditionnelles, et d'engranger les bénéfices de l'augmentation de la demande des économies développées comme des économies émergentes. Elles ont également commencé à avoir des effets positifs, quoique modestes, sur le niveau de vie et la réduction de la pauvreté.

… ne devrait pas inciter à la complaisance

Toutefois, le Pérou demeure à la traîne par rapport à la plupart des pays d'Amérique latine sur le plan du revenu par habitant et de l'investissement dans le capital humain et dans le savoir. Son économie demeure assez peu diversifiée. Les disparités de revenu sont fortes et les emplois informels continuent de représenter une part importante de l'emploi total. Bien que la productivité de la main-d'œuvre ait augmenté depuis 2003, le pays n'en demeure pas moins à la traîne par rapport aux autres pays d'Amérique latine à revenu moyen. La croissance de la productivité totale des facteurs (PTF) qui traduit une utilisation plus efficiente des facteurs, y compris par l'innovation, n'a joué qu'un rôle marginal. Si l'allocation plus efficiente des ressources par suite de réformes structurelles a eu des effets positifs, la croissance économique est due principalement à la formation de capital et à l'augmentation de la contribution de la main-d'œuvre.

Les exportations du Pérou ont plus que quadruplé au cours de la dernière décennie, mais sa spécialisation et sa compétitivité internationale continuent de reposer essentiellement sur ses avantages comparatifs, s'agissant des biens liés aux ressources naturelles, ainsi que sur un coût de main-d'œuvre relativement faible. La part des produits non traditionnels dans les exportations totales a baissé passant de 29 % en 2002 à 21 % en 2010. A l'avenir, le Pérou sera vraisemblablement confronté à une concurrence plus vive des pays présentant les mêmes avantages comparatifs. Pour ce qui concerne ses exportations basées sur ses ressources naturelles, le pays se heurte à l'incertitude de la demande mondiale et à la volatilité des prix des produits.

Lutter contre les faiblesses qui menacent la durabilité ...

L'amélioration de la productivité dans toute l'économie et la diversification des activités économiques au profit d'une production et d'exportations à plus forte valeur ajoutée constituent deux défis majeurs pour le développement et la croissance à moyen et long terme du Pérou. Elles sont également nécessaires pour assurer l'inclusion, notamment par la création d'emplois plus qualifiés et la réduction de l'emploi informel et de la pauvreté. En conséquence, les stratégies et les politiques doivent prendre appui sur un examen attentif des sources potentielles et des schémas de croissance dans un environnement mondial en évolution. Le retard en matière de productivité de la main-d'œuvre présente beaucoup de possibilités d'amélioration, et l'accroissement de l'investissement dans le savoir pour augmenter la capacité d'innovation du Pérou peuvent aider à soutenir la croissance. Comme le rendement de ces investissements n'est pas immédiat, et qu'il aide à déterminer la compétitivité future du secteur des entreprises, il est urgent que les pouvoirs publics interviennent.

Au Pérou comme dans de nombreux pays en développement, la préférence pour les technologies importées par rapport au développement de ses propres capacités d'innovation, a freiné le développement de la capacité d'assimilation et limité la diffusion technologique *via* les échanges internationaux et l'investissement étranger. Il n'y a guère de diffusion de technologie à partir des secteurs plus avancés technologiquement et orientés vers l'exportation que sont l'extraction minière et l'agro-alimentaire, et l'absence de variété de la production et des exportations du pays freine l'émergence de chaînes de valeur fondées sur les technologies tout en réduisant les possibilités d'apprentissage.

A la différence des pays développés comme l'Australie et la Norvège, ou des économies émergentes comme le Brésil et l'Afrique du Sud (où les ressources naturelles contribuent également de manière sensible à la croissance des exportations et du revenu), le Pérou n'a pas été vraiment capable de mobiliser ses ressources pour diversifier les industries amont et aval, ni de mettre au point des services augmentant l'efficience et la durabilité de l'exploitation des secteurs basés sur ses ressources naturelles. Cela tient en partie à la faiblesse des incitations du secteur des entreprises à investir dans ces activités, mais aussi à la pénurie de ressources humaines qualifiées pour développer des activités amont et aval à contenu technologique moyen à fort liées aux secteurs de l'extraction minière et de l'énergie, ou pour assurer une exploitation durable des importantes ressources en biodiversité du pays.

... exige l'innovation comme déterminant de la croissance.

L'expérience des pays développés et émergents ayant réussi montre que le gouvernement pourrait jouer un rôle plus anticipatif en matière de promotion de l'innovation pour aider le Pérou à développer de nouveaux avantages comparatifs et alléger les contraintes connexes. Une politique macroéconomique stable a aussi besoin de mesures encourageant l'innovation et aidant à relever les défis sociaux et des conditions cadres solides peuvent aboutir à un sentier de croissance plus durable, moins sensible aux chocs externes. Ce sentier peut favoriser la croissance et l'inclusion par le biais des gains de productivité offerts par l'investissement lié à l'innovation, y compris dans le capital humain, par le biais de la diffusion technologique et des avantages concurrentiels d'une économie plus diversifiée. Des pays dotés de ressources aussi différents que la Finlande, la Corée ou la Norvège et, plus récemment des économies émergentes comme la Chine, le Brésil et le Chili ont suivi ce sentier, certains de manière très réussie. À la différence du Pérou, ces pays ont augmenté l'investissement public et privé dans la science, la technologie et l'innovation (STI) au cours de la dernière décennie. Naturellement, le Pérou a connu une certaine diversification ces dernières années, notamment dans le secteur agricole non traditionnel où les exportations ont augmenté, passant de 390 millions USD en 2000 à 1 900 millions USD en 2010. Une partie (au moins) de ce succès peut être imputée à des politiques publiques soutenant l'innovation et le transfert de technologie dans ce secteur.

Le système d'innovation péruvien : principales faiblesses et enjeux pour les pouvoirs publics

À la différence d'autres pays d'Amérique latine, et en dépit d'une tradition académique bien établie, le Pérou a largement raté l'opportunité de développer une infrastructure publique solide de science et de technologie (S-T) dans son système universitaire ou ses établissements publics de recherche (EPR) dans les années 60 et 70. En conséquence, le « côté offre » de S-T a été insuffisant. Les dotations en ressources de ces institutions et leur performance en termes de création et de diffusion de savoir ont souvent été extrêmement faibles. Le Pérou continue de souffrir de cette situation, souvent aggravée par la médiocrité de la gouvernance des EPR.

En outre, les changements de politique économique au cours des cycles politiques qui se sont succédé se sont accompagnés de bouleversements parfois drastiques du rôle et de l'orientation de la politique de S-T. Ce phénomène a freiné l'émergence d'un consensus politique fort sur l'importance de l'investissement dans la S-T au service d'un développement et d'une compétitivité durables et inclusifs. D'où la faiblesse des ressources pour la S-T et des conflits en matière d'allocations. Un système cohérent et très élaboré d'innovation dans lequel les acteurs seraient davantage enclins à établir des collaborations plutôt qu'à protéger leurs intérêts propres n'a pas pu voir le jour. Une approche légaliste du renforcement des institutions a aussi conduit à l'émergence de différents échelons institutionnels (dont les responsabilités en matière de conception et de mise en œuvre de politiques correspondent rarement à leur mandat législatif), ainsi qu'à des chevauchements de responsabilités et à des conflits dans l'attribution des maigres ressources.

Le rôle des instruments de soutien pour mobiliser la demande de savoir scientifique et technologique du secteur privé et pour renforcer la capacité de S-T a lui aussi été sous-estimé. Cela vient s'ajouter aux obstacles institutionnels au transfert de ressources publiques au secteur privé. Le Pérou a mis du temps à réaliser l'importance des institutions intermédiaires pour le développement d'infrastructures de S-T et la diffusion technologique.

Insuffisance des ressources pour la S-T : explication partielle des piètres performances en innovation

Comparé aux économies émergentes et aux pays d'Amérique latine présentant des niveaux de développement ou de dotations analogues, le Pérou consacre très peu de ressources publiques ou privées à la recherche-développement (R-D). En 2004 (dernière année pour laquelle on dispose de données dont la fiabilité n'est d'ailleurs pas prouvée), l'intensité de R-D de l'économie péruvienne (dépenses de R-D rapportées au PIB) n'a été que de 0.15 % contre 0.90 % au Brésil, 0.65 % au Chili, 0.43 % au Mexique, et 0.86 % en Afrique du Sud. Depuis lors, l'intensité de R-D a augmenté dans ces pays, et même très fortement au Brésil et en Afrique du Sud, mais a vraisemblablement stagné ou augmenté de façon marginale au Pérou. Selon les estimations, la part du budget total affectée aux institutions de S-T ou à des fonds d'innovation a en fait décru, passant de 1.72 % en 2003 à 1.59 % en 2009. La médiocrité des performances du Pérou en matière de produits de l'innovation, mesurées par les brevets ou la productivité, reflète jusqu'à un certain point le faible niveau d'investissement dans les actifs matériels et immatériels en matière de savoir, ainsi que les inefficiences du système d'innovation, d'où un mauvais rendement de l'investissement lié à la S-T.

Si les ressources aidant à améliorer la capacité de STI, surtout les infrastructures de R-D et de S-T, sont sans nul doute nécessaires, le développement concomitant d'une capacité d'assimilation, notamment en termes de ressources humaines (qualifiées) est nécessaire également. Comme l'indique l'expérience des pays ayant réussi, la performance des systèmes d'innovation dépend aussi de facteurs favorisant la production, l'acquisition, la diffusion du savoir et de la technologie, et assurant une mobilisation efficiente des ressources publiques pour des investissements privés liés à l'innovation dans des collaborations existantes ou nouvelles. Ces facteurs incluent :

- des cadres institutionnels et de gouvernance qui définissent l'orientation, la conception et la mise en œuvre de l'action publique, permettent aux pouvoirs publics d'adapter leur action et limitent les doublons concernant les programmes de soutien ;
- des conditions favorables à la performance des institutions de recherche publique et de transfert de technologie ;
- l'absence de restrictions juridiques ou réglementaires qui nuisent à l'effet de levier des ressources publiques pour à l'investissement privé dans la S-T, ou la construction de partenariats public-privé pour la recherche et l'innovation ;
- un arsenal de politiques qui créent un cercle vertueux d'offre et de demande dans le développement de la capacité de S-T ;
- des instruments de soutien publics et des incitations pour remédier aux défaillances systémiques ou du marché comme le sous-investissement dans les activités de

savoir et l'interaction des savoirs entre acteurs, en particulier s'agissant de celles qui affectent la collaboration et la diffusion technologiques ;

- les effets des conditions cadres et des régimes de réglementation sur le comportement d'investissement des entreprises et leurs incitations à innover, ainsi que sur l'efficience des institutions publiques de S-T.

De gros investissements sont nécessaires dans tous ces domaines pour que l'augmentation des ressources affectées à la S-T soit efficace, et aide le Pérou dans sa capacité d'innover et de relever les défis sociaux.

Récentes initiatives des pouvoirs publics : des résultats positifs mais limités dans un cadre institutionnel morcelé

Au cours de la décennie écoulée, le gouvernement péruvien a pris différentes initiatives, certaines de nature institutionnelle, d'autres pour créer des programmes de soutien, favoriser le développement des capacités d'offre et de demande de S-T, et stimuler l'interaction entre acteurs privés et publics du système d'innovation. Récemment, il a enregistré certains succès par le biais de nouveaux fonds de S-T et d'innovation, certains appuyés par des institutions de financement multilatérales, par le biais de transferts technologiques ainsi que de dispositifs de soutien de la R-D, et par le biais de mesures encore modestes visant à développer le capital humain de la S-T.

La loi cadre de 2004 relative à la S-T et à l'innovation technologique a confié au Conseil national de la science, de la technologie et de l'innovation technologique (CONCYTEC) la responsabilité de piloter la politique de STI, notamment par l'élaboration du plan national pour la STI et la coordination du SINACYT (Système national de S-T et d'innovation technologique). Le CONCYTEC a également été chargé d'assurer des fonctions de mise en œuvre des politiques par le truchement de son bras opérationnel le FONDECYT, qui gère les programmes visant à soutenir la recherche fondamentale et appliquée, le transfert et la diffusion technologiques ainsi que le développement de ressources humaines hautement qualifiées dans le domaine de la S-T.

La création de centres d'innovation technologique (CITE) par le ministère de la Production a commencé en 2000. Bénéficiant de financements du ministère et de sources privées ou d'agences de coopération étrangères, les centres sont conçus pour fournir des services technologiques aux petites et moyennes entreprises (PME) ou à des associations de producteurs afin de combler un important déficit de transfert de technologie.

Deux fonds concurrentiels de STI bien dotés, cofinancés par le gouvernement péruvien, et des prêts d'organisations multilatérales de financement ont été mis en place. INCAGRO a été lancé en 2001 avec une dotation initiale de 20 millions USD (dotation portée à 45 millions USD dans une deuxième phase) pour promouvoir l'innovation et le transfert technologique ainsi que les collaborations public-privé dans le secteur de l'agriculture. FINCYT a été lancé en 2007 avec une dotation de 36 millions USD pour promouvoir une large palette de programmes dont le plus important vise à renforcer les capacités de recherche et d'innovation des entreprises, des universités et des centres publics de recherche, et à favoriser la collaboration entre eux. Ces fonds ont des règles de fonctionnement plus efficientes et comportent des modules d'évaluation globale de la gestion de meilleure qualité que les précédents programmes de nature similaire ou ayant les mêmes objectifs.

En 2006, un nouveau fonds concurrentiel, le FIDECOM, a été créé et doté par le ministère de l'Économie et des Finances de quelque 65 millions USD avec pour objectif de promouvoir l'innovation productive. En 2007, en vertu de la Loi 29152, le ministère de la Production a été chargé de l'opération d'un fonds compétitif utilisant les ressources du FIDECOM. En 2010, il a déboursé 1.9 million USD pour soutenir des projets d'innovation dans le secteur privé, en mettant l'accent sur les projets en collaboration.

En 2004, la loi dite «Canon» a été modifiée pour transférer un prélèvement sur les bénéfices de ce secteur pour attribuer une partie des ressources transférées aux administrations régionales[1] au financement des projets d'investissement visant à développer la capacité de recherche des universités publiques régionales.

Ces initiatives ont aidé à étoffer l'investissement des entreprises dans l'innovation, quoique de façon modeste. Les institutions de recherche, y compris les universités, ont utilisé les augmentations marginales du financement institutionnel pour étoffer leur base de connaissances et, dans une moindre mesure, renforcer leurs activités de transfert de savoir. A la suite de l'amendement de 2004 de la loi Canon, les universités ont reçu d'importantes ressources supplémentaires pour l'investissement dans la R-D (bien que des conditions rigoureuses sur l'utilisation des capitaux aient été imposées). Les institutions de transfert de technologie ont aidé à augmenter la productivité et la compétitivité internationale de certaines branches des secteurs manufacturier non traditionnel, agricole et agro-alimentaire, offrant ainsi de nouvelles possibilités de diversification.

Globalement, ces initiatives n'ont concerné qu'un nombre relativement faible d'entreprises, d'institutions de recherche et d'associations professionnelles et n'ont pas conduit à une croissance durable de la productivité. Elles n'ont pas été le catalyseur d'un processus de mise à hauteur technologique systématique dans les activités existantes par le biais de transactions marchandes et non marchandes inter-institutionnelles en matière de savoir, ni de retombées de savoir inter-industries, dans des chaînes de valeur par exemple. A de rares exceptions près, elles n'ont pas servi à déclencher un processus de diversification fondé sur la technologie, et leur portée est trop limitée pour permettre l'utilisation ou l'appropriation de nouvelles technologies afin de faciliter la mise à hauteur des compétences et de s'attaquer au problème de l'inclusion sociale. En outre, il subsiste d'importantes questions de gouvernance qui n'ont pas été résolues. Des réformes institutionnelles sont nécessaires pour clarifier le paysage confus de la conception des politiques et s'attaquer aux conflits latents dans la mise en œuvre des politiques qui résultent trop souvent de la duplication des programmes de soutien, de l'absence de masse critique et de gaspillages des ressources publiques.

En particulier, le CONCYTEC n'a pas été en mesure d'orienter la politique de STI pour des raisons comme l'absence d'appui politique, la médiocrité de sa gestion, et les difficultés pour trouver un consensus entre des institutions qui s'efforcent de protéger leurs attributions et leurs ressources. Des conflits d'intérêt se font jour également du fait de l'absence de distinction nette entre les responsabilités fonctionnelles et opérationnelles. En outre, il existe un chevauchement considérable des programmes qui appuient la S-T et l'innovation gérés par des institutions différentes (par exemple CONCYTEC et FINCYT). Cela aboutit à un doublement des coûts de gestion et à la prolifération de projets avec de faibles plafonds d'admissibilité en termes de coût des projets.

Toutefois, des enseignements peuvent être tirés de ces initiatives pour élaborer une politique de l'innovation ouvrant la voie à un développement plus durable, et créer un cercle vertueux de demande et d'offre et de diffusion du savoir. Une telle politique exige une gouvernance, des réformes institutionnelles et réglementaires d'un système

d'innovation qui a évolué de façon progressive mais souvent hasardeuse au cours des 40 dernières années.

Carences des institutions d'enseignement supérieur et développement des ressources humaines

Grâce à plus de trois décennies d'efforts, le Pérou a obtenu des niveaux élevés de scolarisation dans le primaire et le secondaire et affiche un taux de littérisme des adultes de plus de 90 %, pourcentage parmi les plus élevés d'Amérique latine. Toutefois, cela a été accompli aux dépens des résultats des élèves du secondaire en compréhension de l'écrit et en science. Ces résultats sont inférieurs à ceux de pays d'Amérique comparables comme le prouve le rang très bas obtenu dans les comparaisons internationales comme le programme PISA de l'OCDE.

Dans le secteur de l'enseignement supérieur, la forte demande stimulée par une croissance économique durable a conduit à la création de quelques universités et instituts de technologie publics et de beaucoup d'établissements privés. Le nombre d'étudiants des universités a augmenté, passant de plus de 346 000 en 1996 (date à laquelle a été autorisée la création d'universités privées à but lucratif) à plus de 839 000 en 2010, les universités privées étant à l'origine de la majeure partie de cette progression. Comme beaucoup, sinon la plupart, des universités privées ne possédaient pas d'accréditation, l'augmentation quantitative s'est faite aux dépens des résultats scolaires des étudiants. Dans la plupart des universités publiques, la croissance rapide des inscriptions a eu un effet négatif, l'afflux excédentaire s'étant conjugué aux effets liés aux bas niveaux de salaire. Dans l'ensemble, il en va de même pour les instituts supérieurs de technologie. Il s'en suit qu'un nombre relativement faible de diplômés possèdent les qualifications leur permettant d'intégrer des programmes du 2e ou du 3e cycle accrédités en S-T et en ingénierie. De surcroît, d'après les normes internationales, très peu de bourses sont disponibles pour les étudiants qualifiés voulant suivre des programmes de ces niveaux.

Les universités sont autonomes et, pour des raisons pratiques, l'obligation de rendre des comptes devant des organes de supervision est minimale. Elles ont donc élaboré des systèmes de gouvernance interne qui, dans leur grande majorité, répondent à des critères autres que l'excellence en matière d'enseignement et de recherche, ou dans ce qu'il est convenu d'appeler la « troisième mission » consistant à promouvoir les interactions en termes de connaissances avec le secteur de la production. Le manque relatif de ressources pour les activités de recherche et le manque d'incitations a conduit de nombreux chercheurs qualifiés à émigrer. D'autres pays confrontés au même problème ont eu recours à des incitations au retour ou à des dispositifs pour attirer les scientifiques étrangers par le biais de formes spéciales de rémunération ainsi qu'à d'autres mesures pour relever le niveau des universités et les rendre plus attrayantes aux yeux des scientifiques hautement qualifiés.

D'après les statistiques disponibles, le secteur de l'enseignement supérieur effectue près de 40 % de la R-D. Ces activités sont menées dans une poignée d'universités. On estime que six d'entre elles (dont deux privées) représentent environ 80 % de la R-D universitaire totale, qui est essentiellement financée par des fonds institutionnels, par les programmes de soutien concurrentiels du CONCYTEC ou par le FINCYT, ainsi que par des sources étrangères de coopération et de financement (comme c'est le cas de l'HAP, de l'IGP et de l'université Cayetano Heredia). Bien que ces universités occupent encore un rang assez bas dans les classements internationaux ou latino-américains, elles servent de pôles d'excellence dans le système de recherche du Pérou.

Le financement additionnel résultant de l'amendement à la loi Canon et attribué à des universités publiques régionales est en principe assez conséquent. Toutefois, ces ressources demeurent en grande partie « gelées » du fait de la rigidité de la réglementation qui pèse sur leur utilisation et de l'insuffisance des capacités d'assimilation des universités. En dépit des initiatives récentes prises par les universités à plus forte intensité de R-D et de la prime pour les activités en collaboration prévue par des fonds tels que le RINCYT, les interactions de recherche et d'innovation entre les établissements d'enseignement supérieur et le secteur de la production sont encore rares.

Les récentes initiatives visant à renforcer le potentiel de recherche des universités comme les chaires et les programmes de bourses du CONCYTEC répondent efficacement aux besoins mais sont de faible ampleur et de portée limitée. Ces programmes devraient compléter d'autres méthodes peut-être même plus efficaces pour constituer un corpus de chercheurs hautement qualifiés. Enfin, le secteur universitaire manque de moyens et de mécanismes de financement suffisants pour développer et entretenir les équipements de l'infrastructure de S-T.

Les instituts publics de recherche : un groupe hétérogène affichant de faibles performances globales

La plupart des instituts publics de recherche (IPR) du Pérou ont été créés dans les années 70 comme des agences décentralisées rattachées à des ministères sectoriels. Ils sont plus divers que dans la plupart des pays. On peut *grosso modo* les regrouper en trois catégories suivant leur mandat ou leur portefeuille d'activités :

- ceux dont la principale mission est de mener des activités de recherche fondamentale et appliquée et de développement technologique dans des domaines jugés utiles pour des secteurs spécifiques, ainsi que d'assurer les transferts de technologie aux entreprises de ces secteurs ;
- ceux qui effectuent des activités scientifiques « dans l'intérêt du public », qui sont bénéfiques pour la société au sens large, contribuent à une meilleure utilisation de la dotation du pays en ressources naturelles et sociales, et qui mènent des activités de transfert de technologie au secteur de la production ;
- ceux dont la mission a trait à la définition de normes ainsi qu'à la fourniture de services d'infrastructures et d'information sur les technologies.

À quelques exceptions près, les performances des instituts publics de recherche œuvrant au développement de la science et de la technologie et à des activités de transfert, mesurées par les produits scientifiques, les brevets et la collaboration avec le secteur de la production, sont assez faibles. Cela tient principalement à leur gouvernance, au mode de financement de leurs activités et à des procédures de gestion interne. La performance de la dernière catégorie, qui n'implique pas à proprement parler des activités de S-T, est généralement à la hauteur des normes internationales même si certains instituts pourraient avoir avantage à mieux gérer la fourniture de services technologiques.

Les relations des IPR avec les ministères sectoriels auxquels ils sont rattachés du point de vue institutionnel se limitent souvent à des discussions des besoins budgétaires. Leur programme de recherche est plus souvent dicté par l'inertie que coordonné avec les parties prenantes et les ministres responsables.

La gouvernance des IPR est médiocre. Elle se borne généralement à des procédures formelles de reddition de comptes qui ne sont pas fondées sur les performances. Comme l'immense majorité des ressources des IPR proviennent des financements institutionnels et que les recettes générées par la vente de services sont minimes, ils n'ont pas de réelles incitations à améliorer leur performance. En même temps, les IPR ne jouissent pas d'une véritable autonomie pour les questions de gestion interne, s'agissant notamment de la gestion des ressources humaines. Dans de nombreux IPR, la nature de l'appropriation des ressources, l'absence d'obligation de rendre des comptes et des contraintes de gestion ont des effets préjudiciables sur la performance. Cela a créé un cercle vicieux dans lequel le potentiel de S-T souffre des préférences accordées au personnel de gestion, aux dépens des ressources humaines de S-T.

Les IPR pourraient constituer un élément important du système d'innovation péruvien. Jouer leur rôle de manière efficiente pour le bien du secteur privé et de la société au sens large exigera de grandes réformes en termes *i)* de gouvernance et de reddition de comptes, *ii)* de diversification des sources de financement avec un meilleur équilibre entre le financement institutionnel et le financement concurrentiel par projet, et *iii)* de produits de la collaboration avec le secteur des entreprises et de fourniture de services à ce secteur.

Faiblesse des investissements des entreprises dans l'innovation

Globalement, le secteur péruvien des entreprises n'a qu'une faible propension à investir dans la R-D et l'innovation. D'après certaines estimations, pas plus de 2 % de l'ensemble des entreprises mènent des activités de S-T.[2] La distribution est extrêmement faussée par la taille des entreprises, et se concentre dans un petit nombre de secteurs. Une part très faible des grandes entreprises entretiennent des liens adéquats avec les sources internationales de technologie et pratiquent l'innovation de procédé incrémentale, principalement par le biais de l'importation de savoir-faire et de biens d'équipement de pointe. Une proportion plus forte, quoique encore modeste, des entreprises du secteur manufacturier et de l'agro-alimentaire s'est dotée de certaines capacités de STI, principalement par le biais du transfert technologique et de la formation de capital humain, et sont en mesure d'effectuer des innovations de produit et de procédé. L'immense majorité des entreprises n'effectuent aucune activité d'innovation hormis le remplacement occasionnel de machines ou d'équipement.

Un certain nombre de facteurs expliquent la faible propension du secteur des entreprises à entreprendre des activités d'innovation. Parmi les plus importants de ces facteurs, on peut citer :

- une aversion au risque en partie ancrée dans les bouleversements profonds de l'environnement économique dans le sillage des changements politiques, et leurs effets sur les taux d'intérêt et d'inflation ;
- de faibles pressions concurrentielles et la prévalence de stratégies de recherche de rentes par des entrepreneurs pusillanimes ;
- le sous-développement des chaînes de valeur dans lesquelles les fournisseurs et les contractants exercent des pressions ou offrent d'autres incitations à l'innovation ;
- la faiblesse des interactions entre les entreprises et les sources nationales de connaissances que sont les instituts et les universités, largement due à l'inadéquation entre l'offre et la demande de connaissances et de services

technologiques, et l'absence d'intermédiaires technologiques pour renforcer les interactions ;

- la relative rareté des personnels de S-T et de gestion hautement qualifiés pour concevoir et mettre en œuvre des projets d'innovation ;
- l'absence de marchés financiers et la rareté des institutions financières susceptibles de réagir aux exigences financières liées à des actions innovantes dans les PME et au développement d'entreprises fondées sur les technologies ;
- le manque de dispositifs d'aide publique efficients pour favoriser l'investissement privé dans la R-D et l'innovation.

Le gouvernement péruvien a pris des initiatives pour améliorer le climat de l'innovation, mobiliser l'investissement privé dans l'innovation et favoriser un meilleur interfaçage entre les instituts publics de recherche et le secteur des entreprises. Les régimes de concurrence et de droits de propriété intellectuelle (DPI) ont été renforcés. Des programmes de soutien au financement concurrentiel des projets d'innovation des entreprises sur la base du partage des coûts comme le PROCOM/FONDECYT ont été mis sur pied, et suivis, à une échelle plus vaste et de manière plus efficiente par des programmes d'innovation technologique. Le succès de ces programmes montre que les incitations qui réduisent les risques et les coûts des projets d'innovation révèlent l'existence d'une demande latente et d'une capacité à entreprendre ces projets. Ces incitations élargissent également les possibilités de développement, de diversification et d'augmentation de la productivité. Comme ces programmes de soutien sont relativement nouveaux, il subsiste des questions importantes concernant le rendement social des ressources publiques, la durabilité de l'impact sur la propension des entreprises à investir dans des actifs immatériels, et l'impact sur le renforcement de l'interaction parmi les acteurs de l'innovation ainsi que sur la diffusion technologique.

Insuffisance du transfert et de la diffusion des technologies

Dans beaucoup de pays de l'OCDE, les centres de technologie et d'innovation jouent un rôle important dans le travail de recherche appliquée, la formation de coopérations avec les entreprises privées et la fourniture de services technologiques à des entreprises, et la promotion de la diffusion technologique, au sein des secteurs et par delà les limites intersectorielles. Dans bien des cas, ces centres participent aussi à des actions de formation. Plusieurs modèles ont émergé suivant la nature de leur statut et leur forme de gouvernance (publique, privée ou mixte), l'éventail des ressources financières (subventions, financement concurrentiel de projets de S-T), et la portée de leurs activités de S-T (sectorielle, multisectorielle ou domaine de la S-T).

Dans les pays en développement, la grande majorité des entreprises des secteurs à contenu technologique faible à moyen ne manquent pas seulement d'une capacité endogène de S-T mais souffrent aussi de la médiocrité de l'accès à l'information, aux normes et aux standards. Cela entrave leur aptitude à innover, à améliorer les procédés de production et à diversifier leurs activités pour s'orienter vers des produits et des marchés plus élaborés. Dans beaucoup de ces pays, des institutions de transfert de technologie ont été créées pour remédier à ces problèmes et développer les capacités de S-T.

Le Pérou, qui fait figure d'acteur relativement nouveau dans ce domaine, a créé son réseau de centres d'innovation technologique (CITE) en 2000 sous l'égide du ministère de la Production qui accorde l'homologation aux différents centres. Les CITE sont

organisés de manière sectorielle et peuvent être soit publics, soit privés. Ils vendent leurs services et seuls les centres publics ont droit à des financements institutionnels. Actuellement, 14 CITE sont en activité (11 privés et 3 publics) dans les industries manufacturières, le secteur des services, l'agro-alimentaire, la foresterie et l'agriculture. Les CITE sont principalement axés sur la demande mais ils opèrent généralement en étroite collaboration avec les associations de producteurs, ont de bonnes capacités à identifier la demande potentielle pour adapter les services technologiques de manière individuelle, y compris les programmes de formation, et affichent de bons antécédents en matière de performance. Toutefois, même si le nombre d'entreprises aidées a sensiblement augmenté au cours des cinq dernières années, l'ouverture des CITE demeure limitée compte tenu de l'ampleur du problème de renforcement des capacités au Pérou. Pour l'heure, ils n'ont ni les moyens ni pour mission de faire de la R-D bien que le développement de ce type d'activité pourrait élargir les services qu'ils offrent, non seulement pour les secteurs dans lesquels ils sont déjà présents, mais aussi pour d'autres secteurs plus avancés du point de vue technologique. Cela exigerait plus de ressources pour l'infrastructure de R-D et le recrutement de ressources humaines présentant un niveau de qualification en S-T plus élevé[3].

C'est peut-être faute de capacités de R-D *intra-muros* que les CITE ne sont pas bien placés pour bénéficier du FINCYT et du FIDECOM, programmes qui stimulent les capacités innovantes dans les réseaux d'entreprises qu'ils desservent, ou pour inclure les DPI dans le développement de leurs propres activités de transfert de technologie. Toutefois, les CITE ont réussi à promouvoir 24 projets communs (en association) avec des PME, qui ont été soumis au FIDECOM.

Les institutions à caractère plus réglementaire jouent un rôle actif dans la diffusion des technologies ou dans le renforcement de la capacité des entreprises à s'assurer que la mise à hauteur technologique ouvre véritablement de nouvelles possibilités de marché. Pour ne citer que deux exemples particulièrement importants dans les pays en développement, les offices de la propriété industrielle peuvent faciliter la diffusion de l'information technologique par le biais de plates-formes en accès libre qui fournissent un savoir sur les technologies avancées, et les agences d'homologation fournissent de l'information sur les normes internationales et les services technologiques connexes tant pour la production en cours que pour le développement de nouveaux produits.

INDECOPI, l'agence en charge de la propriété intellectuelle, affiche des résultats assez satisfaisants en matière de gestion de ce domaine. Toutefois, probablement du fait qu'elle a un large portefeuille incluant d'autres missions, notamment celles liées à la promotion et à l'application de régimes de concurrence, elle n'a pas été à même de consacrer suffisamment de ressources à la promotion de l'accès à de l'information technologique et de sa diffusion

SENASA, placée sous l'égide du ministère de l'Agriculture, est chargée de la promotion et de la certification des normes internationales pour la transformation et l'exportation de produits agricoles et agro-alimentaires. Elle a contribué de manière significative à l'adoption de pratiques de production plus efficientes et à la diversification des produits innovants dans les secteurs agricole et agro-alimentaire. La SENASA a aussi de bons antécédents de collaboration avec les institutions de transfert de technologie dans ces secteurs.

Obstacles réglementaires à l'innovation

Hormis un certain nombre de règlements qui nuisent à l'efficience des structures de gouvernance du système péruvien d'innovation et freinent sa consolidation, des obstacles spécifiques d'ordre juridique et/ou réglementaire diminuent l'efficience du soutien public à l'innovation, entravent les interactions entre acteurs et se répercutent de façon négative sur la performance des institutions de recherche.

- *Restrictions pesant sur le transfert de fonds publics à des institutions du secteur privé*. Dans tous les pays de l'OCDE, des dispositions juridiques ou réglementaires définissent la base de ces possibilités de transfert ou les conditions dans lesquelles ils peuvent être réalisés. C'est notamment le cas de l'aide publique à la R-D. En règle générale, le Pérou interdit les transferts publics au secteur privé. La fourniture d'un soutien financier aux activités de R-D et d'innovation est par conséquent freinée par des obstacles juridiques et administratifs et est très difficile à mettre en place. Des règles visant à faciliter la mise en œuvre des instruments de soutien peuvent impliquer de longs délais et des procédures administratives complexes.
- *Les procédures SNIP qui régulent et valident les dépenses publiques à des fins d'investissement des institutions publiques*. Ces procédures ont été conçues pour l'investissement matériel et il s'est avéré difficile d'appliquer les critères à l'investissement dans la R-D ou les actifs immatériels liés à l'innovation. S'agissant des projets du FINCYT et de l'INCAGRO proposés par le secteur privé, les règlements SNIP ont aggravé les restrictions, les projets devant être définis comme des services fournis par contrat au gouvernement[4]. Dans la quasi-totalité des autres pays, une fois qu'un fonds est créé, ses modalités de fonctionnement sont fixées. Ces règles confèrent à l'agence gestionnaire la pleine responsabilité du choix et de l'approbation des projets pris individuellement, ainsi que du versement des subventions conformément aux règles comptables.
- *La législation du travail applicable aux fonctionnaires* a un impact négatif sur l'aptitude des chercheurs des universités publiques à participer à des projets en collaboration avec d'autres institutions en raison des restrictions pesant sur la mobilité interinstitutionnelle ou de la difficulté, voire l'impossibilité, de recevoir des paiements pour des services rendus à une autre institution tant que ces chercheurs sont rémunérés par l'université.
- *Manque d'autonomie de la gestion du personnel dans les instituts publics de recherche*. Les rigidités de la législation du travail rendent les rotations de personnel difficiles, ce qui oblige à recruter des personnels mieux qualifiés comme travailleurs temporaires aux termes du Contrat administratif de services (CAS) appliqué au secteur public.
- Le régime fiscal ne favorise pas l'investissement dans la R-D et l'innovation en ce sens qu'on ne sait pas très bien si ces investissements peuvent être considérés comme des dépenses pouvant venir en déduction des bénéfices[5].

Lacunes dans l'infrastructure scientifique et technologique

Le développement et la pérennisation des infrastructures scientifiques et technologiques sont importants pour les performances du secteur public de la recherche. Ils facilitent la collaboration avec le secteur privé et sont nécessaires à une concurrence fructueuse pour

l'obtention de subventions nationales et internationales. Au Pérou, le financement des infrastructures de S-T a longtemps été négligé. Les lignes budgétaires correspondant aux infrastructures de S-T figurent rarement comme telles dans le financement institutionnel des instituts publics de recherche (IPR) et encore moins dans celui des universités. De surcroît, à l'instar de l'investissement public, elles sont soumises aux procédures SNIP. Ordinairement, les ressources accordées par le biais de projets concurrentiels dans le cadre du CONCYTEC ou du FINCYT ne couvrent pas les frais généraux nécessaires pour développer et pérenniser les infrastructures de S-T. Naturellement, le financement des équipements de S-T est maintenant disponible par le biais des programmes CONCYTEC et FINCYT mais il demeure assez limité.

Faiblesse des liens de S-T entre les institutions

Le système péruvien d'innovation souffre d'un manque d'interactions du savoir entre les institutions en termes à la fois de coopération entre les IPR et entre ceux-ci et les universités. On observe une réticence à partager les équipements d'infrastructure et à s'engager à moyen et long terme dans la recherche en collaboration. Les intérêts en place sont puissants et l'absence de confiance ou les incertitudes liées aux ressources financières et humaines rendent difficile la perception des avantages à tirer de la coopération. L'absence d'incitations fondées sur les performances renforce cette perception.

La situation n'est guère plus brillante s'agissant des coopérations de S-T entre les instituts de recherche et les entreprises ou de la fourniture de services de S-T. Côté demande, la préférence pour les technologies importées et la faible capacité à assimiler la S-T entravent la demande de services technologiques. Côté offre, les instituts publics de recherche n'ont guère d'incitations à s'engager dans des collaborations ou à fournir des services dans la mesure où leurs ressources proviennent en grande majorité des financements institutionnels où l'on n'applique pas de critères de performances aux activités en collaboration. En outre, comme indiqué précédemment, des obstacles réglementaires entravent ces activités.

Ce problème a commencé à être traité dans les programmes de soutien du FINCYT qui privilégient les projets d'innovation des entreprises impliquant une collaboration avec un institut public de recherche. Toutefois, il est encore trop tôt pour savoir si la collaboration favorisée par des incitations financières générera une dynamique de collaboration fondée sur des intérêts mutuels, et si les programmes de soutien auront un effet « d'additionalité comportementale » sur le sourçage du savoir des entreprises.

Nécessité d'une politique globale de S-T et d'une gouvernance efficace

Le Pérou ne s'est pas doté d'une politique de STI explicite assortie d'orientations stratégiques convenues. Il compte plutôt un ensemble à échelons multiples de politiques de divers ministères et institutions publiques essentiellement peu coordonnées et conçues et mises en œuvre de manière plus ou moins indépendante. Avec relativement peu de ressources consacrées à la S-T d'une manière générale et une faible intégration du système d'innovation, les institutions se fixent leurs propres objectifs. Si certaines initiatives publiques gérées de manière efficiente ont donné des résultats positifs, celles qui ont créé une certaine cohérence ont pour l'essentiel « contourné » les cadres nationaux juridiques, institutionnels et réglementaires parce que leur conception et leur mise en œuvre ont été en grande partie définies dans le contexte de prêts faisant intervenir des institutions financières multilatérales[6]. Toutefois, même si ces résultats peuvent créer

un cercle vertueux et fournir de précieux enseignements, ils ne peuvent remplacer une réforme complète du cadre d'élaboration des politiques.

La palette de politiques de STI d'un pays dépend fortement du cadre institutionnel dans lequel les priorités sont définies et financées par le processus budgétaire, de l'équilibre des pouvoirs entre les parties prenantes, ainsi que des conditions cadres et réglementaires qui influent sur la performance du système d'innovation. Les politiques évoluent également à mesure que le contexte intérieur et international change. Au Pérou, le processus qui devrait aboutir à une palette de mesures efficaces est entravé par une inaptitude à remédier aux principales faiblesses du système d'innovation de manière intégrée, et à déclencher une dynamique vertueuse dans laquelle l'investissement public favorise la performance en matière d'innovation du secteur privé.

Les principales raisons en sont : *i)* la confusion des fonctions de conception des politiques et de financement et gestion des programmes (CONCYTEC, par exemple), et parfois une mise en œuvre des programmes (dans certains instituts publics de recherche) qui peut créer des conflits d'intérêts concernant l'utilisation des ressources (affectées à la gestion interne plutôt qu'au financement de projets, par exemple) ; *ii)* les missions excessivement vastes de certains fonds et institutions (production de savoir et développement du capital humain, R-D et innovation du secteur privé, développement, diffusion et transferts de technologies) ;[7] *iii)* les rigidités institutionnelles et une culture légaliste qui freinent l'élaboration ou l'efficacité des nouveaux instruments d'action au sein d'une architecture institutionnelle déjà en place (par exemple, loi « canon minero » pour les universités régionales, procédures SNIP, système de gouvernance des universités).

L'absence de coordination peut avoir des effets négatifs. Au Pérou, elle a conduit au chevauchement des responsabilités et à la duplication des programmes de soutien par les institutions ou les fonds opérant dans des domaines d'action publique similaires. Cela aggrave le problème chronique de l'insuffisance de la masse critique et réduit l'efficience des programmes de soutien. Cela a également entraîné des angles morts dans la conception des politiques : incapacité à élaborer des politiques ou des programmes de soutien qui dépendent des stratégies de collaboration entre (et éventuellement financés par) plusieurs institutions. Au Pérou, c'est notamment le cas des programmes orientés vers des missions, des politiques de constitution de grappes industrielles et des politiques d'achats publics basées sur l'innovation. Une meilleure coordination exige des informations et des données sur les activités et les ressources de STI permettant de prendre des décisions fondées sur des éléments factuels. Le Pérou a encore beaucoup de chemin à faire pour construire une base d'information adéquate, fiable et à jour. Un autre point faible est l'absence de structure créant les conditions nécessaires à une gouvernance efficace. Beaucoup de données d'observation montrent que, pour un volume donné de ressources consacrées à la STI, les performances en matière d'innovation dépendent de la qualité de la gouvernance des systèmes de STI, c'est-à-dire de l'ensemble des modalités institutionnelles largement déterminées par le secteur public façonnant la conception des politiques, leur mise en œuvre (agences et instruments), leur fourniture et leur évaluation, et déterminant la manière dont les divers acteurs des secteurs privé et public interagissent dans l'affectation et la gestion des ressources consacrées à la STI.

Comme la plupart des composantes du système péruvien d'innovation sont faibles et mal coordonnées, le pays ne dispose pas d'un système d'innovation basé sur une vision globale, permettant de participer effectivement à la fixation des priorités et de coordonner l'orientation des politiques au niveau interministériel, les crédits budgétaires et la mise en

œuvre des politiques. Cela aboutit à un morcellement des programmes qui manquent de masse critique, de synergies et de complémentarités. En fait, la dilution des responsabilités de gouvernance et l'écart entre les responsabilités formelles confiées à CONCYTEC par la loi de 2004 sur la S-T et son aptitude à les assumer exige un nouveau cadre institutionnel, voire une nouvelle législation. Mais le processus de réforme ne doit pas compromettre les programmes de soutien gérés avec efficience.

Tâches stratégiques et principes directeurs

Malgré les performances impressionnantes et la résilience de son économie au lendemain de la crise financière de 2008, le Pérou affiche un faible niveau de productivité qui met en péril la viabilité à long terme de son mode de croissance. Étant donné la volatilité potentielle de ses débouchés traditionnels d'exportation et l'âpreté accrue de la concurrence mondiale, le Pérou devrait se préoccuper au premier chef d'aller vers un modèle de croissance plus axé sur l'innovation afin d'accroître sa productivité et sa compétitivité dans un plus large éventail d'activités, de lutter contre la pauvreté et de mieux satisfaire les besoins de la société.

Pour ce faire, il convient de maintenir les politiques macroéconomiques et les conditions cadres qui ont permis le réveil de l'économie péruvienne depuis le début du XXI^{e} siècle. Toutefois, pour exploiter le potentiel scientifique et technologique du pays et progresser dans l'échelle de l'innovation, il faut que le pays consacre davantage de ressources publiques à la création, à la diffusion et à l'utilisation des connaissances et des technologies ; les réformes institutionnelles dans la gouvernance de la science et de la technologie, ainsi que dans la conception et la mise en œuvre des politiques publiques, doivent être poursuivies et accélérées, car elles favorisent l'efficience des instruments d'action.

Pour que l'économie et la société récoltent les fruits des investissements réalisés en science et technologie, il faut du temps et de la continuité d'action. Un certain nombre d'ingrédients sont essentiels au succès des politiques scientifiques, technologiques et d'innovation : *un engagement politique durable,* un consensus entre parties prenantes sur les priorités du pays et une bonne visibilité quant aux bienfaits pour l'économie et la société dans son ensemble. Il faut pour cela des mécanismes de supervision qui permettent de veiller au respect des priorités dans la conception des politiques d'innovation, dans les dotations budgétaires et dans les dispositifs institutionnels de mise en œuvre des politiques. Les fruits de cet investissement public accru, qu'ils soient scientifiques, économiques ou sociaux, doivent être mis en avant dans le débat public, d'où l'importance de la redevabilité.

Toute stratégie de développement socioéconomique fondée sur l'innovation nécessite une *base de ressources humaines qualifiées*. Le Pérou souffre de graves faiblesses dans ce domaine et ne doit pas tarder davantage à faire un effort quantitatif et qualitatif sur toute la chaîne d'éducation et de formation, depuis l'école primaire jusqu'aux études postuniversitaires et, plus précisément, le développement de connaissances et de compétences en sciences, mathématiques et technologie. Or, la faiblesse de l'offre est ici aggravée par celle de la demande. Une grande partie de la main-d'œuvre est non qualifiée ou faiblement qualifiée et le déficit en compétences de management dont souffre une grande majorité d'entreprises entrave leur capacité à adopter les technologies. Il signifie aussi qu'elles ne sont pas prêtes à prendre les risques qu'exige l'innovation. Cette

situation appelle un effort de grande ampleur pour développer des programmes de formation et des mesures pour inciter le secteur privé à s'y intéresser.

La politique d'innovation du Pérou devrait accompagner et aider *l'évolution des structures et la diversification* et réduire la dépendance du pays aux activités basées sur les ressources naturelles au profit de productions à plus forte intensité de savoir dans des pôles d'activités où le Pérou possède ou peut développer des avantages comparatifs et concurrentiels du fait des ressources naturelles dont il dispose et de ses liens avec l'amont ou l'aval dans les industries extractives et énergétiques, notamment dans les services, comme l'ont fait des pays comme le Chili et l'Afrique du Sud.

Il faudrait mettre l'accent sur certains *programmes de R-D et d'innovation axés sur des missions spécifiques* mis en place en partenariat ou en collaboration avec des instituts publics de recherche et le secteur privé. Compte tenu des limites du pays en termes de ressources et de capacités, ces programmes devraient porter uniquement sur des domaines où le Pérou détient des avantages concurrentiels grâce à ses ressources naturelles (tels l'utilisation des biotechnologies pour la préservation et l'exploitation durable de la biodiversité, l'exploitation minière respectueuse de l'environnement) ou qui peuvent l'aider à répondre à des besoins de sa société (par exemple dans les domaines de la santé ou de la restauration de la qualité des eaux et de l'environnement). La coopération internationale doit être poursuivie activement pour le développement de programmes de ce type.

L'innovation ne peut prospérer que s'il existe, d'une part *des infrastructures physiques modernes* en quantité suffisante – *communications, logistique et transports* – et d'autre part une infrastructure technologique véritablement accessible pour les services tels que la métrologie, la certification, la normalisation et la gestion de la propriété intellectuelle. Ces infrastructures ont besoin d'être renforcées au Pérou, pour les premières en ouvrant éventuellement la participation au secteur privé, et pour les secondes en donnant davantage de moyens aux institutions concernées et en les rendant plus accessibles aux PME.

Compte tenu de ces orientations, les politiques gouvernementales doivent suivre un certain nombre de *principes clés*.

D'abord, étant donné le large éventail des questions qui influent sur la performance d'innovation et la pluralité des ministères concernés, il faudrait de plus en plus privilégier une approche pangouvernementale dans l'élaboration de la politique d'innovation. Cette approche aurait d'importantes conséquences sur l'efficience des mécanismes de gouvernance.

Deuxièmement, il est important d'éviter les configurations institutionnelles et réglementaires qui entravent les investissements liés à l'innovation, les transferts de ressources publiques vers le secteur privé et la collaboration entre secteurs public et privé. Les cadres institutionnels et réglementaires doivent être revus pour répondre aux besoins des politiques de l'innovation.

Troisièmement, il est important que la gouvernance soit efficace. Il faut pour cela établir certaines conditions qui ne sont pas réunies actuellement au Pérou :

- *Un engagement politique fort* des pouvoirs publics aux niveaux décisionnels les plus élevés afin que les activités STI bénéficient de dotations budgétaires suffisantes par l'intermédiaire des départements ministériels ou des établissements publics autonomes dont elles relèvent ;

- *Des processus de construction de consensus efficients* entre les départements ministériels concernés et les principales institutions pertinentes pour l'établissement des grandes orientations et priorités des politiques scientifique, technologique et d'innovation, ainsi qu'une bonne coordination interministérielle pour leur exécution ;
- *La coordination des politiques.* Le manque de coordination des politiques et l'inertie des institutions signifient que les orientations établies ne sont pas traduites sous forme d'une panoplie de mesures pertinente face aux nouveaux défis, aux nouveaux besoins des acteurs du système d'innovation et à leurs interactions.
- *Une délimitation claire des fonctions des institutions.* La séparation entre formulation et exécution des politiques doit être claire. Ces deux fonctions requièrent des compétences différentes et doivent être soumises à des circuits de responsabilité différents. Leur confusion peut donner lieu à des conflits d'intérêt.
- *Imputabilité et évaluation.* L'évaluation régulière des programmes d'aide et institutions qui reçoivent des fonds publics doit être la norme, et elle doit avoir des répercussions concrètes sur les dotations ultérieures. Cela étant, il importe de trouver le bon équilibre entre la nécessité de procéder à des ajustements périodiques consécutifs aux évaluations et celle d'assurer une certaine stabilité des programmes de soutien, condition qui garantit leur impact prolongé sur le comportement des bénéficiaires.
- *Suivi de la performance du système d'innovation.* A un niveau plus large, une bonne gouvernance nécessite un système d'information qui produit de manière continue des statistiques et des indicateurs comparables internationalement. Cela permet de suivre les performances du système d'innovation et de les comparer aux objectifs quantitatifs de l'action publique et aux performances des autres pays. A cet égard, le Pérou est en retard par rapport aux pays de l'OCDE et à la plupart des autres pays d'Amérique latine.

L'utilisation efficiente des fonds publics pour répondre aux problèmes économiques et sociaux est un principe de bonne gestion budgétaire. Le développement scientifique et technologique est en concurrence pour l'obtention des ressources publiques avec d'autres postes d'investissement, dans des domaines souvent perçus comme relevant d'une priorité plus grande ou plus immédiate, particulièrement dans les pays en développement, où la nécessité de lutter contre la pauvreté et de développer les infrastructures sociales et économiques met les budgets à rude épreuve. L'affectation de ressources aux politiques scientifique et technologique entraîne un coût d'opportunité, et la légitimité de ces dépenses pour pallier les défaillances du marché et du système doit être justifiée au moyen d'une comptabilité fiable des rendements économiques et sociaux attendus, complétée par des évaluations *a posteriori*. Les effets multiplicateurs de l'investissement public sur l'investissement privé peuvent représenter à cet égard des signaux forts.

Voici les aspects les plus importants pour la bonne *exécution des politiques* :

- *Fonctionnalité opérationnelle : consolidation du système d'aides.* Il s'agit de veiller à ce qu'il n'y ait pas de chevauchements inutiles entre agences d'exécution au niveau de l'objet des programmes de soutien, de faire en sorte que ces agences se concentrent sur leurs compétences de base, réduisent leurs coûts de gestion et de transaction et évitent la duplication de programmes et les programmes n'atteignant pas la masse critique. C'est là un problème au Pérou.

- *Instruments de financement.* Les programmes et les projets peuvent être financés de diverses manières. Pour les fonds d'innovation destinés aux projets du secteur privé, l'abondement doit être le mécanisme privilégié. Il peut être complété par des dispositifs tels que l'octroi de garanties, qui permettent d'obtenir des contributions des établissements financiers. Le montant des subventions doit être établi en tenant compte des risques d'évincement de l'effort privé et d'effet d'aubaine. S'agissant des règles régissant le financement des programmes ou des projets, il faut systématiquement envisager d'accorder un avantage (octroi prioritaire ou niveau plus élevé de la subvention) aux initiatives partenariales. Dans la recherche publique, l'évaluation de la performance doit être le critère qui détermine le volume du financement des institutions. Ce n'est pas encore le cas au Pérou.
- *Gestion et exécution*. Les critères d'admissibilité des dépenses d'innovation doivent être clairs et restrictifs. Des procédures bien conçues, professionnelles et rapides doivent être établies pour la sélection des projets présentés dans le cadre de programmes d'aide. Cela nécessite des processus d'exécution rationnels, dénués de formalités administratives inutiles, et la constitution de panels comportant des experts capables d'évaluer la pertinence scientifique ou technologique des projets, mais aussi leur viabilité commerciale. On veillera aussi à intégrer des experts étrangers dans les panels. L'évaluation des programmes de soutien doit faire partie intégrante de leur conception, et l'évaluation des performances des agences d'exécution doit être régulière.

Recommandations

Amélioration de la gouvernance et réforme des institutions

L'absence d'une structure de gouvernance effective accentue la fragmentation du système d'innovation du Pérou et se traduit par une utilisation peu efficiente des ressources publiques. L'établissement de bons mécanismes de gouvernance est une nécessité absolue. Cela pourrait passer par des réformes législatives et institutionnelles. Il existe plusieurs approches, inspirées par les pratiques de différents pays, que le Pérou pourrait adopter en tenant compte de ses caractéristiques nationales, mais aucune n'apportera les améliorations attendues si un certain nombre de conditions préalables ne sont pas remplies. Ces conditions sont les suivantes : respect des principes de bonne gouvernance énoncés précédemment, en particulier engagement politique, processus formels de coordination interministériels et fonctionnalité institutionnelle ; sauvegarde des programmes de soutien efficaces déjà en place.

Voici trois options possibles pour la structure générale de gouvernance.

a) Un nouveau ministère de la science, de la technologie et de l'innovation

Au Pérou, la création d'un tel ministère est appelée de ses vœux par le CONCYTEC et par une fraction importante de la communauté universitaire. Les deux principaux arguments avancés sont les suivants :

- Un statut ministériel, en garantissant une participation directe aux discussions budgétaires, permettrait plus facilement d'accroître des dotations budgétaires des institutions scientifiques et technologiques, des programmes et des activités de soutien.

- Un ministère pourrait assurer le pilotage du système STI. En principe, il serait mieux placé que le CONCYTEC pour assurer la coordination et la cohérence des politiques et réduire la fragmentation du système.

Ces arguments ne sont pas sans fondement mais ils apparaissent fragiles, et ce pour deux raisons. D'abord, on ne peut pas poser que l'existence d'un ministère STI garantira à elle seule une augmentation nette des ressources totales consacrées aux activités de STI. Deuxièmement, l'expérience montre que la voie ministérielle est surtout efficace lorsque le ministre participe (parfois à titre de premier parmi ses pairs) à un organe de coordination interministériel avec d'autres départements ministériels. Un tel organe supervise les politiques susceptibles d'avoir un impact sur la performance en matière d'innovation, et il existe une séparation claire entre la conception des politiques et leur mise en œuvre. Ce n'est pas le cas au Pérou, où seuls la Présidence du conseil des ministres (PCM) et le Ministère de l'économie et des finances (MEF) ont le pouvoir de piloter la coordination interministérielle et les dotations budgétaires.

Si le gouvernement envisageait cette option, il faudrait s'assurer que le nouveau ministère soit en mesure d'assurer effectivement ses fonctions de pilotage, de coordination et d'intégration.

b) Conception horizontale des politiques avec une agence d'exécution principale

Dans cette option, une agence gouvernementale décentralisée est formée, pour jouer le rôle de bras armé d'une instance gouvernementale à haut niveau investie de responsabilités de coordination interministérielle pour la conception et la mise en œuvre des politiques. D'une certaine manière, cette option est formellement la même que celle envisagée par la loi de 2004 sur la science et la technologie, qui a placé le CONCYTEC sous l'égide du PCM.[8] Mais pour qu'elle puisse fonctionner, il faudrait de nouveaux mécanismes de gouvernance, afin d'éviter un échec dû à l'inapplicabilité *de facto* de la loi de 2004. A savoir :

- Un rôle véritablement moteur du PCM ou du MEF dans le pilotage de l'instance de coordination interministérielle, notamment pour la définition des priorités et leur traduction en dotations budgétaires.
- Une refonte du CONCYTEC afin qu'il devienne l'organe exécutif de l'instance interministérielle ; le CONCYTEC aurait compétence dans la conception des politiques et leur évaluation.
- Une réelle participation à la coordination de ministères sectoriels tels que PRODUCE et des ministères de l'agriculture, de la santé, de l'éducation, de l'environnement, de l'énergie et des mines, des transports et des télécommunications. Ces ministères seraient responsables du financement et de l'évaluation des programmes de soutien et/ou des institutions sectorielles chargées de la mise en œuvre des politiques.
- Une coopération effective entre le CONCYTEC et les ministères sectoriels dans la conception et le financement des programmes sectoriels.
- Un « nouveau » CONCYTEC vraiment capable de gérer les programmes de soutien avec la même efficacité que le FINCYT, et la suppression des programmes du CONCYTEC faisant double emploi avec des programmes du FINCYT.

Cette option devrait, en principe, être réalisable. En pratique, son succès dépendra fortement de la capacité des institutions à surmonter les rivalités héritées du passé autour des compétences et des ressources. Dans le contexte actuel au Pérou, il pourrait s'avérer difficile de métamorphoser le CONCYTEC et de lui donner une « nouvelle » mission qu'il n'a pas su remplir dans le cadre de la loi de 2004 sur la science et al technologie.

c) Une conception coordonnée des politiques et un système d'agences d'exécution réparties

Cette troisième option s'inspire de structures de gouvernance qui ont fait leurs preuves au Chili. L'organe interministériel qui chapeaute le processus de gouvernance est directement chargé de hiérarchiser les priorités, de définir les orientations stratégiques et les dotations budgétaires. Dans ce dispositif, il n'existe pas d'agence d'exécution principale. Les ministères sectoriels qui participent au processus de coordination assurent la supervision et le financement des agences décentralisées chargées de l'exécution des politiques. Dans le cas du Pérou, cela nécessiterait :

- Une loi portant création d'un Comité interministériel pour la science, la technologie et l'innovation. Ce comité pourrait réunir le PCM, les ministères de l'économie et des finances, de la production, de l'éducation de l'agriculture, de la santé, de l'énergie et des mines, des transports et des télécommunications. Il pourrait être présidé ou piloté par le PCM ou le MEF, l'un et l'autre étant dotés de responsabilités interministérielles. Étant donné le rôle du MEF dans l'attribution des budgets, la supervision des investissements publics et les cadres réglementaires, ce ministère pourrait être le mieux placé pour assurer la présidence du Comité.
- Le CONCYTEC resterait sous l'égide du Ministère de l'éducation. Grâce à des moyens accrus et à des capacités managériales améliorées, il aurait des compétences équivalentes à celle du CONICYT au Chili dans le soutien à la recherche scientifique et au développement technologique (infrastructures comprises) à travers le financement des établissements de recherche, l'octroi de bourses de recherche, le développement des ressources humaines et l'évaluation des EPR.
- Le MEF et le PRODUCE auraient la responsabilité partagée des fonds d'innovation destinés au secteur privé et à la diffusion et au transfert de technologies.
- Les EPR continueraient de dépendre des différents ministères de tutelle, et compteraient un représentant du CONCYTEC dans leur Conseil d'administration. Ce dernier serait chargé de la conception et du suivi du contrat d'objectif de l'établissement.

Comme au Chili, le Comité pourrait être assisté d'un conseil consultatif restreint sur la science et la technologie comportant un petit nombre de représentants d'EPR, d'universités publiques et privées et d'entreprises. Ce conseil consultatif aurait pour fonction de proposer les orientations stratégiques, de présenter de nouveaux instruments de politiques, de regrouper les programmes d'aide et de réformer les réglementations qui entravent la performance d'innovation. Il pourrait aussi être chargé de l'évaluation des politiques et d'un système d'information pour suivre en continu les performances du système d'innovation.

Cette dernière option paraît la plus adaptée aux besoins actuels du Pérou. Elle présente plusieurs avantages : *i)* elle entérine l'engagement à haut niveau envers la science et la technologie, en confiant la responsabilité de la gouvernance à un organe interministériel, évitant ainsi le risque de mainmise par une agence d'exécution principale : *ii)* elle limite au minimum le risque de chevauchement entre les responsabilités des différentes agences d'exécution ; *iii)* elle permet d'exploiter les complémentarités entre établissements et la coopération sur la conception et la mise en œuvre des politiques.

Quelle que soit l'option retenue *in fine,* la mise en place d'une nouvelle gouvernance posera des problèmes de transition pour gérer certains programmes d'aide en cours. On pense en particulier aux programmes financés par des organismes de financement multilatéraux, étant donné leur importance dans l'architecture actuelle des politiques scientifiques et technologiques et leurs performances généralement satisfaisantes. S'agissant de l'INCAGRO, ce programme a déjà été placé sous l'égide de l'Institut national pour l'innovation agricole (ITIA). Si la qualité de sa gestion était maintenue, ce qui est loin d'être garanti, cette décision correspondrait au mode de gouvernance préconisé. Pour le FINCYT, nous recommandons qu'il reste pendant plusieurs cycles sous la tutelle du MEF, qu'il conserve sa direction et ses procédures de suivi ou les améliore si les obstacles réglementaires peuvent être levés ou atténués. Enfin, le FINCYT devrait s'occuper essentiellement des programmes de soutien à l'innovation privée, et fusionner avec le FIDECOM.

Recommandations spécifiques

On trouvera ci-dessous une synthèse des recommandations du présent rapport ainsi que d'autres qui découlent implicitement de l'évaluation du système d'innovation du Pérou et des faiblesses dont il souffre du fait des politiques publiques et du paysage institutionnel.

Enseignement supérieur et ressources humaines

- Accélérer l'établissement d'un processus d'accréditation aligné sur les normes internationales sur l'ensemble du système d'enseignement supérieur (universités et instituts supérieurs de technologie).
- Engager une réforme de la gouvernance universitaire qui valorise l'excellence dans la recherche et facilite la rétention et la promotion des plus qualifiés. Mener cette réforme par le biais du financement institutionnel des universités publiques et évoluer vers les modèles axés sur les performances comme dans de nombreux pays de l'OCDE. Dans ces modèles, le financement des établissements est lié à des critères d'excellence, et une part croissante des ressources des activités scientifiques et technologiques prend la forme de subventions octroyées sur concours et de services de recherche et de développement technologique.
- Encourager la participation aux réseaux internationaux de recherche par le biais de bourses de recherche postdoctorale octroyées dans le cadre d'accords de coopération internationale dans les domaines prioritaires pour le Pérou.
- Avec la participation de l'INDECOPI, favoriser le développement de pratiques de gestion des DPI dans le secteur de l'enseignement supérieur, en priorité dans les établissements ayant le meilleur potentiel scientifique et technologique.

- Réformer la loi *canon minero* en élargissant la notion d'investissement public pour y intégrer le capital humain. Faciliter l'accès des universités régionales aux ressources du *canon minero* pour les projets de R-D en collaboration avec d'autres universités ou des entreprises privées, ou d'autres dépenses afin d'accroître leurs capacités scientifiques et technologiques (bourses doctorales et postdoctorales ; retour des chercheurs expatriés).
- Éliminer les obstacles universitaires administratifs (équivalences de crédits) qui empêchent les diplômés des instituts supérieurs technologiques de poursuivre leurs études en troisième cycle universitaire.
- Envisager une nette augmentation des bourses de troisième cycle pour les universités nationales et étrangères.
- Offrir des incitations (assorties de délais d'extinction) aux entreprises pour le recrutement de diplômés du troisième cycle dans les disciplines scientifiques et technologiques.
- Assouplir les réglementations qui empêchent des chercheurs des universités publiques de participer ou de contribuer à des activités ou projets scientifiques ou technologiques d'entreprises privées et, plus généralement, qui entravent la mobilité des chercheurs.
- Mettre au point des programmes susceptibles d'attirer des scientifiques étrangers ou expatriés compte tenu de l'expérience qu'ils ont acquise dans d'autres pays.

Établissements publics de recherche (EPR)

- Définir les critères associés au statut d'établissement public de recherche (proportion de personnel scientifique et technologique dans l'effectif total, par exemple) ; adapter leur statut juridique aux pratiques d'autres pays d'Amérique latine ou de l'OCDE, dans la mesure où les institutions et lois du Pérou le permettent, afin d'accroître leur autonomie de gestion, notamment en ce qui concerne les ressources humaines, et réduire les effets pervers liés à la rigidité des lois du travail et aux contrats à court terme pour les chercheurs qualifiés.
- Réformer la gouvernance des EPR de manière à ce qu'ils remplissent avec efficience leur mission fondamentale dans la recherche, le développement et la diffusion des technologies. Élargir leurs conseils d'administration à des représentants des principales parties prenantes. Responsabiliser les acteurs, passer des contrats d'objectifs – avec une incidence sur le volume du financement des établissements – et établir des objectifs pour le partage des fonds issus des concours, contrats et ventes de services technologiques. Les contrats d'objectifs doivent prévoir des perspectives ou des engagements provisoires concernant le retour sur investissement attendu de projets collaboratifs et de la vente de services, ainsi que, le cas échéant, des indications sur les perspectives de collaboration internationale.
- Développer les capacités managériales des DPI en collaboration avec l'INDECOPI.

- Envisager une restructuration du système des EPR par la dissolution, la fusion ou la privatisation partielle de certains de ces établissements, en fonction de la satisfaction des contrats d'objectifs sur plusieurs années et des économies d'échelle ou de gamme envisageables.
- Encourager l'élaboration d'un consortium formel d'EPR dans l'objectif de promouvoir les programmes ou projets de recherche multidisciplinaires et de faciliter la mobilité du personnel.
- Envisager l'utilisation de ressources du *canon minero* par le biais de collaborations avec les universités qui en bénéficient.
- Prévoir des incitations à la mobilité du personnel scientifique et technologique des EPR vers le secteur privé et *vice versa,* et faciliter ou accroître les contrats des doctorants en entreprise privée par le biais de bourses CONCYTEC et de bourses de recherche postdoctorale.
- Encourager les EPR à participer à des projets internationaux de recherche, en particulier dans le cadre de projets ciblés en collaboration avec des établissements de recherche d'autres pays de la région et du reste du monde.

Promotion de l'innovation dans le secteur des entreprises

- Accroître la participation du secteur des entreprises à la gouvernance du système d'innovation et à la définition des orientations stratégiques et des priorités d'action.
- S'intéresser davantage aux freins à l'innovation dus aux goulets d'étranglement ou aux déficiences des infrastructures physiques (transport, technologies de l'information et de la communication, logistique) dont pâtissent non seulement l'infrastructure scientifique et technologique, mais aussi l'ensemble des secteurs (métrologie, normes, EPR) et qui touchent en particulier les PME.
- Accroître la capacité de l'INDECOPI à améliorer la protection des DPI et des lois sur la concurrence, à établir une culture de la propriété intellectuelle et à renforcer les capacités de gestion des DPI des entreprises.
- Maintenir les programmes axés sur la chaîne de valeur élaborés par les ministères PRODUCE et MINCETUR.
- Remédier aux facteurs qui entravent la création et l'émergence de nouvelles entreprises technologiques. Envisager d'ajouter des dispositifs d'aide spécifiques aux fonds d'innovation existants ; réaliser une évaluation des obstacles à l'entrepreneuriat et engager des réformes à la lumière de cette évaluation.
- Adopter une politique de marchés publics pour promouvoir l'innovation dans les secteurs pour lesquels la demande sociale est forte (santé, énergie, transports, environnement, éducation).
- Réexaminer les régimes réglementaires applicables au transfert de ressources publiques au profit du secteur privé compte tenu de la propension de ces transferts de favoriser les activités scientifiques, technologiques et d'innovation dans les entreprises.

- Pour les dotations en provenance des fonds d'innovation, continuer de donner l'avantage aux projets en collaboration entre secteurs public et privé (à l'initiative de la base).
- Envisager des programmes de soutien ciblés sur une mission ponctuelle ou un secteur (à l'initiative des autorités de tutelle) reposant sur des accords de collaboration entre secteurs privé et public et conditionnés à l'abondement des ressources par les entreprises, des EPR et éventuellement des collectivités locales. Utiliser cet instrument pour favoriser l'émergence de pôles d'innovation. Sélectionner les programmes en fonction de critères liés à l'intérêt national et aux ressources naturelles, susceptibles d'apporter des avantages concurrentiels (par exemple le domaine de la biodiversité).
- Lever ou réduire les obstacles à la collaboration entre les EPR et le secteur privé ; faciliter les accords contractuels.

Institutions intermédiaires

- Envisager un développement plus ambitieux des CITEs (Centres d'innovation technologique) en termes de couverture sectorielle et de capacité scientifique et technologique en recherche appliquée, afin qu'ils répondent mieux aux besoins des entreprises ayant un potentiel d'innovation ; développer la capacité technologique d'un plus large ensemble d'entreprises ou d'organisations présentant un retard dans ce domaine ; offrir des services de formation à ces entreprises.
- Renforcer les établissements qui fournissent des éléments incorporels d'infrastructure scientifique et technologique (informations technologiques, DPI, métrologie, certification, normes) et faciliter l'accès à leurs services et à leur propriété intellectuelle.

Réforme des cadres législatif et réglementaire

- Réviser le code des impôts et fixer des règles claires qui autorisent l'amortissement des frais de R-D.
- Dans la loi sur la fonction publique et les règles qui régissent les Contrats de services administratifs, envisager l'ajout de dispositions répondant aux caractéristiques propres aux activités scientifiques et technologiques.
- Réviser les lois du travail applicables à la recherche publique qui font obstacle à la mobilité des chercheurs et, plus généralement, les lois et règlements qui imposent des restrictions aux collaborations entre public et privé.
- Réexaminer et réviser les procédures du Système national d'investissements publics (SNIP) qui s'appliquent aux investissements dans la R&D et l'innovation (ou aux aides publiques à ce type d'activité). S'agissant de l'application des procédures SNIP aux projets du Fonds pour l'innovation, il serait souhaitable de généraliser les règles en vigueur pour le FINCYT.

Tableau synthétique : analyse AFOM (atouts, faiblesses, opportunités, menaces) du système d'innovation du Pérou

Atouts	Faiblesses
• Un environnement macroéconomique sain et stable • Des industries fortes axées sur les ressources naturelles et tournées vers l'exportation • L'existence d'un certain nombre de programmes bien conçus et bien gérés d'abondement (fonds) qui soulignent l'existence d'un potentiel latent de R-D, de science, de technologie et d'innovation et catalysent des activités de recherche, de développement et d'innovation (RDI) • Des institutions performantes de transfert de technologies (les CITEs) • Des pôles d'excellence en recherche scientifique • L'existence d'entreprises fortes développant des modèles économiques innovants • Les bonnes performances de certains établissements d'enseignement et de formation professionnelle	• Un niveau historiquement bas d'investissement public et privé dans les activités de RDI • L'absence de mécanismes de gouvernance efficaces, qui ouvre la voie à des conflits de compétences et d'accès aux ressources entre établissements • L'absence de connexion entre planification et dotations budgétaires • La faiblesse du système d'information, de suivi et d'évaluation, le manque de données sur les activités et les ressources STI • Les effets pervers des lois et des réglementations régissant l'investissement public en activités STI • La lourdeur des procédures administratives • La faiblesse des performances de la R-D et la gouvernance déficiente de la plupart des établissements des systèmes publics de recherche et universitaire. • La mauvaise articulation entre le secteur des entreprises et les EPR • La faiblesse de la culture et des capacités de gestion de la propriété intellectuelle dans les secteurs éducatifs public et privé, et dans l'enseignement supérieur. • Une offre limitée et une faible mobilité des ressources humaines scientifiques et technologiques • Une capacité d'absorption généralement faible dans la majorité des PME, et l'importance du secteur informel • La faible performance du système éducatif et la prépondérance des études non scientifiques et technologiques dans le troisième cycle • Le manque de diversité de la structure de production, qui limite les possibilités de transmission interdisciplinaire des technologies • Le peu de profondeur des pôles (clusters) axés sur les ressources naturelles • La formalité excessive et la faible efficience de la coordination centrale et régionale des programmes d'investissement et de soutien à la RDI • L'inadaptation des marchés de capitaux aux investissements ayant trait à l'innovation • Le retard d'investissement dans les infrastructures …/…

Tableau synthétique : analyse AFOM (atouts, faiblesses, opportunités, menaces) du système d'innovation du Pérou *(suite)*

Opportunités	Menaces
• Une meilleure sensibilisation de la classe politique au rôle des pouvoirs publics dans le soutien à l'innovation • La prise de conscience du secteur privé de l'importance de l'investissement dans l'innovation • Le soutien continu des organismes de financement multilatéraux à la R-D et aux programmes d'aide à l'innovation • La multiplication des retombées technologiques de l'investissement direct étranger • Une plus large exploitation des ressources agroindustrielles et de biodiversité rendue possible par l'innovation • Un meilleur développement des pôles et un engagement accru des PME dans la chaîne de production	• La volatilité inhérente aux marchés d'exportation traditionnels axés sur les ressources naturelles • Un risque de transmission insuffisante des technologies à travers la structure de production faute de programmes d'accompagnement volontaristes. • Des rigidités institutionnelles qui empêchent l'expérimentation dans l'élaboration et l'exécution des politiques publiques ou aboutissent à des phénomènes de captation par des institutions inefficientes • Un risque de conflits liés à une endogénéisation des programmes d'aide partiellement financés par les organismes de financement multilatéraux • La pénurie de personnel scientifique et technologique hautement qualifié

Gestion de la transition

Il y a lieu de se préoccuper de l'avenir des fonds et programmes d'innovation qui bénéficient de crédits émanant d'organismes de financement multilatéraux tels que INCAGRO et FINCYNT. L'importance de ces organismes dans la promotion des capacités scientifiques et technologiques et de la performance d'innovation du Pérou est indéniable. Leur succès s'explique par une multitude de raisons, notamment :

- D'abord, ils ont favorisé l'émergence d'une demande latente de recherche et de développement technologique, et, mieux que tout autre type de programme entrepris jusqu'à présent, ils contribuent à développer la capacité scientifique et technologique dans toute l'économie, tant dans le secteur public que dans le secteur privé.
- Deuxièmement, leur structure et les objectifs répondent bien aux faiblesses reconnues du système d'innovation du Pérou.
- Enfin, ils bénéficient d'une gestion et d'un fonctionnement efficients, malgré les nombreux obstacles réglementaires et parfois institutionnels auxquels ils sont confrontés.

Encore une fois, il serait souhaitable de maintenir le FINCYT et l'INCAGRO pendant un certain nombre de cycles, en conservant les mêmes règles, la même direction et les mêmes procédures de suivi, voire en les améliorant si certains obstacles réglementaires peuvent être levés ou atténués. A plus longue échéance, ces fonds et programmes devront être financés par le Trésor public du Pérou. Dans ce cas, leur structure, leur centrage et leur direction pourront être modifiés pour accompagner la transformation évoquée précédemment des formes de gouvernance.

Notes

1. Comprenant une partie de l'impôt sur les sociétés et les redevances versées par les sociétés minières, de pétrole, de gaz, d'hydroélectricité, de sylviculture et de pêche.
2. D'après l'enquête ENCYT sur les enterprises ayant un chiffre d'affaires supérieur à 30 000 USD (CONCYTEC, 2010).
3. Dans les pays les plus avancés et les pays en développement, les centres de technologie ont développé des capacités internes de R-D et ont élargi leur portefeuille de services. Cela vaut également pour la Colombie.
4. Le dispositif s'est révélé plus compliqué à mettre en œuvre pour l'INCAGRO que pour le FINCYT.
5. L'article 37 de la législation fiscale (*Ley de Impuesto a la Renta*) définit les dépenses qui peuvent venir en déduction des bénéfices. Dans le cas des coûts liés à l'innovation, l'entreprise doit apporter la preuve que ces dépenses sont « nécessaires pour produire et entretenir la source de profits ». La possibilité d'amendes dans le cas où l'argumentation ne serait pas acceptée par les inspecteurs des impôts conduit les entreprises à ne pas déduire ces dépenses.
6. INCAGRO a joué un rôle positif dans le pilotage du « système d'innovation agricole », et le FINCYT a fait de même pour le système global d'innovation. En dépit de leur succès, ces programmes manquent de la légitimité institutionnelle pour mener un processus participatif de pilotage.
7. Cependant, si la décision d'accorder une si vaste mission au FINCYT n'était pas la meilleure solution, elle était la plus appropriée.
8. Ce modèle de gouvernance est à peu près le même qu'au Mexique, où le CONACYT est une agence décentralisée qui dépend de la Présidence de la République. Outre le CONACYT, plusieurs ministères sectoriels ont des responsabilités importantes dans l'élaboration des politiques scientifiques et technologiques et le financement des établissements de S&T et des programmes d'aide.

Références

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Estudio de la OCDE de las políticas de innovación de Perú: Evaluación general y recomendaciones

Mantener la recuperación: buscando fortalecer el rol de la innovación en el desarrollo económico de Perú

La sólida recuperación de la última década…

Durante la última década, el Perú ha logrado un crecimiento económico excepcional. Con un crecimiento anual promedio de 6,3% en el PIB y 4,5% en el PIB per cápita, ha sido uno de los actores económicos latinoamericanos de mejor desempeño. Pudo sortear la crisis económico-financiera reciente y en 2010 registró una sólida recuperación. Este excelente desempeño estuvo fundamentado en políticas macroeconómicas sanas, reformas estructurales dirigidas a mejorar el funcionamiento de los mercados de bienes y de mano de obra y una apertura de la economía al comercio internacional y la inversión extranjera. Estas políticas han fomentado la inversión, la productividad y la generación de empleo. Asimismo, han permitido que el Perú aproveche sus ventajas comparativas en los sectores de recursos naturales y en las industrias tradicionales, logrando cosechar los beneficios de una creciente demanda tanto en economías desarrolladas como en mercados emergentes. Estas políticas también han comenzado a tener efectos positivos, aunque moderados, sobre los niveles de vida y la reducción de la pobreza.

…no debe llevar a la complacencia

Sin embargo, Perú continúa rezagado con respecto a la mayoría de los demás países latinoamericanos en materia de ingreso per cápita e inversión en capital humano y conocimiento. Su economía sigue siendo relativamente poco diversificada. Existen grandes disparidades de ingreso y el empleo informal aún representa una porción significativa del empleo global. Aunque la productividad de la mano de obra ha crecido desde 2003, continúa rezagada con respecto a la de otros países latinoamericanos de ingresos medios. El papel jugado por el crecimiento de la productividad total de factores (PTF) – el cual refleja un uso más eficiente de insumos de factores, incluyendo la generada por procesos de innovación – ha sido marginal. Aunque la asignación más eficiente de recursos ocasionada por las reformas estructurales ha tenido efectos positivos, el crecimiento económico ha estado asociado principalmente a la formación de capital y a mayores insumos de mano de obra.

Durante la última década las exportaciones peruanas se han cuadruplicado; sin embargo, la especialización de sus exportaciones y su competitividad internacional siguen dependiendo esencialmente de sus ventajas comparativas en productos básicos vinculados a recursos naturales y de costos laborales relativamente bajos; la participación de los productos no tradicionales en las exportaciones totales se redujo de 29% en 2002 a 21% en 2010. En el futuro Perú probablemente enfrentará más competencia de países con ventajas comparativas similares. Sus exportaciones basadas en recursos naturales enfrentan las incertidumbres de la demanda mundial y una alta volatilidad en los precios de productos básicos.

Para combatir las debilidades que amenazan la sostenibilidad…

El mejoramiento de la productividad en la economía en su conjunto y la diversificación de actividades económicas hacia productos y exportaciones de mayor valor agregado son dos desafíos cruciales para la sostenibilidad del crecimiento y desarrollo de Perú a mediano y largo plazo. Son también necesarios para alcanzar la inclusión, principalmente mediante la creación de más empleos calificados, la reducción del empleo informal y el alivio de la pobreza. Estos objetivos requieren la implementación de estrategias y políticas públicas basadas en un examen exhaustivo de posibles fuentes y modelos de crecimiento en un entorno global cambiante. El rezago en la productividad de la mano de obra indica que existe mucho potencial de mejoría, y una mayor inversión en activos de conocimiento para ampliar la capacidad de innovación de Perú podría contribuir a mantener el impulso del crecimiento. Esta es una tarea de política pública que debe abordarse de manera urgente, ya que la concreción de resultados en este tipo de inversión toma tiempo y contribuirá a determinar los futuros niveles de competitividad del sector empresarial.

En Perú, al igual que en muchos países en desarrollo, una preferencia por el uso de tecnología importada en desmedro del desarrollo de capacidades propias de innovación ha impedido el desarrollo de capacidades de absorción y limitado la difusión de tecnologías mediante el comercio internacional y la inversión extranjera. Los sectores minero y agroindustrial de exportación están entre los más tecnológicamente avanzados del país, pero generan muy poca difusión de tecnología. Además, la falta de diversidad en la producción y exportación limita el surgimiento de cadenas de valor fundamentadas en capacidades tecnológicas y reduce las oportunidades de aprendizaje.

A diferencia de países desarrollados como Australia y Noruega o economías emergentes como Brasil y Sudáfrica, donde los recursos naturales también contribuyen considerablemente al crecimiento de las exportaciones y los ingresos, Perú ha sido relativamente menos capaz de aprovechar su base de recursos para diversificarse hacia industrias aguas arriba y aguas abajo o desarrollar servicios que eleven la eficiencia y sostenibilidad de la explotación de sus sectores basados en recursos naturales. Esto se debe en parte a la debilidad de los incentivos al sector empresarial para invertir en dichas actividades, pero está asociado también a la escasez de recursos humanos calificados para desarrollar tecnologías intermedias o avanzadas en actividades aguas arriba y aguas abajo vinculadas a los sectores minero y energético, o para la explotación sostenible de los enormes recursos de biodiversidad del país.

...es necesaria la innovación como motor del crecimiento

La experiencia de países desarrollados y emergentes exitosos indica que un papel gubernamental más proactivo en la promoción de la innovación puede contribuir a que Perú desarrolle nuevas ventajas competitivas y reduzca las restricciones que obstaculizan este proceso. Medidas para incentivar la innovación y contribuir a dar respuesta a desafíos sociales son un complemento para políticas macroeconómicas estables y marcos de referencia institucionales sólidos, y pueden llevar a una vía de crecimiento más sostenible y menos vulnerable ante sacudidas externas. Una vía de este tipo puede fomentar el crecimiento y la inclusividad mediante incrementos de productividad generados por inversiones asociadas con la innovación, incluyendo inversiones en capital humano, mediante la difusión tecnológica y a través de las ventajas competitivas que ofrece tener una economía más diversificada. Este camino ha sido seguido por países con dotaciones de recursos tan diversos como Finlandia, Corea y Noruega, y, más recientemente, por economías emergentes como China, Brasil y Chile, y algunos de ellos lo han hecho muy exitosamente. A diferencia de Perú, durante la última década esos países elevaron su inversión privada y pública en ciencia, tecnología e innovación (CTI). En Perú ha ocurrido, por supuesto, cierta diversificación en años recientes, particularmente en el sector agrícola no tradicional, donde las exportaciones crecieron de US$ 0,39 mil millones en 2000 a US$ 1,9 mil millones en 2010. Al menos parte de este éxito puede atribuirse a políticas públicas para apoyar la innovación y la transferencia de tecnología en ese sector. Para aprovechar mejor las nuevas fuentes de crecimiento será necesario implementar reformas adicionales en materia institucional y de política pública.

El sistema de innovación de Perú: principales debilidades y desafíos de política pública

A diferencia de otros países latinoamericanos, y a pesar de una tradición académica bien consolidada, en los años sesenta y setenta Perú perdió casi enteramente la oportunidad de desarrollar una infraestructura pública sólida de ciencia y tecnología (C&T) en su sistema universitario o sus institutos públicos de investigación (IPI). En consecuencia, su "oferta" de C&T ha sido insuficiente. Las dotaciones de recursos de estas instituciones y su desempeño en términos de generación y difusión de conocimiento fueron con frecuencia extremadamente limitados. Perú sigue sufriendo las consecuencias de esta situación, la cual a menudo se ve exacerbada por una gobernanza deficiente de los IPI.

Además, los cambios de política económica ocurridos durante varios ciclos políticos consecutivos estuvieron acompañados por ajustes, a veces drásticos, en el papel y orientación de la políticas sobre C&T, lo cual impidió que surgiera un consenso político sólido sobre la importancia de la inversión en C&T para alcanzar un desarrollo sostenido e incluyente y fortalecer la competitividad. Esto condujo a una baja asignación de recursos en el área de C&T y a conflictos de asignación, minando el surgimiento de un sistema de innovación coherente y articulado donde los actores tiendan más a la cooperación que a la defensa de intereses creados. Un enfoque legalista en materia de construcción institucional llevó también a la creación de capas de instituciones cuyas responsabilidades en materia de diseño e implementación de políticas pocas veces se correspondían con sus mandatos legislativas, así como a solapamientos de responsabilidades y conflictos en torno a recursos escasos.

También se ha subestimado el papel de los instrumentos de apoyo para la promoción de la demanda de conocimiento científico y tecnológico en el sector privado y la construcción de capacidades de generación de C&T. Esto se ve complicado adicionalmente por obstáculos institucionales a la transferencia de recursos públicos al sector privado. Perú ha tardado en percatarse de la importancia de las instituciones de intermediación en el desarrollo de la infraestructura de C&T y la difusión tecnológica.

Recursos insuficientes para C&T: explicación parcial del desempeño deficiente en innovación

En comparación con economías emergentes y países latinoamericanos de nivel similar de desarrollo o dotación de recursos, Perú dedica muy pocos recursos públicos o privados a la investigación y el desarrollo (I&D). En 2004, el año más reciente para el que se tienen estadísticas (de confiabilidad incierta), la intensidad de I&D de la economía peruana (relación entre gastos en I&D y el PIB) fue de apenas 0,15%, mientras llegaba a 0,90% en Brasil, 0,65% en Chile, 0,43% en México y 0,86% en Sudáfrica. Desde entonces la intensidad de I&D ha crecido en estos otros países – y sustancialmente en Brasil y Sudáfrica – mientras que en Perú probablemente se ha estancado o crecido muy poco. De hecho, se estima que la porción del presupuesto total dedicado a instituciones de C&T o fondos de innovación disminuyó de 1,72% en 2003 a 1,59% en 2009. El débil desempeño de Perú en términos de productos de innovación, medido mediante número de patentes o niveles de productividad, refleja en cierta medida el bajo nivel de inversión en activos físicos y activos intangibles de conocimiento, así como las ineficiencias en el sistema de innovación que generan retornos deficientes de la inversión realizada en C&T.

Aunque ciertamente se necesitan recursos que contribuyan a fortalecer las capacidades en CTI, particularmente en materia de I&D y de infraestructura C&T, también es necesario el desarrollo concomitante de capacidades de absorción, particularmente en términos de recursos humanos (calificados). Como lo indica la experiencia de los países más exitosos, el desempeño de los sistemas de innovación depende también de factores cualitativos que promuevan la generación, adquisición, difusión y aplicación de conocimientos y tecnologías y que garanticen que los recursos públicos tengan un efecto multiplicador eficiente sobre la inversión privada relacionada con la innovación, ya sea en empresas nuevas o existentes. Estos factores incluyen:

- parámetros institucionales y de gobernanza que dirigen la orientación, diseño e implementación de las políticas, permiten adaptar las respuestas de las políticas públicas y limitan la duplicación en los programas de apoyo;
- condiciones favorables para el desempeño de las instituciones de investigación pública y transferencia de tecnología;
- ausencia de restricciones legales o regulatorias que afecten negativamente el uso de recursos públicos para promover la inversión privada en C&T o el desarrollo de asociaciones público-privadas para fines de investigación e innovación;
- una combinación de políticas que genere un círculo virtuoso de oferta y demanda en el desarrollo de capacidades de C&T;
- instrumentos de apoyo e incentivos públicos que aborden situaciones de falla de mercado o fallas sistémicas, tales como la baja inversión en actividades de conocimiento y en interacciones de conocimiento entre agentes, particularmente las que inciden sobre actividades de colaboración y la difusión tecnológica;

- el efecto de las condiciones marco y los regímenes regulatorios sobre los comportamientos de inversión de las empresas y sus incentivos para innovar, así como sobre la eficacia de las instituciones públicas de C&T.

Se necesitan mejoras importantes en todas estas áreas para garantizar que el incremento en la asignación de recursos a actividades de C&T sea eficaz y contribuya a elevar la capacidad innovadora de Perú y abordar sus desafíos sociales.

Iniciativas recientes de política pública: positivas, pero de resultados limitados en un entorno institucional fragmentado

Durante la última década el gobierno peruano ha adoptado diversas iniciativas de política pública. Algunas fueron de naturaleza institucional; otras estuvieron dirigidas a crear programas de apoyo, promover el desarrollo de capacidades de oferta y demanda de C&T y fomentar interacciones entre actores privados y públicos en el sistema de innovación. Recientemente se han alcanzado ciertos éxitos mediante nuevos fondos de C&T y de innovación, algunos de los cuales han recibido el respaldo de instituciones financieras multilaterales; mediante mecanismos de apoyo a la transferencia de tecnología y la I&D; y a través de medidas aún incipientes para desarrollar capital humano en el área de C&T.

La Ley Marco de Ciencia, Tecnología e Innovación Tecnológica de 2004 asignó al Consejo Nacional de Ciencia, la Tecnología y la Innovación Tecnológica (CONCYTEC) la responsabilidad de conducir la política en materia de CTI, particularmente mediante el desarrollo del Plan Nacional de CTI y la coordinación del llamado Sistema Nacional de C&T e Innovación Tecnológica (SINACYT). Al CONCYTEC se le asignaron también atribuciones de implementación de políticas a través de FONDECYT, brazo operacional de CONCYTEC que administra programas dirigidos a apoyar la búsqueda de conocimientos básicos y aplicados, la transferencia y difusión de tecnologías y el desarrollo de recursos humanos altamente calificados en materia de C&T.

En 2000 el Ministerio de Producción inició el desarrollo de los centros de innovación tecnológica (CITEs). Con financiamiento del Ministerio y fuentes privadas u organismos extranjeros de cooperación, los centros fueron diseñados para proporcionar servicios tecnológicos a pequeñas y medianas empresas (PyMEs) o asociaciones de productores, buscando llenar una brecha importante en la transferencia tecnológica.

Se crearon dos fondos de CTI competitivos con una buena dotación de recursos, financiada conjuntamente por el gobierno peruano y préstamos de organismos financieros multilaterales. INCAGRO comenzó sus operaciones en 2001 con una asignación inicial de US$ 20 millones, cifra que se elevó en una segunda fase a US$ 45 millones. Tiene como objetivo promover la innovación, la transferencia tecnológica y la colaboración entre entes públicos y privados en el sector agrícola. FINCYT fue iniciado en 2007 con un asignación de US$ 36 millones para promover una amplia gama de programas, el más importante de los cuales estaba dirigido a fortalecer la capacidad de investigación e innovación de empresas, universidades y centros públicos de investigación y promover la colaboración entre ellos. Estos fondos tienen reglas operacionales más eficientes y registros de evaluación de desempeño gerencial que, en términos generales, son mejores que los de programas anteriores de naturaleza similar u objetivos similares.

En 2006, el Ministerio de Economía y Finanzas creó el FIDECOM, un fondo con una asignación de cerca de US$ 65 millones, cuyo objetivo es promover la innovación productiva. En 2007, la Ley Nº 29152 encomendó al Ministerio de la Producción la

operación de un fondo concursable utilizando los recursos del FIDECOM. En 2010 se desembolsaron US$ 1,9 millones que financiaron proyectos de innovación en el sector empresarial, especialmente proyectos colaborativos.

En 2004 la Ley de Canon fue enmendada para destinar parte de los recursos transferidos a los gobiernos regionales[1] a financiar proyectos de inversión dirigidos a desarrollar capacidades de investigación en universidades públicas regionales.

Estas iniciativas han contribuido a ampliar la inversión empresarial en innovación, aunque de manera modesta. Las instituciones de investigación, incluyendo las universidades, han utilizado los incrementos marginales en su financiamiento institucional para ampliar su base de conocimientos y, en menor medida, sus actividades de transferencia de conocimiento. Tras la enmienda de la Ley de Canon en 2004 las universidades recibieron sustanciales recursos adicionales para la inversión en I&D (aunque el uso de estos recursos está sujeto a condiciones estrictas). Las instituciones de transferencia de tecnología han contribuido a elevar la productividad y competitividad internacional de algunas industrias en los sectores de manufactura no tradicional, agricultura y agroindustria, abriendo de esta manera nuevas oportunidades para la diversificación.

En términos generales estas iniciativas solo han involucrado a un número relativamente pequeño de empresas, instituciones de investigación y asociaciones profesionales, y no han generado un crecimiento sostenido de la productividad; tampoco lograron catalizar un proceso de mejora tecnológica sistemática en actividades existentes mediante transacciones interinstitucionales de conocimiento, ya sea en el mercado o fuera de él, ni generaron difusión de conocimiento, *p.ej.,* en cadenas de valor agregado. Con pocas excepciones, no han logrado iniciar un proceso de diversificación fundamentado en tecnología y su alcance es demasiado limitado para permitir el uso o apropiación de nuevas tecnologías que faciliten la actualización de destrezas y aborden el problema de la inclusión social. Es más, siguen sin resolverse algunas problemáticas cruciales en la gobernanza de las políticas públicas. Se necesitan reformas institucionales que permitan aclarar el panorama confuso en materia de diseño de políticas públicas y abordar conflictos latentes en la implementación de políticas que, con demasiada frecuencia, ocasionan duplicaciones en los programas de apoyo, insuficiencias de masa crítica y despilfarros de recursos públicos.

En particular, CONCYTEC no ha logrado orientar las políticas en materia de CTI por razones asociadas a una falta de respaldo político, una gerencia deficiente y dificultades para alcanzar consensos entre las diversas instituciones involucradas, cada una de las cuales busca proteger sus propias atribuciones y recursos. También surgen conflictos de interés debido a una falta de claridad en la distinción entre atribuciones funcionales y operacionales. Además, existe un solapamiento significativo entre los diversos programas de apoyo a la C&T y la innovación administrados por instituciones diferentes (*p.ej.,* CONCYTEC y FINCYT); esto lleva a una duplicación de costos administrativos y una proliferación de proyectos cuyos techos de elegibilidad en materia de costo son muy bajos.

Sin embargo, de estas iniciativas dirigidas a desarrollar políticas de innovación pueden derivarse lecciones para preparar el terreno hacia la adopción de una vía de desarrollo más sostenible y la generación de un círculo virtuoso de demanda, oferta y difusión de conocimiento. Tal política requeriría reformas en la gobernanza, el diseño institucional y el marco regulatorio de un sistema de innovación que durante los últimos 40 años ha evolucionado de manera incremental y en ocasiones desarticulada.

Deficiencias en las instituciones de educación superior y el desarrollo de recursos humanos

Debido a esfuerzos que viene adelantando por más de tres décadas, Perú ha alcanzado tasas altas de inscripción en educación primaria y secundaria y el nivel de alfabetismo de su población adulta llega a más del 90%, uno de los más altos de América Latina. Sin embargo, esto se ha alcanzado sacrificando los logros de estudiantes de secundaria en materia de lectura y comprensión de la ciencia, materia en la que están por debajo de estudiantes de países latinoamericanos comparables, como lo refleja en la ubicación sumamente baja de Perú en comparaciones internacionales como la del programa PISA de la OCDE.

En el sector de educación superior, el crecimiento económico sostenido generó una alta demanda de servicios educativos, contribuyendo a la creación de algunas universidades públicas y numerosos institutos tecnológicos y universidades privadas. El número de estudiantes universitarios creció de poco más de 346.000 en 1996, año en que se autorizó la creación de universidades privadas con fines de lucro, a más de 839.000 en 2010. La mayoría de ese crecimiento se concentró en las universidades privadas. Muchas (quizás la mayoría) de las universidades privadas carecían de mecanismos de acreditación, por lo que la expansión cuantitativa ocurrió a expensas del desempeño académico de los estudiantes. En la mayoría de las universidades públicas el rápido crecimiento de la inscripción también tuvo efectos negativos sobre el desempeño, ya que el hacinamiento exacerbó el efecto de los bajos salarios docentes. En términos generales, la situación de los institutos de alta tecnología es similar. En consecuencia, el número de graduados con la calificación necesaria para inscribirse en programas acreditados de posgrado en C&T e ingeniería es relativamente bajo. Es más, el número de becas disponibles para estudiantes que califican para completar programas de posgrado es muy bajo, particularmente si se lo compara con niveles internacionales.

Las universidades son autónomas; en términos prácticos, la rendición de cuentas ante los cuerpos reguladores es mínima. En consecuencia, las universidades han desarrollado sistemas de gobernanza internos que responden abrumadoramente a criterios distintos a los de la excelencia en la enseñanza y la investigación, y alejados igualmente de la llamada "tercera misión": la promoción de interacciones de conocimiento con el sector productivo. La carencia relativa de recursos e incentivos para actividades de investigación ha llevado a muchos investigadores calificados a tomar la decisión de emigrar. Otros países con problemas similares han usado incentivos de repatriación o mecanismos para atraer científicos extranjeros con formas especiales de compensación, junto con otras medidas dirigidas a mejorar las universidades y ampliar los incentivos para científicos altamente calificados.

Las estadísticas disponibles indican que el sector de educación superior realiza cerca del 40% de toda la I&D. Estas actividades son realizadas por un puñado de universidades; se estima que seis de ellas (de las cuales dos son privadas) realizan cerca de 80% de la I&D académica total, la cual se sostiene en su abrumadora mayoría a través de

financiamientos institucionales, programas competitivos de apoyo de CONCYTEC y FINCYT, y fuentes extranjeras de cooperación y financiamiento (*p.ej.,* los casos de IIAP, IGP y la Universidad Cayetano Heredia). Aunque estas universidades ocupan escaños relativamente bajos en las clasificaciones internacionales o latinoamericanas, de todos modos constituyen islas de excelencia dentro del sistema de investigación de Perú.

El financiamiento adicional derivado de la enmienda de la Ley de Canon y asignado a universidades públicas regionales es, en principio, bastante sustancial. Sin embargo, una parte importante de estos recursos se mantiene congelada debido a regulaciones rígidas que limitan su uso, así como por insuficiencias en la capacidad de las universidades para absorberlos. A pesar de ciertas iniciativas recientes de universidades con mayor intensidad de I&D, así como de la existencia de primas para actividades de colaboración en fondos como FINCYT, las interacciones en materia de investigación e innovación entre las instituciones de educación superior (IES) y el sector productivo siguen siendo muy incipientes.

Iniciativas recientes dirigidas a fortalecer el potencial de investigación de las universidades, tales como los programas de cátedras y becas de CONCYTEC, responden de manera eficaz a necesidades reales, pero son de pequeño alcance y dimensión. Estos programas deberían servir como elemento complementario para otras modalidades quizás más efectivas para el alcance de la meta de obtener un conjunto altamente calificado de investigadores. Finalmente, el sector académico carece de medios y mecanismos de financiamiento suficientes para desarrollar y mantener equipos de infraestructura de C&T.

Institutos públicos de investigación: conjunto heterogéneo de desempeño deficiente

La mayoría de los IPI de Perú fueron creados en los años setenta como organismos descentralizados adscritos a ministerios sectoriales. Están caracterizados por una heterogeneidad mayor a la observada en la mayoría de los países. Pueden agruparse de manera aproximada en tres categorías, según sus objetivos o sus carteras de actividades:

- los que tienen como misión principal realizar investigación básica, investigación aplicada y actividades de desarrollo tecnológico en áreas estimadas útiles para sectores específicos, así como concretar procesos de transferencia tecnológica hacia las empresas que integran esos sectores;
- los que realizan actividades científicas como "bienes públicos" que benefician a la sociedad en su conjunto, contribuyen a un mejor uso de la dotación nacional de recursos naturales y sociales, y realizan actividades de transferencia tecnológica hacia el sector productivo;
- aquellos cuya misión está asociada a la definición de normas y estándares, así como al suministro de información tecnológica y servicios de infraestructura.

Con pocas excepciones, el desempeño de los IPI dedicados a actividades de desarrollo y transferencia de C&T – medido en términos de producción científica, registro de patentes o colaboración con el sector productivo – es muy deficiente. Esto se debe principalmente a sus formas de gobernanza, las modalidades de financiamiento de sus actividades y sus procedimientos administrativos internos. El desempeño de la tercera categorías recién descrita – la cual no involucra, en sentido estricto, actividades de C&T – se corresponde en términos generales con los estándares internacionales correspondientes,

aunque algunos de sus organismos podrían beneficiarse con una mejor gerencia en el suministro de servicios tecnológicos a usuarios.

Las relaciones de los IPI con los ministerios sectoriales a los que están institucionalmente adscritos se limitan muchas veces a discusiones en torno a necesidades presupuestarias. Sus agendas de investigación están mayormente determinadas más por la inercia que por coordinaciones realizadas con partes interesadas o los ministerios responsables de cada área.

La gobernanza de los IPI es débil. Generalmente se limita a realizar procedimientos formales de rendición de cuentas que no se evalúan su desempeño. Una porción abrumadora de los recursos manejados por los IPI proviene de financiamientos institucionales, siendo mínimos los ingresos provenientes de ventas de servicios. En consecuencia, no existe incentivo real alguno para buscar mejorías en el desempeño. Al mismo tiempo, los IPI no tienen verdadera autonomía en sus asuntos administrativos internos, particularmente en lo referente a la gerencia de recursos humanos. En muchos IPI la naturaleza del proceso de asignación de recursos, la ausencia de rendición de cuentas y las restricciones administrativas tienen efectos perjudiciales sobre el desempeño. Esta situación genera un círculo vicioso donde las potencialidades en materia de C&T se ven perjudicadas debido a sesgos que privilegian al personal administrativo a expensas de la procura de recursos humanos dedicados a labores de C&T.

Los IPI pudieran constituirse en una pieza significativa del sistema peruano de innovación. Para que puedan desempeñar su papel eficazmente en beneficio tanto del sector privado como de sociedad en general, se requerirán reformas importantes en términos de *i)* gobernanza y rendición de cuentas; *ii)* diversificación de fuentes de financiamiento, con un mayor equilibrio entre el financiamiento institucional y el financiamiento competitivo de proyectos; y *iii)* la obtención de recursos financieros a partir de colaboraciones con el sector empresarial y de la prestación de servicios a ese sector.

Un sector empresarial que invierte poco en innovación

Como conjunto, el sector empresarial peruano es muy heterogéneo y tiene una baja propensión a invertir en I&D e innovación. Solamente menos del 2% de todas las empresas realiza actividades de C&T; la distribución está altamente sesgada en términos de tamaño y está concentrada en un número limitado de sectores[2]. Una porción muy pequeña de las empresas grandes está muy bien conectada con fuentes internacionales de tecnología y realiza procesos de innovación incrementales, asociados principalmente con la importación de experticia y de bienes de capital. Un porcentaje mayor, pero aún pequeño, de empresas en los sectores manufacturero y agroindustrial ha generado ciertas capacidades de CTI, principalmente mediante la transferencia de tecnología y la formación de capital humano, y es capaz de emprender innovaciones de procesos y productos. La abrumadora mayoría de las empresas no participa en actividad alguna de innovación, aparte de la sustitución ocasional de maquinaria y equipos.

La baja propensión del sector empresarial a participar en actividades de innovación observada en la encuesta de innovación de 2004 se debe a un conjunto diverso de factores. Entre los más importantes están los siguientes:

- una aversión al riesgo, fundamentada en parte en experiencias traumáticas asociadas a cambios en el entorno económico ocurridos como consecuencia de cambios políticos, con efectos sobre las tasas de interés y de inflación;
- bajos niveles de presión competitiva y un predominio de estrategias rentistas entre empresarios conservadores;
- cadenas de valor agregado poco desarrolladas donde proveedores y contratistas ejercen presiones u ofrecen otros incentivos para la innovación;
- interacciones débiles entre las empresas y las fuentes nacionales de conocimiento en los institutos de investigación y universidades, debido mayormente a una falta de correspondencia entre la oferta y la demanda de conocimientos y servicios tecnológicos y la ausencia de gestores tecnológicos dedicados a fomentar esa interacción;
- escasez relativa de personal gerencial y personal altamente capacitado en C&T capaz de diseñar e implementar proyectos de innovación;
- ausencia de mercados de capital y escasez de instituciones financieras dispuestas a atender las necesidades financieras de emprendimientos innovadores en las PyMEs y el desarrollo de empresas basadas en tecnología;
- carencia de mecanismos públicos de apoyo eficientes para el fomento de la inversión privada en I&D e innovación.

Ante este entorno adverso el gobierno peruano ha tomado iniciativas para mejorar el clima de innovación, fortalecer la inversión privada en innovación y promover una mejor articulación entre los institutos públicos de investigación y el sector empresarial. Los regímenes de competencia y de derechos de propiedad intelectual (DPI) han sido fortalecidos. Se establecieron programas de apoyo para el financiamiento competitivo de proyectos de innovación de empresas con un criterio de costos compartidos, como el PROCOM/FONDECYT; esas iniciativas fueron continuadas a mayor escala y de manera más eficiente a través del FINCYT y los programas FIDECOM de innovación tecnológica. El éxito de estos programas muestra que la oferta de incentivos que limitan los riesgos y costos involucrados en proyectos de innovación revela la existencia de una demanda latente por los conocimientos de C&T, así como de una capacidad para emprender este tipo de proyectos. Muestra también que estos incentivos amplían las oportunidades para el desarrollo, la diversificación y los incrementos de productividad. Estos programas de apoyo son relativamente nuevos, por lo que aún existen interrogantes importantes respecto al rendimiento social del uso de recursos públicos, el impacto duradero sobre la propensión de las empresas a invertir en activos de conocimiento y el impacto sobre el fortalecimiento de las interacciones entre actores de innovación y la difusión tecnológica.

Transferencia y difusión tecnológica insuficiente

En muchos de los países de la OCDE los centros de tecnología e innovación juegan un papel importante en la conducción de investigación aplicada, emprendiendo procesos de cooperación con, y suministro de servicios a, empresas privadas, al tiempo que promueven la difusión de tecnologías, ya sea dentro de sectores específicos o traspasando barreras entre sectores. En muchos casos están involucrados también en actividades de capacitación. Estos centros han evolucionado para generar diversos modelos, dependiendo de la naturaleza de su situación y su modalidad de administración (ya sea

pública, privada o mixta); la composición de sus recursos financieros (subvenciones, financiamiento competitivo de proyectos C&T); y el alcance de su actividades de C&T (sectorial, multisectorial o dirigido a todo el ámbito de la C&T).

En los países en desarrollo, la gran mayoría de las empresas en los sectores de tecnología baja e intermedia no solo carecen de capacidades endógenas en materia de C&T; enfrentan además problemas de acceso limitado a la información y en la aplicación de normas y estándares. Esto limita su capacidad para innovar, mejorar sus procesos de producción y diversificar sus actividades hacia productos y mercados más sofisticados. Muchos países han creado instituciones de transferencia tecnológica para abordar estos problemas y desarrollar capacidades de C&T.

Perú, país que se incorporó al tema de manera relativamente reciente, creó su red de centros de innovación tecnológicos (CITEs) en 2000 bajo el patrocinio del Ministerio de Producción, organismo que otorga la acreditación a cada centro individual. Los CITEs están organizados por categorías sectoriales y pueden ser privados o públicos. Venden sus servicios y solo los centros públicos tienen derecho a obtener financiamiento institucional. Actualmente están funcionando 14 CITEs (11 privados y 3 públicos) en las áreas de industria manufacturera, servicios, agroindustria, silvicultura y agricultura. Los CITEs son impulsados principalmente por la demanda, pero generalmente operan en estrecha coordinación con asociaciones de productores, han demostrado ser capaces de identificar demandas potenciales para diseñar servicios tecnológicos a la medida de las necesidades detectadas, lo que incluye la oferta de programas de capacitación; tienen además un buen historial de desempeño. Sin embargo, y aunque el número de empresas que ha recibido asistencia creció considerablemente durante los últimos cinco años, el alcance de los CITEs sigue siendo limitado, dada la magnitud del problema de creación de capacidades en Perú. Actualmente no tienen los medios necesarios para emprender I&D ni el mandato de hacerlo, aunque desarrollar este tipo de actividades pudiera ampliar la gama de servicios que proporcionan, no sólo a sectores en donde ya están presentes, sino también a otros sectores más tecnológicamente avanzados. Para esto se necesitaría dedicar más recursos a la infraestructura de C&T y el reclutamiento de recursos humanos más altamente calificados en C&T.[3]

Debido posiblemente a una carencia de capacidades de I&D *intra muros*, los CITEs no están bien posicionados para beneficiarse de FINCYT y FIDECOM, programas que impulsarían las capacidades de innovación en las redes de empresas que atienden, ni para involucrar a los IPI en el desarrollo de sus propias actividades de transferencia tecnológica. Sin embargo, los CITEs han logrado promover varios proyectos con PyMEs que han sido presentados a FIDECOM.

Las instituciones de naturaleza más regulatoria desempeñan un papel activo en la difusión de tecnología o el fortalecimiento de la capacidad de las empresas para lograr que la modernización tecnológica realmente abra nuevas oportunidades de mercado. Planteando apenas dos ejemplos particularmente importantes para los países en desarrollo, mencionemos aquí que las oficinas de propiedad industrial pueden facilitar la diseminación de información tecnológica mediante plataformas de acceso abierto que proporcionan conocimiento sobre tecnologías avanzadas; por otra parte, las agencias de certificación proporcionan información sobre normas internacionales y servicios tecnológicos relacionados, tanto para la producción actual como para el desarrollo de nuevos productos.

INDECOPI, organismo encargado del tema de la propiedad intelectual, ha tenido una actuación mayormente satisfactoria en la gerencia del área, en la cual se han registrado mejorías en años recientes. Sin embargo, y probablemente debido a una amplia cartera de responsabilidades que incluye otros mandatos, particularmente sobre temas relacionados con la promoción y operación de regímenes de competencia, no ha podido dedicar recursos suficientes a la promoción del acceso a la información tecnológica y su diseminación.

SENASA, organismo adscrito al Ministerio de Agricultura, se encarga de la promoción y certificación de normas internacionales para el procesamiento y exportación de productos agrícolas y agroindustriales. Ha contribuido considerablemente a la adopción de prácticas de producción más eficientes, así como a una diversificación innovadora de productos en los sectores agrícola y agroindustrial. SENASA tiene también un buen historial de colaboración con instituciones de transferencia de tecnología en estos sectores.

Obstáculos regulatorios a la innovación

Además del conjunto de disposiciones legales que contribuyen a generar estructuras de control ineficaces en el sistema peruano de innovación y dificultan cualquier esfuerzo de consolidación, algunos obstáculos legales y/o regulatorios específicos reducen la eficacia del apoyo público a la innovación, dificultan las interacciones entre agentes y afectan negativamente el desempeño de las instituciones de investigación.

- *Restricciones a la transferencia de fondos públicos a instituciones de sector privado.* En todos los países de la OCDE existen disposiciones legales y regulatorias que definen la forma y condiciones en que dichas transferencias pueden ocurrir. Esto es particularmente cierto en el caso del apoyo público para la I&D. Perú, como regla general, prohíbe las transferencias públicas al sector privado. En consecuencia, el suministro de apoyo financiero a la I&D y actividades de innovación se ve entorpecido por obstáculos legales y administrativos y es muy difícil de implementar. Las reglas para facilitar la promulgación e implementación de instrumentos de apoyo pueden involucrar largas demoras y procedimientos administrativos complejos.
- *Los procedimientos SNIP* que regulan y validan el gasto público con fines de inversión en instituciones públicas. Estos procedimientos fueron concebidos para ser aplicados a la inversión física, y ha resultado difícil aplicar estos criterios a la I&D y la inversión intangible asociada con la innovación. Para los proyectos de FINCYT e INCAGRO propuestos por el sector privado, las regulaciones SNIP elevan aún más las restricciones. Para encontrar una solución a esta situación compleja se hace necesario definir los proyectos como servicios contratados por el gobierno.[4] En prácticamente todos los demás países, una vez que se crea un fondo sus reglas operacionales quedan definidas y el organismo administrador asume plena responsabilidad en la selección y aprobación de proyectos individuales, así como en el desembolso de subvenciones de conformidad con normas contables establecidas.
- *La legislación laboral aplicable a funcionarios públicos* afecta negativamente la capacidad de los investigadores de universidades públicas para participar en proyectos de colaboración con otras instituciones debido a restricciones a la movilidad interinstitucional o la dificultad – y hasta imposibilidad – de recibir

pagos por servicios prestados a otra institución mientras estén en la nómina universitaria.

- *Falta de autonomía en la administración de personal de institutos públicos de investigación*. Rigideces en la legislación laboral dificultan la rotación de personal y hacen necesario contratar personal de mayor calificación bajo la figura de trabajadores temporales a través del denominado Contrato Administrativo de Servicio (CAS) aplicado al sector público.
- *El régimen* tributario es desfavorable a la inversión en I&D y en innovación, ya que no existe claridad respecto a si esa inversión califica como gasto amortizable contra las ganancias.[5]

Insuficiencias en la infraestructura científica y tecnológica

El desarrollo y mantenimiento de la infraestructura científica y tecnológica es importante para el desempeño del sector público de investigación. Facilita la colaboración con el sector privado y es necesario para competir con éxito para la obtención de subvenciones nacionales e internacionales. En Perú el financiamiento de la infraestructura de C&T ha sido objeto de abandono por mucho tiempo. Las asignaciones presupuestarias para infraestructura de C&T casi nunca son declaradas como tales en el financiamiento institucional de los institutos públicos de investigación, e incluso menos en el de las universidades. Además, por constituir inversión pública tales asignaciones estarían sujetas a los procedimientos SNIP. Los recursos concedidos a través de proyectos competitivos en el marco de CONCYTEC o FINCYT generalmente no son suficientes para cubrir los costos requeridos para desarrollar y mantener infraestructura de C&T. Por supuesto, actualmente ya existe disponibilidad de financiamiento para equipos de C&T mediante los programas de CONCYTEC y FINCYT, pero esos recursos siguen siendo más bien limitados.

Debilidad de vínculos interinstitucionales en C&T

El sistema de innovación de Perú adolece de una falta de interacciones de conocimiento entre instituciones, tanto en términos de cooperación entre diversos IPI como entre éstos y las universidades. Existe renuencia a compartir equipos de infraestructura y asumir compromisos de mediano y largo plazo para esfuerzos conjuntos de investigación. Los intereses creados están muy arraigados y una falta de confianza, aunada a incertidumbres sobre la disponibilidad de recursos financieros y humanos, enturbia la percepción de los beneficios que pueden obtenerse mediante la cooperación. Esa percepción se ve fortalecida por la ausencia de incentivos basados en el desempeño.

La situación es similar en el ámbito de la colaboración en C&T entre institutos de investigación y empresas, así como en el suministro de servicios de C&T. Del lado de la demanda, una preferencia por el uso de tecnología importada y una baja capacidad de absorción de C&T obstaculiza la demanda de servicios tecnológicos. Del lado de la oferta, los institutos públicos de investigación tienen poco incentivo para emprender procesos de colaboración o suministrar servicios, ya que sus recursos provienen abrumadoramente de fuentes de financiamiento institucional que no emplean criterios de desempeño para evaluar las actividades de colaboración. Además, como se observó anteriormente, este tipo de actividades enfrenta obstáculos regulatorios.

Este problema de falta de articulación ha comenzado a ser abordado en programas de apoyo del FINCYT que privilegian proyectos de innovación de empresas que contemplen colaboraciones con institutos públicos de investigación. Sin embargo, aún es demasiado pronto para saber si la colaboración impulsada por incentivos financieros generará una dinámica de colaboración fundamentada en intereses mutuos, o si los programas de apoyo tendrán un efecto de "generación de conductas" en los procesos de búsqueda de conocimiento de las empresas.

Necesidad de una política integral de CTI y de una gobernanza eficaz

Perú no tiene una política explícita de CTI con orientaciones estratégicas acordadas. Tiene más bien un conjunto de políticas en estratos múltiples que generalmente no están coordinadas entre sí y son diseñadas e implementadas de manera más o menos independiente por diversos ministerios y organismos públicos. La relativa escasez de recursos dedicados a CTI en su conjunto y la débil integración del sistema de innovación lleva a que cada una de las instituciones persiga sus propias metas individuales. Aunque algunas iniciativas de política han sido administradas eficazmente y logrado algunos resultados positivos, aquellas que han logrado generar cierta coherencia parecen haber "obviado" los marcos legales, institucionales y regulatorios del país debido a que su diseño y modalidades de implementación fueron definidos mayormente en el contexto de préstamos en los que participaron instituciones financieras multilaterales.[6] Sin embargo, y aunque estos resultados pudieran iniciar un proceso de círculo virtuoso y ofrecer lecciones útiles, no pueden sustituir la tarea necesaria de rediseñar el marco de elaboración de políticas públicas.

La combinación de políticas de CTI utilizado por un país está condicionada de manera sustancial por el marco institucional en el que las prioridades se definen y se financian en el proceso presupuestario, por el equilibrio de poder entre las principales partes involucradas y por el marco regulador y las condiciones regulatorias que inciden sobre el desempeño del sistema de innovación. Las políticas también evolucionan a medida que cambia el entorno nacional e internacional. En Perú, el proceso que debiera llevar a la adopción de una combinación eficaz de políticas se ve minado por una incapacidad para abordar las principales debilidades del sistema de innovación de manera integrada y dar inicio a una dinámica virtuosa en donde la inversión pública promueva el desempeño innovador en el sector privado.

Las principales causas de esto son: *i)* una confusión entre las funciones de diseño de políticas y de financiamiento y gerencia de programas (*p.ej.,* CONCYTEC), y a veces incluso con las de implementación de programas (en algunos institutos públicos de investigación), lo cual puede generar conflictos de interés en cuanto al uso de recursos (*p.ej.,* dedicándolos a la gerencia interna en lugar del financiamiento de proyectos); *ii)* los mandatos excesivamente amplios asignados a algunos fondos e instituciones, los cuales cubren toda la gama de ámbitos de políticas de C&T (generación de conocimiento y desarrollo de capital humano, I&D e innovación en el sector privado, desarrollo, difusión y transferencia tecnológica)[7]; y *iii)* rigideces institucionales y una cultura legalista que limita el desarrollo o eficacia de nuevos instrumentos de política en el marco de la arquitectura institucional existente (*p.ej.,* la Ley de Canon para las universidades regionales, los procedimientos SNIP, el sistema de control administrativo de las universidades).

La falta de coordinación puede tener efectos adversos. En Perú, esto ha llevado a que existan superposiciones de responsabilidades y duplicaciones de programas de apoyo en instituciones o fondos que operan en ámbitos similares de política pública. Esto agrava el problema crónico de insuficiencia de masa crítica y reduce la eficacia de los programas de apoyo. También ha permitido que existan espacios vacíos en el diseño de las políticas: no ha sido posible desarrollar políticas o dar apoyo a programas que dependen de la colaboración entre varias instituciones, y posiblemente del financiamiento conjunto que dichas instituciones aportan. En este sentido se destaca en Perú el caso de los programas orientados a cumplir mandatos específicos, las políticas de agrupación productiva ("clusters") y las políticas de compras gubernamentales impulsadas por la innovación. Para una mejor coordinación se necesita información y datos sobre las actividades de CTI y los recursos disponibles en el área, a fin de tomar decisiones basadas en realidades. Perú aún tiene un largo camino por recorrer en la construcción de una base de información adecuada, confiable y actualizada. Un área relacionada de debilidad es la carencia de una estructura que genere las condiciones necesarias para un control administrativo eficaz. Existen indicaciones sustanciales de que, para un volumen dado de recursos dedicados a la CTI, el desempeño de la innovación depende de la calidad de la gobernanza de los sistemas de CTI, es decir del conjunto de mecanismos institucionales, determinados en gran parte en el ámbito público, que rigen el diseño, implementación (organismos e instrumentos), suministro y evaluación de políticas públicas, y que determinan también la manera en que los diversos actores públicos y privados interactúan para la asignación y administración de los recursos dedicados a la CTI.

La mayoría de los componentes del sistema de innovación de Perú son débiles y están mal articulados entre sí; por tal razón, el sistema carece de un mecanismo operativo de gobernanza basado en una perspectiva integral y capaz de emprender eficazmente la tarea de fijar prioridades y coordinar las orientaciones de política pública a ser implementadas por diversas carteras ministeriales, así como en procesos de asignación presupuestaria y de implementación de políticas. El resultado es un conjunto fragmentado de programas que no logran alcanzar masas críticas y carecen de sinergias y complementariedades. De hecho, la dilución de las responsabilidades de gobernanza y la brecha existente entre las responsabilidades formalmente asignadas a CONCYTEC en la Ley de C&T de 2004 y su capacidad para llevarlas a cabo pone en evidencia la necesidad de un nuevo marco institucional, y posiblemente de la aprobación de una nueva ley. El proceso de reforma no debería sin embargo poner en peligro los programas de apoyo que actualmente están siendo administrados eficazmente.

Tareas estratégicas y principios orientadores

A pesar del impresionante desempeño de la economía peruana y de su capacidad de recuperación tras la crisis financiera de 2008, su bajo nivel de productividad pone en riesgo la sostenibilidad a largo plazo de su modelo de crecimiento. Dada la potencial volatilidad de los ingresos que obtiene con sus exportaciones tradicionales en un entorno global cada vez más competitivo, Perú debería fijarse como objetivo fundamental el de avanzar sin demora hacia una vía de crecimiento sustentable más basado en la innovación, a fin de elevar su productividad y competitividad en una gama más amplia de actividades, aliviar la pobreza y abordar necesidades sociales de manera más eficaz.

Para lograr esto deben mantenerse las políticas macroeconómicas sanas y las condiciones marco favorables que han dado sustento a la recuperación desde principios de siglo. Sin embargo, y para aprovechar el potencial que ofrece la ciencia y la tecnología y subir la escalera de la innovación, deben dedicarse más recursos públicos a la generación, difusión y uso del conocimiento y la tecnología; deben continuarse y profundizarse reformas institucionales en la gobernanza y el diseño e implementación de políticas de C&T, ya que dichas reformas inciden sobre la eficacia de los instrumentos.

La cosecha de los beneficios económicos y sociales generados por la inversión en ciencia y tecnología requiere tiempo y continuidad. *El compromiso político sostenido*, la construcción de consensos entre partes involucradas para determinar prioridades nacionales y la visibilidad social de los beneficios obtenidos por la economía y la sociedad en su conjunto son elementos esenciales para lograr políticas exitosas en materia de C&T e innovación. Para esto se necesita la implantación de procesos de vigilancia que garanticen que dichas prioridades realmente se aborden en el diseño de políticas de innovación y queden reflejadas tanto en las asignaciones presupuestarias como los mecanismos institucionales de implementación de políticas. Los logros científicos, económicos y sociales derivados de una mayor inversión pública deberían ponerse de relieve en el debate público; de ahí la importancia de una efectiva rendición de cuentas.

Una *base de recursos humanos calificados* es una piedra angular para cualquier estrategia de desarrollo económico basada en la innovación. Perú adolece de debilidades severas en esta materia y no deberían postergarse el emprendimiento de esfuerzos cuantitativos y cualitativos para fortalecer toda la cadena de educación y capacitación desde la primaria hasta los estudios de posgrado y, más específicamente, desarrollar los conocimientos y destrezas en ciencias, matemáticas y tecnología. Los problemas de oferta se ven complicados por problemas de demanda. La mayoría de la mano de obra es no está calificada o tiene baja calificación, y la carencia de destrezas gerenciales en una amplia mayoría de las empresas limita su capacidad para absorber tecnologías. También hace que esas empresas tengan poca disposición a asumir los riesgos asociados con la innovación. Para superar esto se requieren esfuerzos de amplio alcance para desarrollar programas de capacitación y ofrecer incentivos que animen al sector privado a participar en ellos.

La política de innovación de Perú debería facilitar y fomentar *el cambio estructural y la diversificación* para superar la dependencia de las industrias basadas en recursos naturales y tender hacia una producción que use el conocimiento más intensivamente en agrupaciones productivas ("clusters") de actividades donde Perú tiene o puede desarrollar ventajas comparativas o competitivas, ya sea basadas en recursos naturales o en encadenamientos aguas arriba y aguas abajo con sus sectores minero y energético, incluyendo industrias de servicios, tal como se ha hecho en países como Chile y Sudáfrica.

Debería dársele énfasis a programas seleccionados de *I&D e innovación orientados a alcanzar objetivos específicos* y desarrollados mediante asociaciones o colaboraciones entre institutos públicos de investigación y el sector privado. Dadas las limitaciones en materia de recursos y capacidades, los programas deberían circunscribirse y concentrarse en áreas donde Perú tiene ventajas competitivas derivadas de sus recursos naturales (*p.ej.,* biotecnologías para la preservación y explotación sostenible de la biodiversidad, una explotación minera más limpia) o donde puedan abordarse necesidades sociales (*p.ej.,* salud, rescate de recursos acuáticos y medio ambiente). Para desarrollar este tipo de programas debiera emprenderse una búsqueda activa de fuentes de cooperación internacional.

La innovación no puede prosperar sin que exista tanto un nivel adecuado de *infraestructura física moderna* en comunicaciones, logística y transporte, así como una infraestructura tecnológica fácilmente accesible que proporcione servicios en áreas como metrología, certificación, normalización y protección de la propiedad intelectual. Estas infraestructuras deben fortalecerse en Perú. En el primer conjunto mencionado de infraestructuras podría participar el sector privado; para el segundo sería necesario asignar mayores recursos a las instituciones respectivas y garantizar un mayor acceso a ellas por parte de las PyMEs.

De conformidad con estas orientaciones, la política gubernamental debería seguir algunos *principios orientadores claves*.

En primer lugar, debido al amplio alcance de los temas que afectan el desempeño de la innovación e inciden en las atribuciones y competencias de diversas carteras ministeriales, para la formulación de políticas de innovación debería adoptarse un enfoque que involucre a "todo el gobierno". Un enfoque de esta naturaleza tiene consecuencias importantes para la eficacia de los mecanismos de gobernanza.

En segundo lugar, es importante evitar condiciones institucionales y regulatorias que limiten la inversión relacionada con la innovación, la transferencia de recursos públicos al sector privado y la colaboración entre los sectores público y privado. Los marcos reguladores e institucionales debieran reexaminarse a la luz de su efecto sobre las políticas de innovación.

En tercer lugar, debe garantizarse una gobernanza eficaz. En Perú esto dependerá del logro de ciertas condiciones que actualmente no existen:

- *Un compromiso político* a los más altos niveles ejecutivos del gobierno, para asegurar que existirán disponibilidades presupuestarias adecuadas para las actividades de CTI y su asignación a las respectivas carteras ministeriales y/o organismos públicos autónomos.
- *Procesos* eficientes *de construcción de consensos* que incluyan a las carteras ministeriales relevantes y las principales instituciones concernidas para fijar las orientaciones y prioridades de más amplio alcance en materia de C&T e innovación y realizar las coordinaciones interdepartamentales requeridas para la implementación.
- *Coordinación de políticas.* Faltas de coordinación en la implementación de políticas y actitudes de inercia institucional pueden limitar la capacidad para traducir las orientaciones de política pública en conjuntos específicos de políticas que respondan adecuadamente a los nuevos desafíos y a las necesidades cambiantes de los actores del sistema de innovación y su interacción.
- *Delimitación clara de funciones institucionales.* Debe quedar sumamente clara la distinción entre las funciones de formulación de políticas y de implementación de políticas. Estas dos actividades requieren capacidades distintas y cada una de ellas debe estar sujeta a requerimientos de rendición de cuentas diferentes. La confusión entre funciones puede generar conflictos de interés.
- *Rendición de* cuentas *y evaluación.* La evaluación regular de los programas e instituciones de apoyo que reciben recursos públicos debería constituirse en norma, con consecuencias prácticas para las rondas subsiguientes de asignación de recursos. Sin embargo, debe alcanzarse un equilibrio entre la necesidad de ajustes

periódicos basados en la evaluación y la estabilidad de los programas de apoyo, a fin de asegurar su impacto a largo plazo sobre la conducta de los beneficiarios.

- *Monitoreo del desempeño del sistema de innovación*. A nivel más amplio, la buena gobernanza supone la existencia de un sistema de información que produzca estadísticas e indicadores internacionalmente comparables de manera regular. Esto hace posible monitorear el desempeño del sistema de innovación y efectuar evaluaciones comparadas con los objetivos cuantitativos de política pública y con el desempeño de otros países. En esto Perú registra grandes rezagos respecto a los países de la OCDE, pero también con respecto a la mayoría de las otras economías latinoamericanas.

El uso eficiente de fondos públicos para abordar desafíos económicos y sociales es un principio sano de gerencia presupuestaria. Los recursos públicos para el desarrollo tecnológico y científico compiten con otros gastos corrientes o de inversión en áreas que a menudo se perciben como de mayor prioridad o de prioridad más inmediata, particularmente en países en desarrollo donde las necesidades de alivio de la pobreza y de desarrollo de la infraestructura social y económica generan fuertes presiones sobre el presupuesto. Los costos de oportunidad de los recursos públicos dedicados a políticas de C&T y la legitimidad de su uso para abordar fallas sistémicas o de mercado deben justificarse a través de la apropiada evaluación contable de los retornos económicos y sociales previstos y de evaluaciones *ex post*. Los efectos multiplicadores de la inversión pública sobre la inversión privada pueden ofrecer indicios importantes en este sentido.

Entre las áreas de gran importancia para la *implementación sana de políticas* sana están las siguientes:

- *Funcionalidad operacional: consolidación del sistema de apoyo.* Esto involucra la reducción de solapamientos injustificados entre organismos implementadores en el ámbito de los programas de apoyo para asegurar que concentren su atención en sus áreas principales de atribución, reduzcan sus costos administrativos y de transacción y eviten duplicaciones de programas de dimensión menor a la masa crítica. Éste puede ser un problema bastante extendido en Perú.

- *Instrumentos de financiamiento.* Los programas y proyectos pueden recibir recursos de modos diversos. Para los fondos de innovación destinados a proyectos público-privados, el mecanismo de preferencia debiera ser el de aportes equivalentes. Esto pudiera complementarse mediante mecanismos como ofertas de garantía que permitan apalancar contribuciones de instituciones financieras. Las tasas de subsidio deberían tomar debida cuenta de posibles efectos de copamiento del mercado financiero y de ganancias extraordinarias imprevistas. En las reglas que gobiernan el financiamiento de programas o proyectos debiera evaluarse sistemáticamente la posibilidad de otorgar primas (de prioridad o con mayores tasas de subsidio) a emprendimientos realizados en colaboración. En el caso de los institutos públicos de investigación, la evaluación basada en el desempeño debería proporcionar criterios para determinar el volumen del financiamiento institucional. Esto todavía no ocurre en Perú.

- *Administración y adjudicación*. Los criterios de elegibilidad para los gastos relacionados con la innovación deberían ser claros y limitativos. Deben establecerse procedimientos de evaluación sólidos, profesionales y oportunos para la selección de proyectos presentados en el marco de los programas de apoyo. Esto hace necesario adoptar procesos de adjudicación que eviten procedimientos

burocráticos innecesarios, así como tener paneles con expertos capaces de evaluar no solo la relevancia científica o tecnológica de proyectos, sino también su viabilidad comercial. Los paneles debieran incluir expertos extranjeros. La evaluación de programas de apoyo debiera formar parte integral de su diseño y la evaluación del desempeño de los organismos implementadores debiera realizarse con regularidad.

Recomendaciones

Mejora de la gobernanza y reformas institucionales

La carencia *de facto* de una estructura eficaz de gobernanza exacerba la naturaleza fragmentada del sistema peruano de innovación y contribuye al uso ineficaz de recursos públicos. Es absolutamente necesario establecer mecanismos apropiados de gobernanza, para lo cual pudieran requerirse reformas legislativas e institucionales. Diversas opciones inspiradas en prácticas de otros países podrían adaptarse para usarlas en Perú, ajustándolas para tomar en cuenta especificidades nacionales; sin embargo, ninguna podrá alcanzar la mejoría prevista a menos que se cumplan algunos prerrequisitos particularmente importantes, a saber: cumplimiento con los principios de buena gobernanza previamente descritos, particularmente respecto al compromiso político, los procesos formales de coordinación interdepartamental y la funcionalidad institucional; así como la preservación de los programas de apoyo eficaces que ya están en operación.

A continuación se describen tres opciones para una estructura de gobernanza que aborde al sistema en su conjunto.

a) Un nuevo Ministerio de Ciencia, Tecnología e Innovación

La creación de un ministerio de este tipo ha sido promovida en Perú por CONCYTEC y una porción sustancial de la comunidad académica, basándose fundamentalmente en dos argumentos:

- • Un nivel ministerial permitiría tener participación directa en los debates sobre asignación presupuestaria y ofrecería mejores oportunidades para concretar incrementos en las asignaciones presupuestarias para instituciones, programas de apoyo y actividades de C&T.
- • Un ministerio podría asumir la conducción del sistema de CTI de un modo que CONCYTEC nunca estuvo en condiciones de emprender. En principio, tendría más capacidad para garantizar una mayor coordinación y coherencia entre diversas políticas y reducir los niveles de fragmentación.

Estos argumentos son pertinentes, pero en el contexto peruano son algo débiles por dos razones. En primer lugar, no puede presumirse que la mera existencia de un ministerio de CTI garantizará un incremento neto en la asignación total de recursos para CTI. En segundo lugar, la experiencia indica que una opción ministerial es más eficaz cuando el ministerio participa (a veces como *primus inter pares*) en un ente de coordinación interministerial con otras carteras ministeriales. Dicho ente ejerce vigilancia sobre políticas que pueden incidir sobre el desempeño de la innovación y debe existir una clara distinción entre las funciones de diseño de políticas e implementación de políticas. Esto ciertamente no ocurre en Perú, ya que la Presidencia del Consejo de Ministros

(PCM) y el Ministerio de Economía y Finanzas (MEF) son los únicos entes con competencia para emprender labores de coordinación interministerial y asignación presupuestaria.

Si el gobierno evalúa la posibilidad de adoptar esta opción, deberá asegurarse de que el nuevo ministerio esté en capacidad de llevar a cabo sus funciones de dirección, coordinación e integración de manera eficaz.

b) Diseño horizontal de políticas con un solo organismo implementador principal

Esta opción contempla establecer un organismo gubernamental descentralizado como brazo ejecutivo de un ente oficial de alto nivel facultado pare realizar coordinaciones interministeriales en materia de diseño e implementación de políticas. En cierta medida, esta opción es formalmente similar a la contemplada en la Ley de C&T aprobada por Perú en 2004, donde CONCYTEC fue adscrito a la PCM.[8] Sin embargo, su eficacia dependería de la adopción de nuevos mecanismos de gobernanza para evitar un fracaso derivado de la falta de aplicabilidad *de facto* de la Ley de 2004. Para esto se requeriría:

- Un liderazgo efectivo de la PCM o el MEF en la conducción del ente de coordinación interministerial, particularmente en cuanto a la definición de prioridades de política pública y su expresión concreta en la asignación de recursos presupuestarios.
- Una reformulación institucional de CONCYTEC que le permita convertirse en brazo ejecutivo del ente interministerial encargado de diseñar y evaluar políticas públicas.
- Una participación eficaz en la coordinación de ministerios sectoriales como PRODUCE y las carteras de agricultura, salud, educación, medio ambiente, energía y minas, transporte y comunicaciones. Estos ministerios serían los encargados de apoyar los programas y/o instituciones sectoriales responsables de implementar las políticas, incluso en materia de su financiamiento y evaluación.
- Una cooperación operativa entre CONCYTEC y los ministerios sectoriales en el diseño y financiamiento de programas sectoriales.
- Una demostración de que el "nuevo" CONCYTEC puede administrar programas de apoyo con una eficacia similar a la de FINCYT. Descontinuar los programas actuales de CONCYTEC que duplican a los de FINCYT.

En principio, esta opción podría ser viable. Sin embargo, en la práctica su éxito dependería sustancialmente de la capacidad de las instituciones para superar un legado de conflictos sobre atribuciones y recursos. En el contexto peruano, puede que sea difícil plantear una reformulación de CONCYTEC dirigida a asignarle, como misión "nueva", la misma tarea que no pudo realizar en el marco de la Ley de C&T de 2004.

c) Diseño coordinado de políticas con un conjunto distribuido de organismos de implementación

Esta tercera opción toma como referencia las estructuras de gobernanza que han sido implementadas exitosamente en Chile. En esta opción el ente interministerial que dirige el proceso de gobernanza es responsable directo de fijar prioridades, definir orientaciones estratégicas de política y realizar asignaciones presupuestarias. Este esquema no contempla la existencia de un organismo implementador principal. Los ministerios

sectoriales involucrados en el proceso de coordinación son los encargados de supervisar y financiar los organismos descentralizados que ejecutan las políticas. En caso de Perú esto requeriría:

- La creación mediante ley de un Comité Interministerial de Ciencia, Tecnología e Innovación. Este comité podría incluir a la PCM y los Ministerios de Economía y Finanzas, Producción, Educación, Agricultura, Salud, Energía y Minas, Transporte y Comunicaciones. Dadas sus atribuciones interministeriales, la PCM o el MEF pudieran presidir u orientar el comité. Debido al papel del MEF en la asignación presupuestaria, la supervisión de inversiones públicas y la operación de marcos regulatorios, ese ministerio pudiera ser el más adecuado para presidir el comité.
- CONCYTEC continuaría adscrito al Ministerio de Educación. Con mayores recursos y una mejor capacidad gerencial, sus competencias serían similares a las del CONICYT chileno, dando apoyo a la investigación científica y el desarrollo tecnológico (incluyendo la infraestructura) mediante financiamientos institucionales y competitivos, el desarrollo de recursos humanos y la evaluación de los institutos públicos de investigación.
- MEF y PRODUCE compartirían la responsabilidad de administrar los fondos de innovación orientados a promover la innovación y la difusión y transferencia de tecnología en el sector privado.
- Los institutos públicos de investigación seguirían operando como organismos adscritos a sus respectivos ministerios, con un representante de CONCYTEC en sus juntas directivas. Dichas juntas estarían encargadas de diseñar y monitorear el acuerdo de desempeño suscrito por sus respectivas instituciones.

Al igual que en Chile, el comité podría ser asesorado por un pequeño consejo consultivo de C&T integrado por un número limitado de representantes de institutos públicos de investigación, universidades públicas y privadas y el sector empresarial. Este ente sería el encargado de proponer orientaciones estratégicas de política pública, introducir nuevos instrumentos de política, consolidar programas de apoyo y reformar regulaciones que inciden sobre el desempeño de la innovación. También podría confiársele la evaluación de políticas y dotarlo de un sistema de información para monitorear el desempeño del sistema de innovación.

Esta opción parece la más ajustada a las necesidades actuales de Perú, ya que: *i)* confirma el compromiso de alto nivel con la C&T al asignar la responsabilidad de la gobernanza a un ente interministerial, evitando de este modo el riesgo de su captura por un organismo principal de implementación; *ii)* garantiza un menor solapamiento de responsabilidades en los organismos de implementación; y *iii)* fomenta complementariedades interinstitucionales y la cooperación entre organismos en el diseño e implementación de políticas.

Cualquiera que sea la opción adoptada, el establecimiento de nuevos procedimientos de gobernanza plantea problemáticas de transición asociadas con la gerencia de los programas de apoyo existentes. Esto incide particularmente sobre los programas financiados por instituciones financieras multilaterales, dada su importancia en la arquitectura actual de políticas de C&T y su buen desempeño general. Adoptar un nuevo marco de gobernanza no debería poner en peligro la operación de programas relevantes y eficaces. En el caso de INCAGRO, el programa ya ha sido adscrito al Instituto Nacional de Innovación Agraria (INIA). Si la calidad de la gerencia mantiene los estándares anteriores, algo lejos de estar garantizado, este cambio sería compatible con los

procedimientos de gobernanza propuestos. En el caso de FINCYT, este informe recomienda que sea renovado para continuar en fases adicionales bajo el auspicio del MEF, manteniendo su gerencia actual y monitoreando sus procedimientos – o mejorándolos si llegan a eliminarse o reducirse los obstáculos regulatorios actuales. Finalmente, FINCYT debería orientarse principalmente al suministro de programas de apoyo a la innovación privada y ser fusionado con FIDECOM.

Recomendaciones específicas

A continuación se resumen algunas de las recomendaciones de política propuestas en este informe, así como otras implícitas en la evaluación del sistema peruano de innovación y los desafíos institucionales y de política pública que enfrenta el país.

Educación superior y recursos humanos

- Acelerar el establecimiento, en el conjunto del sistema de educación superior (universidades e institutos de alta tecnología), de un proceso de acreditación compatible con estándares reconocidos internacionalmente.
- Iniciar una reforma de la gobernanza universitaria que promueva la excelencia en la investigación y facilite la retención y promoción del personal más calificado. Usar el financiamiento institucional de las universidades públicas para llevar a cabo esta reforma y realizar una transición hacia modelos de financiamiento basados en el desempeño como los implementados en muchos países de la OCDE. Estos modelos vinculan el financiamiento institucional con criterios de excelencia; además, una porción creciente de los recursos para actividades de C&T proviene de subvenciones competitivas y del suministro de servicios de investigación y desarrollo tecnológico.
- Fomentar la participación en redes internacionales de investigación mediante becas de investigación otorgados en el marco de acuerdos de cooperación internacionales en áreas prioritarias para Perú.
- Promover, con la participación de INDECOPI, el desarrollo de prácticas de gerencia de DPI en el sector de educación superior, concentrando esfuerzos prioritariamente en instituciones con el mayor potencial en materia de C&T.
- Reformar la Ley de Canon para ampliar el concepto de inversión pública de modo que incluya al capital humano. Ampliar las posibilidades para que las universidades regionales puedan utilizar recursos de la Ley de Canon en proyectos de colaboración en I&D con otras universidades o con empresas privadas, o para realizar gastos alternativos que eleven sus capacidades de C&T (p.ej., becas para doctorados y pos-doctorados; repatriación de investigadores).
- Eliminar barreras universitarias (equivalencia de créditos) que impiden que estudiantes de institutos de alta tecnología emprendan estudios de posgrado en el sistema universitario.
- Evaluar la posibilidad de elevar considerablemente el número de becas para estudios de posgrado en universidades nacionales y extranjeras.
- Proporcionar incentivos al sector privado para contratar graduados con posgrados en C&T, con cláusulas de caducidad.

- Hacer menos estrictas las regulaciones que impiden la participación o contribución de investigadores universitarios públicos en actividades o proyectos de C&T realizadas por empresas privadas y que, en términos más generales, dificultan la movilidad interinstitucional.
- Desarrollar programas que atraigan a científicos extranjeros o expatriados, tomando en consideración las experiencias de otros países.

Institutos públicos de investigación

Definir criterios de calificación para la condición de instituto público de investigación (*p.ej.,* proporción del personal de C&T en el personal total); ajustar su situación legal para acercarla a la practicada en otros países latinoamericanos o de la OCDE, en la medida en que lo permitan las instituciones y leyes peruanas, con miras a ampliar su autonomía gerencial, particularmente en materia de recursos humanos, y reducir los efectos perversos de reglas laborales rígidas y contratos de corta duración para investigadores calificados.

Reformar la gobernanza de los IPI para velar por que cumplan eficazmente sus objetivos centrales de investigación, desarrollo y difusión tecnológica. Ampliar la composición de sus juntas directivas para incorporar a representantes de las principales partes interesadas en sus labores. Implementar la rendición de cuentas e instituir acuerdos de desempeño con consecuencias sobre el volumen de los recursos obtenidos del financiamiento institucional y fijar objetivos sobre la porción del financiamiento que deberá provenir de subvenciones competitivas, contratos y ventas de servicios tecnológicos. Los acuerdos de desempeño deberían incluir proyecciones o compromisos provisionales sobre los retornos previstos en emprendimientos de colaboración y ventas de servicios, así como indicaciones, de corresponder, sobre las perspectivas de colaboración internacional.

- Desarrollar capacidades gerenciales en materia de DPI, en coordinación con INDECOPI.
- Evaluar la posibilidad de racionalizar el sistema de institutos públicos de investigación mediante la disolución, fusión o privatización parcial de algunos institutos, tomando como criterio el cumplimiento de acuerdos de desempeño a lo largo de varios años y la adopción de economías de escala o alcance.
- Promover el desarrollo de un consorcio formal de IPI para promover programas o proyectos de investigación multidisciplinarios y facilitar la movilidad del personal.
- Evaluar el posible uso de recursos provenientes de la Ley de Canon, en colaboración con las universidades que se benefician de ellos.
- Proporcionar incentivos para la movilidad de personal de C&T que labora en los IPI hacia el sector privado y viceversa*,* facilitando o ampliando la contratación de estudiantes de posgrado mediante becas de CONCYTEC y becas de investigación.
- Incentivar la participación de los IPI en redes internacionales de investigación, particularmente mediante mecanismos de cooperación específicos con instituciones de investigación en otros países de la región y fuera de ella.

Promoción de la innovación en el sector empresarial

- Dar un papel más destacado al sector empresarial en la gobernanza del sistema de innovación y la definición de orientaciones estratégicas y prioridades de política pública.
- Prestar más atención a impedimentos a la innovación relacionados con cuellos de botella o carencias en la infraestructura física (transporte, tecnología de información y comunicaciones, logística) que afectan a todos los sectores, así como a impedimentos a la innovación en la infraestructura de C&T (metrología, estándares, DPI) que afectan principalmente a las PyMEs.
- Fortalecer la capacidad de INDECOPI para hacer cumplir las leyes de protección de DPI y de competencia, difundir una cultura de PI y mejorar las capacidades de gerencia de DPI en el sector empresarial.
- Mantener los programas basados en cadenas de valor desarrollados por PRODUCE y MINCETUR.
- Abordar los obstáculos a la creación y desarrollo inicial de nuevas empresas basadas en tecnología (NEBT). Evaluar la posibilidad de crear mecanismos específicos de apoyo en el marco de los fondos de innovación existentes; realizar una evaluación de barreras al espíritu emprendedor, tomando sus conclusiones como insumo para emprender reformas.
- Iniciar una política de compras gubernamentales dirigida a apoyar la innovación en sectores donde existe una demanda social sustancial (salud, energía, transporte, medio ambiente, educación).
- Revisar los regímenes regulatorios que rigen la transferencia de recursos públicos al sector privado a la luz de la legitimidad de dichas transferencias para fomentar actividades privadas de C&T e innovación.
- Seguir ofreciendo primas a proyectos de colaboración público-privados en las subvenciones otorgadas por fondos de innovación (proyectos que surgen de la base).
- Evaluar la posibilidad de implementar programas de apoyo orientados hacia objetivos o de naturaleza sectorial (impulsados desde arriba) basados en acuerdos de colaboración entre los sectores público y privado que contemplen la contribución de recursos correspondientes por parte de empresas, IPI o, posiblemente, gobiernos regionales. Usar este instrumento para desarrollar agrupaciones productivas ("clusters"). Seleccionar programas en base a criterios relacionados con el interés nacional y las dotaciones de recursos naturales que pudieran generar ventajas competitivas (*p.ej.,* biodiversidad).
- Eliminar o reducir obstáculos legales a la colaboración entre institutos públicos de investigación y el sector privado; facilitar la concreción de acuerdos contractuales.

Instituciones de intermediación

- Evaluar la posibilidad de una expansión significativa de los CITEs en términos de: cobertura sectorial; fortalecimiento de su capacidad de C&T en investigación aplicada para atender mejor a empresas con potencial de innovación; elevar la

capacidad de demanda de tecnología de una cartera más extensa de empresas u organizaciones de baja capacidad tecnológica; y ofrecer servicios de capacitación para esas empresas.

- Fortalecer instituciones que proporcionan infraestructura de C&T intangible (información tecnológica, DPI, metrología, certificación, estándares) y facilitar el acceso a sus servicios y sus DPI.

Reforma legal y regulatoria

- Revisar el código tributario para fijar reglas claras que permitan amortizar la inversión en actividades de I&D contra las ganancias.
- Evaluar la posibilidad de incluir disposiciones en la Ley de Carrera Pública y las reglas que rigen los contratos CAS que contemplen la naturaleza específica de las actividades de C&T.
- Modificar leyes laborales que impiden la movilidad institucional de investigadores públicos y, en términos más generales, las leyes y reglamentos que imponen restricciones a acuerdos de colaboración entre entes públicos y privados.
- Examinar y modificar los procedimientos SNIP aplicables a la inversión pública en actividades de I&D y de innovación (o al apoyo público a dichas actividades). En cuanto a la aplicación de procedimientos SNIP a proyectos de fondos de innovación, las reglas aplicadas a FINCYT deberían generalizarse.

Temas de transición

El futuro de los fondos o programas de innovación que se benefician de préstamos otorgados por instituciones financieras multilaterales, como INCAGRO y FINCYT, es un tema significativo. Su importancia para la promoción de las capacidades de C&T y el desempeño de la innovación en el Perú es evidente. Las razones de su éxito son diversas, pero las principales son:

- En primer lugar, han logrado catalizar la demanda latente de investigación y desarrollo tecnológico y están contribuyendo de manera efectiva con un incremento en la capacidad de C&T en el conjunto de la economía, tanto en el sector privado como en el público, que no había sido logrado por otros tipos de programas.
- En segundo lugar, ha habido una buena correspondencia entre el diseño y orientación de estos programas y la atención de las debilidades reconocidas del sistema de innovación de Perú.
- Finalmente, su operación en términos de gerencia y prestación ha sido eficaz, a pesar de los numerosos obstáculos regulatorios (y a veces institucionales) enfrentados.

Como se ha mencionado previamente, tanto FINCYT como INCAGRO deberían ser renovados por períodos adicionales, manteniendo los mismos marcos institucionales actuales y los mismos procedimientos de gerencia y monitoreo – o incluso mejorándolos, si algunos obstáculos regulatorios llegan a ser eliminados o reducidos. En el futuro mediato este tipo de fondos y programas deberá eventualmente ser financiado por el Tesoro peruano. En ese caso, es posible que su diseño, orientación y gerencia sean modificados de conformidad con la evolución en las formas de gobernanza sugeridas en párrafos anteriores.

Cuadro resumen: Análisis FODA (fortalezas, debilidades, oportunidades, amenazas) del sistema de innovación de Perú

Fortalezas	Debilidades
• Entorno macroeconómico sano y estable • Industrias sólidas basadas en recursos naturales y orientadas a la exportación • Existencia de algunos programas de apoyo de fondos correspondientes bien diseñados y administrados (fondos) que evidencian la presencia de un potencial latente de I&D, C&T e innovación y logran catalizar el desarrollo de actividades de investigación, desarrollo e innovación (IDI) • Instituciones de transferencia de tecnología (CITEs) en plena operación • Espacios de excelencia en materia de investigación científica • Existencia de empresas líderes con modelos de negocios innovadores • Desempeño sano de algunas instituciones de formación profesional y vocacional	• Registros muy bajos de inversión pública y privada en actividades de IDI • Falta de mecanismos eficaces de gobernanza, lo que hace que surjan conflictos institucionales en torno a atribuciones y recursos • Falta de vinculación entre ejercicios de planificación y asignaciones presupuestarias • Sistema de información, monitoreo y evaluación deficiente; falta de datos sobre actividades y recursos de CTI • Efectos perversos de leyes y reglamentos que rigen la inversión pública en actividades de CTI • Demoras en procedimientos administrativos debido a trámites burocráticos significativos • Desempeño débil de I&D y gobernanza deficiente en la mayoría de las instituciones del sistema de investigación pública y el sistema académico • Articulación débil entre el sector empresarial y las instituciones públicas de investigación • Debilidad en la cultura de PI y en las capacidades de gerencia de PI en los sectores público, privado y de educación superior • Suministro limitado y baja movilidad de recursos humanos en ciencia y tecnología • Falta generalizada de capacidad de absorción en la mayoría de las PyMEs; peso significativo del sector informal • Desempeño inadecuado del sistema educativo y sesgo favorable a estudios de posgrado distintos a los de C&T • Baja diversidad en la estructura de producción obstaculiza efectos de traslado intersectorial de tecnologías • Desarrollo limitado de agrupaciones productivas (“clusters”) basadas en recursos naturales • Alto nivel de formalidad y baja eficacia en la coordinación entre gobierno central y gobiernos regionales en materia de inversión y programas de apoyo a la IDI • Mercados financieros poco preparados para atender inversiones relacionadas con innovación • Rezagos en la inversión en infraestructura

…/…

Cuadro resumen: Análisis FODA (fortalezas, debilidades, oportunidades, amenazas) del sistema de innovación de Perú *(continuación)*

Oportunidades	Amenazas
• Mayor conciencia política del papel del gobierno en el fomento de la innovación • Elevar la consciencia del sector privado sobre la importancia de la inversión en innovación • Respaldo continuo de las instituciones financieras multilaterales al financiamiento de programas de apoyo a la I&D y la innovación • Incremento en los traslados intersectoriales de tecnología ocasionados por la inversión extranjera directa • Mayor explotación de recursos agroindustriales y de biodiversidad mediante la innovación • Desarrollo más profundo de agrupaciones productivas de PyMEs y mayor participación de PyMEs en la cadena de suministros	• Posible volatilidad de mercados tradicionales de exportación basados en recursos naturales • Bajos niveles de traslado intersectorial de tecnologías en la estructura productiva por la carencia de programas proactivos de apoyo • Rigideces institucionales que limitan la experimentación en el diseño e implementación de políticas o llevan a su captura por instituciones ineficaces • Posibles conflictos por la endogenización de programas de apoyo financiados parcialmente por instituciones financieras multilaterales • Escasez de personal altamente calificado en C&T

Notas

1. Que comprende parte de la recaudación del Impuesto a la Renta y regalías cobradas a las empresas mineras, petroleras, gasíferas, hidroeléctricas, forestales y pesqueras.
2. Inferencias basadas en la Encuesta de ENCYT de 2004 para empresas con una facturación de US$ 30.000 o más (CONCYTEC, 2010).
3. En países más avanzados y países en desarrollo los centros de tecnología han desarrollado capacidades de I&D *intra muros* y ampliado de esta manera su cartera de servicios. Esto también es cierto en Colombia.
4. Este mecanismo resultó ser más complicado de implementar en el caso de INCAGRO que en el de FINCYT.
5. El artículo 37 de la ley tributaria (*Ley de Impuesto la Renta*) define los gastos que pueden ser amortizados contra las ganancias. En el caso de costos relacionados con la innovación la empresa debe proporcionar pruebas de que estos gastos son "necesarios para producir y mantener la fuente de ganancias". El riesgo de exponerse a posibles multas si las pruebas no son aceptadas por los auditores tributarios lleva a las empresas a abstenerse de amortizar estos gastos.
6. INCAGRO desempeñó un papel positivo en la conducción del "sistema de innovación agraria" y FINCYT hizo lo mismo para el sistema de innovación en su conjunto. A pesar de su éxito, estos programas carecían de la legitimidad institucional requerida para participar en un proceso participatorio de conducción del sector.
7. Sin embargo, en caso de FINCYT la decisión de otorgarle un alcance amplio fue el más apropiado y la mejor solución alternativa al no poder adoptarse la que hubiera sido preferible.
8. Este modelo de gobernanza es en esencia el aplicado en México, con CONACYT como agencia descentralizada bajo la autoridad de la Presidencia de la República. Sin embargo, y

además de CONACYT, varios ministerios sectoriales tienen responsabilidades importantes en el desarrollo de políticas de C&T y en el financiamiento de instituciones y programas de apoyo relacionados con la C&T.

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Chapter 1

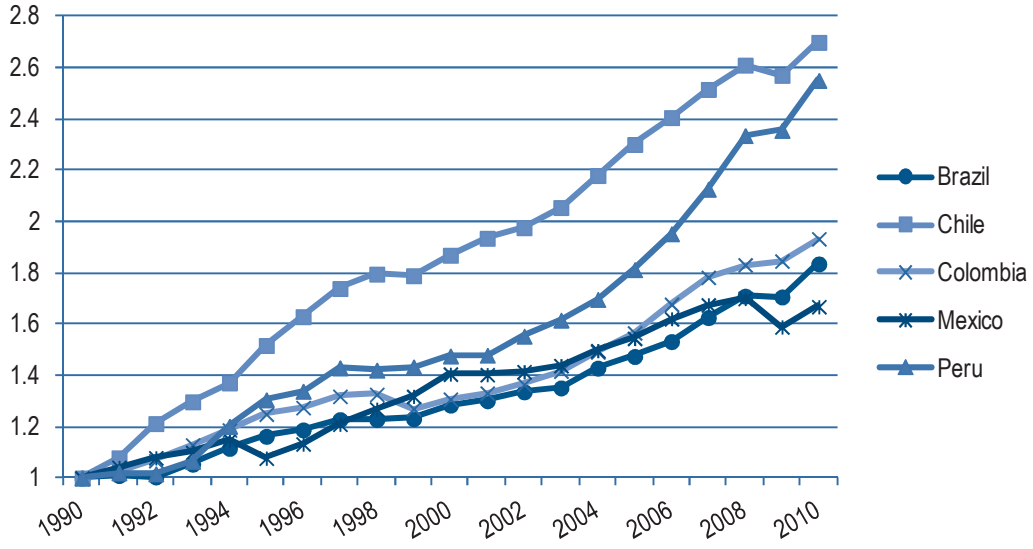
Economic performance and structural change: Innovation as a key driver of sustainable growth

This chapter first provides a short overview of Peru's economic performance in the medium-term and discusses emerging issues of the sustainability of a high-growth path, including a weak diversification of exports, the predominance of technologically undeveloped business firms and the productivity challenge faced by Peru. Attention is next drawn to the potential role of innovation as a key driver of sustainable future growth. Subsequently the focus is put on major aspects of the framework conditions – such as macroeconomic stability, international openness, an innovation-friendly regulatory regime, well-functioning financial and other markets, infrastructure and, importantly, qualified people – which are necessary for innovation performance to take off although they need to be complemented by additional measures. Pointing at a currently insufficient information base, the final section benchmarks Peru's innovation performance which is characterised as being at a low level by international standards overall.

1.1. Impressive growth in the last decade

A 15-year period of economic collapse, during which GDP per capita dropped dramatically in Peru, ended at the beginning of the 1990s. Since then economic growth has picked up vigorously, with a marked acceleration at the beginning of the 2000s. Between 2001 and 2010, GDP rose at an average annual 6.3%, and GDP per capita grew by 4.5% a year, making Peru one of the top economic performers in Latin America (Figure 1.1, Table 1.1). The economy also demonstrated remarkable resilience in the face of the 2008 financial crisis; it was one of the few countries in which the economy continued to grow in 2009, albeit moderately, by 0.9%, and accelerated again in 2010.

Figure 1.1. Growth of GDP: Peru and selected Latin American countries, 1990-2010



Source: IMF, World Economic Outlook Database.

This impressive recovery has been underpinned by a number of factors that jointly exerted positive effects over the last two decades, and particularly since 2002. Among the factors underpinning Peru's remarkable performance are the sound macroeconomic policies initiated in the 1990s to stabilise the economy, coupled with structural reforms aimed at improving the functioning of product and labour markets, and the economic and business environment more generally, and the greater openness of the economy to international trade and foreign investment. Beyond the short-term dampening effect of stabilisation measures on economic activity, these policies and reforms facilitated a strong recovery. They contributed to a more efficient allocation of resources and encouraged investment, labour and capital productivity, and job creation. In due time, they allowed Peru to reap the benefits of increased demand from both developed and emerging economies for the country's natural resource-based sectors and traditional industries and allowed it to exploit its comparative advantages.[1]

Stable macroeconomic policy triggered the return to sound fundamentals

At the beginning of the 1990s the rate of inflation reached three digits but during the last decade it dropped dramatically to fluctuate between 2% and 4%.[2] The reduction of interest rates facilitated by the check on inflationary pressures helped to sustain investment and aggregate economic activity. Over the last decade the ratio of private gross fixed capital formation to GDP has averaged close to 19%, with a peak of 22.5% in 2008.[3] Public finances also showed a marked improvement owing to the combined effects of better control over budgetary expenditures and increased fiscal revenues from the expansion of economic activity, along with a broader tax base and stricter enforcement of tax collection. The improvement in public finances led to a rapid decrease in the public debt as a proportion of GDP from 45.5% in 2000 to 23.9% in 2010.

Table 1.1. Growth of GDP per capita, Peru and selected Latin American countries, 2001-10

	Annual average growth at constant prices	GDP per capita (current prices USD PPP)[1]		
	(local currency)	2000	2005	2010
Peru	**6.3%**	**5 069**	**6 474**	**9 358**
Brazil	3.8%	7 207	8 603	11 273
Chile	3.8%	9 507	12 244	15 040
Colombia	4.4%	5 855	7 340	9 593
Mexico	1.9%	10 823	12 483	14 406

1. Implied PPP conversion rate of national currency per international US dollar.

Source: IMF, World Economic Outlook Database.

Peru's recovery has begun to produce positive, albeit still moderate, effects on living standards and poverty reduction. While a significant share of the population remains marginalised, living either under conditions of semi self-sufficiency in rural or on precarious informal jobs in urban areas, the share has diminished as the economy has expanded, especially in the export-oriented and services sectors, and as new opportunities have arisen in the agricultural and agro-industrial sectors. Having reached more than 50% in the early 2000s, the poverty rate[4] declined from 2003 to 35% in 2009.

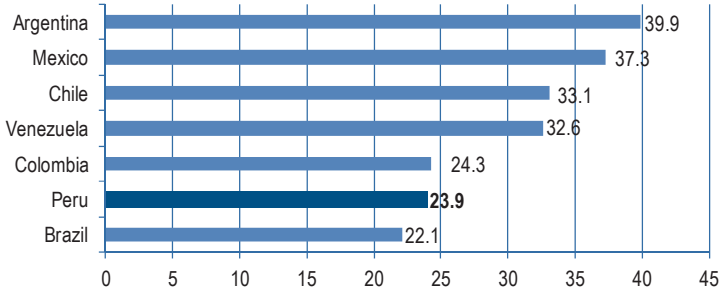
However, this excellent performance should not lead to complacency. Income disparities remain high. Informal jobs still account for a large share of total employment. The growth of real wages lags behind the rise in labour productivity and in 2008 barely reached the level of ten years earlier. Peru still lags behind most Latin American countries in terms of productivity, per capita income, and investment in human capital and knowledge.

Structural reforms lead to more efficient resource allocation

Although Peru's labour productivity is still low compared to other Latin American countries (Figure 1.2) it grew at an average annual 3.8% between 2002 and 2008.[5] This was mainly due to more efficient allocation of resources across sectors and, to a much lesser extent, within sectors (apart from the most export-oriented). This reallocation was facilitated by structural reforms and had a positive effect on investment, employment and productivity in an economic environment characterised by macroeconomic stability and expanding export markets for the resource-based industries in which Peru enjoys a comparative advantage. However, the process of structural reform has slowed somewhat in the last decade even though certain structural rigidities remain, notably in the labour market and the regulatory environment that affects the creation and development of businesses (BCRP, 2008; WEF, 2010).

Figure 1.2. Labour productivity,[1] Peru and selected Latin American countries, 2009

(United States = 100)



1. GDP per worker.

Source: World Bank (2010).

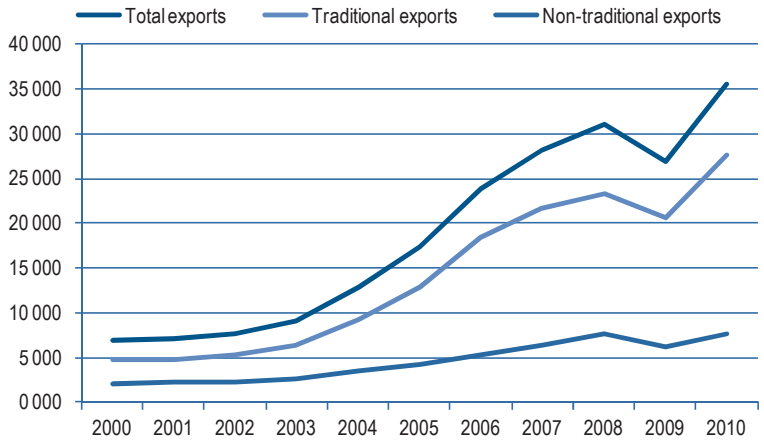
Greater openness to international trade and foreign direct investment

As part of its structural reforms since the early 1990s, Peru adopted a more open stance towards international trade, complemented by liberalisation of foreign direct investment (FDI), to foster economic growth and competitiveness. This involved the liberalisation of international trade, the elimination of restrictions on imports, the simplification of the tariff structure and lower effective protection. These measures were complemented by initiatives to improve market access, promote Peruvian exports, and support Peruvian exporters abroad and international and domestic tourism in Peru.[6] During the second half of the last decade, this orientation was reinforced by important free trade agreements (FTA), notably with the United States, China, Chile, Canada, Singapore, the European Union, and, more recently, Korea.[7] As a result, Peru's trade openness (measured as the ratio of exports plus imports to GDP) grew dramatically, from 21% to 49% between 1990 and 2010. Coupled with a significant and sustained improvement in Peru's terms of trade, this generated a boom in exports. Exports grew more than fivefold from the beginning of the decade to exceed USD 35 billion in 2010 (21.2% of GDP) and led to a surplus in the trade balance which helped to fuel growth momentum.

However, the growth of exports has not been accompanied by a diversification of the export structure. Rather, the export boom has consolidated the prevailing export structure, which is largely concentrated in traditional natural resource-based products, mainly commodities with low levels of processing.[8] Over the last decade some diversification has taken place in terms of both exports and destinations, with a threefold increase in non-traditional exports. Nonetheless, the latter's share in total exports actually declined from 30% to 21% in the course of the decade (Figure 1.3).[9]

Figure 1.3. Total, traditional and non-traditional exports, 2000-2010

USD millions

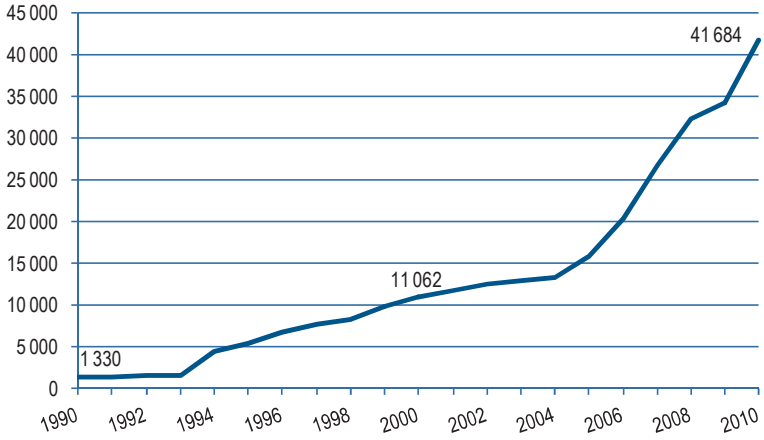


Source: BCRP (2008).

After the surge that followed the privatisation of public enterprises at the beginning of the 1990s, FDI flows continued to grow, albeit at a more modest rate, in the first half of the past decade but then quite strongly (Figure 1.4), mainly in the mining, manufacturing, energy, communications and financial sectors. Together these accounted for close to 85% of the total FDI stock in 2009.

Figure 1.4. Net stock of foreign direct investment, 1990-2010

USD millions



Source: BCRP.

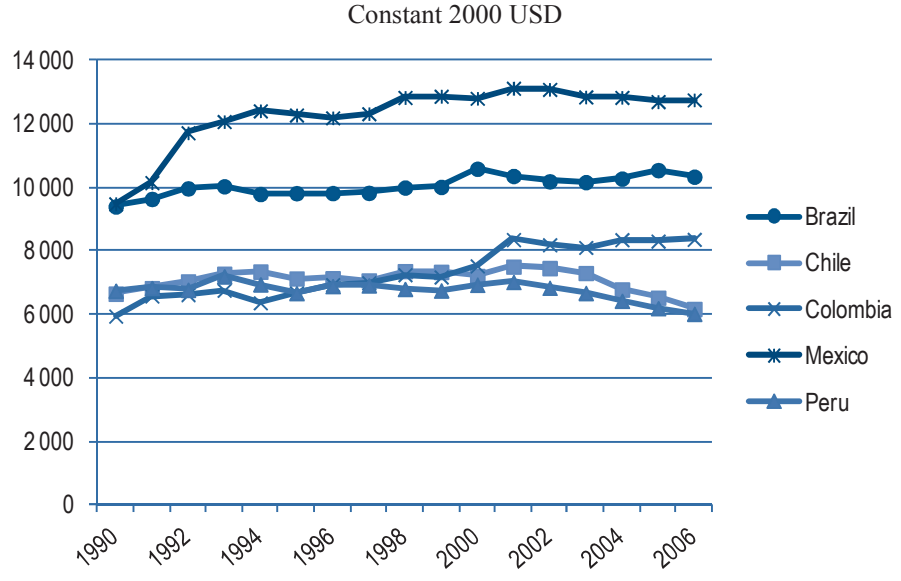
The boom in FDI not only had a strong impact on output growth in these industries, it also contributed to their modernisation and to a boost in productivity, making them the most dynamic industries in the Peruvian economy. However, this had very little effect on the rest of the economy in terms of the development of supplier industries, the emergence of integrated value chains, and technology spillovers to other sectors.[10] The technology used by these industries is largely in the form of imported machinery and equipment and know-how, so that their technological upgrading does not contribute significantly to the development of S&T capacity or to the strengthening of knowledge interactions with public S&T institutions through demand for R&D services or collaborative innovation activities.

1.2. Sustainability of the development path: Emerging issues

Little diversification of exports

Peru's export structure remains specialised in an unsophisticated export basket essentially based on natural resources-based commodities and relatively low labour costs in price-elastic low-/medium-technology manufactures such as textiles. Peru is likely to encounter increasing competition from countries with similar comparative advantages, unless it makes progress in diversification through technological and non-technological innovation. For its natural resource-based exports Peru also faces the uncertainty of world demand and the price volatility of commodities. The fact that Peru's economy is overly dependent on cyclical commodity prices raises concerns about sustainability in the long term, especially its capacity to overcome less favourable international conditions or external shocks, such as the collapse of its exports in the 1980s. This situation constrains the economy's growth potential. In contrast to countries such as Mexico, Brazil, Colombia, Costa Rica and Ecuador, which started with similar initial levels of export sophistication three decades ago, Peru has failed to move to more sophisticated, higher value-added products (Figure 1.5).

Figure 1.5. Export sophistication (EXPY), Peru and selected Latin American countries, 1990-2006



Source: World Bank PRMED, *http://info.worldbank.org/etools/prmed/Default.aspx*.

Overall, unlike developed countries such as Australia and Norway or some emerging economies such as South Africa, where natural resources also make a large contribution to exports and growth, Peru has shown little ability to leverage its resource base to diversify into upstream and downstream industries (linked to the mining and energy sectors), including in knowledge-intensive services, or to address the sustainable use of its large biodiversity resources. This is partly due to the business sector's weak incentives to invest in activities for which the returns appear more uncertain than those expected from keeping with standard practices and the import of technologies to meet expanding global demand. But even if incentives to invest in such activities were more powerful, business would still be faced with the problems of scarce qualified human resources and poor S&T infrastructure to engage efficiently and in a significant way in a diversification process around the natural resources sector, either in the development of medium to high technology in upstream and downstream industries.

While companies in the better-performing sectors of the Peruvian economy possess a stock of technological knowledge and sectoral technology transfer institutions (CITEs) have recently been established, cross-sectoral diffusion of technology from the more technologically advanced export-oriented mining and agro-industrial sectors remains limited. Cross-sectoral spillovers are hindered by the relatively low pervasiveness of the technologies used in these sectors. The lack of variety in production and exports also hampers the emergence of technology-based value chains and knowledge transfer, a problem that is compounded by a lack of absorptive capacity (Haussmann and Klinger, 2008).

Small, technologically undeveloped enterprises predominate

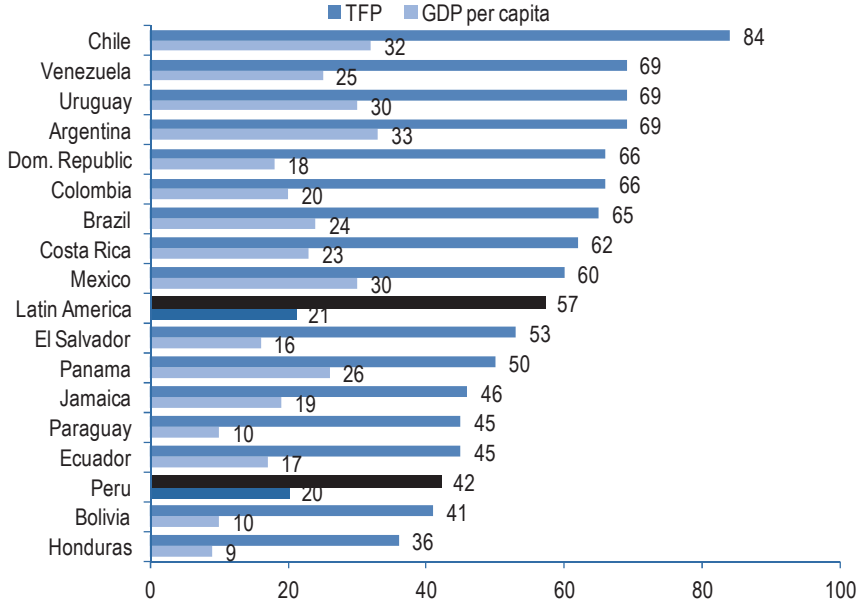
One of the main reasons for the very low level of productivity of the Peruvian economy is the overwhelming share of small and micro companies and self-employed workers (or one-person enterprises). These are typically the least productive businesses in developing countries. In 2006, micro and small firms accounted for about 99% of all formal private businesses or corporate taxpayers,[11] 88% of employment and 41% of GDP generated by private firms.[12] In contrast, 800 large and almost 11 000 medium-sized companies (1.2% of total private enterprises) together account for 11.8% of employment, and account for 58.5% of the private business sector's contribution to GDP.[13] On average, compared with large enterprises, medium-sized, small and micro companies are respectively 2, 6 and 15 times less productive (GRADE, 2010).[14] The business sector's very low overall propensity to invest in scientific, technological and innovation activities and the very skewed distribution of such investment, which is concentrated in large and medium-sized firms, also help explain the low overall level of productivity of the Peruvian economy. Productivity increases are mainly due to intersectoral reallocation of resources and, within sectors, to enterprises with higher productivity that have undertaken technological upgrading and offer better growth opportunities.[15]

The productivity challenge

As highlighted in a number of studies of Peru's economic growth dynamics ,[16] the accumulation of capital and labour has been the main source of growth, a pattern consistent with those observed in most fast-growing developing countries. Total factor productivity (TFP), whose contribution to growth represents, *inter alia,* factors related to technological innovation and more efficient mixes of production factors, remains very

low in Peru – not only as compared to high income countries but also as compared to other Latin American countries (Figure 1.6).

Figure 1.6. Relative TFP and GDP per capita in Latin American countries, 2007



Source: Vera Tudela (2010).

Moreover, as illustrated in Table 1.2, the contribution of TFP to GDP growth over the last 40 years was negative in the first half of the period and very weak in the second. The variation in TFP over time reflects a combination of factors that underpin Peru's specific pattern of growth in a historical perspective.[17]

Table 1.2. Contributions to GDP growth in Peru, 1971-2007

	1971-80	1981-90	1991-2000	2002-04	2005-07	1995-2007
GDP growth	3.5	-0.6	4.1	4.7	7.4	4.5
Contribution of labour	2.2	2.0	1.9	1.1	1.0	1.2
Contribution of capital	2.4	1.4	1.3	3.6	4.6	3.2
Contribution of TFP	-1.1	-4.1	0.9	0.0	1.9	0.0

Source: Abusada and Cusato (2007) for 1971-2000 and, BCRP (2008) for 2002-07.

- First, throughout the period, the low level of investment in research and development (R&D) and other innovation-related activities, notably in the enterprise sector, has been, and continues to be, a characteristic weakness of the Peruvian economy. Without increases in such investment, and a concurrent development of absorptive capacity, technological progress remains largely limited to technological upgrading embedded in capital investment with modest productivity gains and little inter and intra-sectoral spillovers.

- Second, the very poor TFP performance in the 1970s and 1980s can largely be explained by the misallocation of resources due to ill-judged macroeconomic and microeconomic policies in the context of falling terms of trade. These affected export-driven growth and led to inefficient combinations of factors of production. In contrast, the positive, albeit small, contribution of TFP in the 1990s reflects an improvement in the resource allocation process due to sounder macroeconomic management, the alleviation of constraints that prevent efficient functioning of product and labour markets, as well as trade and FDI liberalisation policies.
- Third, the contribution of TFP gradually became nil by the middle of the present decade as the benefits from the improved allocation of resources became exhausted. In the absence of other factors, such as the entry of new and more productive firms and stepped-up innovation-related investment, including in skilled human capital, the contribution of TFP is bound to remain weak and limited to technological upgrading (which is not reflected at the macro level). A parallel can be made with the case of Chile where the trend in TFP declined sharply after the so-called "golden period "of the 1990s (Table 1.3). In fact, as argued in a recent study commissioned by Chile's National Council of Innovation for Competitiveness (Bitran and González, 2010): "Once the benefits [of TFP] have been reaped in the first years following structural changes signs pointing to an exhaustion of the model begin to appear".
- Fourth, the TFP pick-up that occurred after 2005 is promising but might not be yet a decisive turning point. This evolution can result from increased reliance on technological inputs in export industries, such as the adoption of technological best practices to reap the benefits of comparative advantages in the non-traditional agro-industrial sector in Peru's coastal area. It may therefore be due more to a significant increase in the terms of trade and FDI flows than to widespread endogenous technological development and diffusion (Tello and Tavara, 2010).

Table 1.3. Contributions to GDP growth in Chile, 1986-2008

	1986-91	1992-2007	1998-2003	2004-08
GDP growth	6.7	7.9	2.7	4.7
Contribution of labour	2.8	2.1	1.2	2.7
Contribution of capital	1.8	3.6	2.2	3.1
Contribution of TFP	2.1	2.2	-0.7	0.0

Source: OECD calculations based on Chile's MEF data (OECD, 2010a).

Without more vigorous innovation and TFP growth, the main contributions to Peru's GDP growth would have to come from: *i)* a deepening of the accumulation process based on an increase in the volume and/or productivity of capital and labour inputs that have still margins for increasing returns to scale; and *ii)* continuous exploitation of static comparative advantages. This is certainly a possible growth path but has important limitations that reduce its sustainability in the longer term.

While the manufacturing sector still has a low capital/output ratio and a large infrastructure deficit,[18] heavy dependence on commodity exports carries risks in terms of world demand, price volatility and effects on levels of income and output. In the longer term the benefits of capital accumulation are bound to decline owing to diminishing returns to scale in the absence of sustained productivity gains. This calls attention to the central roles of TFP in ensuring growth sustainability and investment in physical and intangible infrastructure as a vital enabling factor.

Demographic expansion and high levels of informal and partial employment create margins of manoeuvre for increasing the labour force in the formal sector of the economy. However, the expected contribution of labour input to GDP growth is limited by the quality of the workforce and the difficulty of raising the level and range of qualifications significantly given the rather poor performance of the education system.[19] Raising the overall skill level of the labour force to bridge the gap between demand and supply of qualified workers and raise productivity remains a formidable challenge to enhance Peru's innovation performance. It is a long term endeavour that requires not only significant resources but also long overdue institutional reforms throughout the education system.

In sum, while a growth path based on factor accumulation is still viable, its sustainability is eroding. Given the low level of labour productivity and the constraints that are bound to affect capital accumulation, it is essential to raise both the skills of the labour force through improvements in the education system and the contribution of TFP to growth through increased investment in tangible and intangible knowledge assets at the macro and micro levels. As the returns to such investments take time, they should have the highest priority for ensuring the competitiveness of the private sector.

1.3. Framework conditions for innovation

Shifting to a more sustainable growth path driven by innovation and productivity gains requires overall framework conditions that nurture a climate conducive to business-sector innovation. They can help to increase the impact of dedicated S&T policy measures directly aimed at strengthening the innovation performance of the economy and thus improving its competitiveness. Framework conditions for innovation are necessary for the success of any country, irrespective of its stage of development institutional specificities. At the same time it has to be more difficult for less advanced countries to put favourable framework conditions in place, as they may require a high level of institutional development and related (past and present) investment, including by the public sector. Among the framework conditions that are important for innovation the following stand out (OECD, 2010b):

- *Macroeconomic stability.* Sound macroeconomic policies that encourage a stable economy, low inflation and lower and less volatile interest rates help reduce uncertainty and enhance the efficiency of resource allocation. Overall, they create a more favourable investment framework that allows entrepreneurs to adopt a longer-term horizon for their investment decisions and reduces the risks inherent in innovation activities. There is no doubt that Peru's emphasis on a sound and stable macroeconomic policy has underpinned its growth performance in the last decade and should be pursued.

- *International openness.* International openness provides greater trade opportunities on a larger set of external markets. Better access to markets facilitates investment in innovation, as evidenced, for example, by the development of the most dynamic segments of Peru's agricultural and agro-industrial sectors. Openness also contributes to the diffusion of knowledge and technology. There is evidence for Peru, as for other technologically lagging countries, that technology diffusion through foreign investment projects has been limited.[20] This is related in part to their concentration in a small set of sectors (and a marked preference for imported technology). Rather than challenging the fundamental importance of openness, these shortcomings calls for complementary policy initiatives aimed at leveraging foreign investment opportunities by developing domestic S&T capacities and better linking foreign subsidiaries to the domestic economy, *e.g.* through innovative clusters or services.

- *Regulatory regimes.* Vigorous competition, adequate protection of intellectual property rights (IPR), good product market regulations and the development and diffusion of standards and norms can all stimulate innovation. The efforts made by agencies such as INDECOPI in the area of competition and IPR and by SENASA for certification, standards and quality control in the agriculture sector should continue, notably in terms of enforcement. The regulations and red tape that affect the creation and closure of firms also require attention; in this area Peru lags behind a number of comparable countries.[21]

- *Well-functioning financial markets.* The financing of innovation requires capital markets able to cater for risky, longer-term investment and sources of equity such as venture capital and business angels. It requires the ability to account for intangible assets when assessing loan operations, particularly for small and medium-sized enterprises (SMEs) and start-ups. Financial markets are well developed in Peru but its traditional, risk-averse banking sector has not yet adapted to the requirements of innovation financing. On the one hand, there is little demand for more sophisticated financial products. Large firms' innovation-related investment is primarily financed in house or through domestic or foreign loans for technology embedded in imported capital goods, and demand from SMEs is still low. On the other hand, Peruvian financing institutions do not generally have the ability to assess the risks and returns associated with innovation projects. Assessment capacity is currently being developed in the framework of innovation funds such as FINCYT. It could also be used to leverage complementary financing through systems of guarantees or project labelling in order to facilitate access to traditional financial instruments. Venture capital is underdeveloped compared to other Latin American countries such as Chile, Brazil, Mexico and Colombia. There are private initiatives aimed at the development of private equity funds and business angels associations, but it would be useful to consider public initiatives to favour the creation of venture capital funds.

- *Conducive tax regime.* Beyond the policy choice concerning the use of fiscal incentives to encourage private investment in R&D and innovation activities,[22] it is important to minimise the possible negative effects of corporate tax regimes on investment in innovation-related activities. Peru's tax regime is deemed neutral (it does not have R&D fiscal incentive provisions). However, R&D and innovation-related investment expenditures cannot be written off against profits at a 100% depreciation rate as they can be in many countries. The possibility of write-off is

subject to certain provisions of the tax code. As these provisions are subject to different, and often arbitrary, interpretations, firms are reluctant to apply for this given the penalties they might incur (see Box 2.1).

- *Well-functioning labour markets.* Labour markets rigidities impinge upon the efficient reallocation of resources from less to more productive activities among and between sectors. As such, they have a negative impact on the development of innovative activities which can alter the skill mix within enterprises and raise the demand for a more qualified workforce. As highlighted in a recent report on the labour market in Peru (World Bank, 2010), despite recent changes in the regulatory regimes for SMEs,[23] rigidities remain and are reflected in international rankings.[24]
- *Qualified human resources.* Innovation performance depends on an adequate supply of skilled workers. An inadequate supply can strongly limit the absorptive capacity of firms and research institutions and the effectiveness of public S&T expenditures and support programmes. However, the rapid expansion and liberalisation of Peru's education system over the last two decades that resulted in a spectacular growth of enrolment at all levels has not achieved corresponding results in terms of quality of education as measured in international comparisons.[25] Low performance of secondary education institutions has consequences on the achievements that can be expected from tertiary institutions. The quality of graduates also suffers from a lack of robust certification procedures to ensure the quality of programmes and tuition in these institutions.
- *A well-developed infrastructure.* Infrastructure deficiencies in communications, transport, logistics platforms and energy distribution represent major constraints on firms' engagement in innovative activities. These constraints may affect firms' ability to use available technology efficiently. They can also limit the ability of potentially innovative firms to reap the benefits of expanding domestic and foreign markets. Peru still suffers from an important infrastructure deficit and investment priorities will have to be set. These should make use of criteria that take into account the strengthening of innovation capacity, including S&T infrastructure and the communication and logistics infrastructures that broaden opportunities for new products and services and affect price competitiveness on foreign and domestic markets.

1.4. Innovation as a key driver of sustainable future growth

To improve medium- to long-term sustainability and to ensure inclusive economic growth and development, Peru will need appropriate strategies and policies as well as institutional and policy reforms. This will require a close examination of the sources and patterns of growth in an uncertain global environment. As the successful experience of developed and emerging countries has shown, government will have to play a more proactive role in developing Peru's competitive advantages and in alleviating the constraints that hold this evolution back.[26]

Higher productivity across the economy and the diversification of economic activities towards higher value-added production and exports are therefore two of the most important challenges for the medium to long-term sustainability of Peru's development path. They are necessary for an inclusive growth process that creates more qualified jobs, reduces informal employment and alleviates poverty.

Box 1.1. Innovation-fuelled growth: new empirical evidence and policy initiatives

In an increasingly global economy, innovation has become the key driver of growth and competitiveness

Most of the rise in living standards since the Industrial Revolution has been the result of new and improved products, processes and services. However, innovation has now become even more important for a wider spectrum of economic and social activities. Globalisation is forcing all countries to move their economic activity further up the value chain to ensure that they will continue to compete and prosper. Leadership, but also the capability to catch up, will therefore come from staying a step ahead of the competition in higher value-added elements of the economic process. Economic research provides new empirical evidence of this tightening relationship between innovation capability and economic success at both the macro (aggregate) and micro (firm) level:

- *At the macro level*, about half of the cross-country differences in per capita income and growth are due to differences in total factor productivity. This in turn is mainly driven by technological development and innovation, with a strong influence of R&D. Recent empirical research (Coe *et al*., 2008) confirms the role of both domestic and foreign R&D capital as significant determinants of TFP. Human capital and institutional factors, notably those that condition the efficiency of national innovation systems (NIS), also have a significant impact on TFP. Moreover, countries where doing business is facilitated and the quality of tertiary education is high tend to derive more benefits from domestic R&D, from R&D spillovers from abroad and from human capital formation.

- *At the micro level*, it has been demonstrated that in all sectors of activity, from high-technology to the more traditional resource-based industries, innovative firms exhibit better performance and create more and better jobs. For example, recent OECD analysis of innovation at the firm level (OECD, 2009a) shows that product innovation increases business firms' labour productivity: in a sample of 16 OECD countries plus Brazil, productivity is higher in firms with more sales of innovative products per worker in almost all countries, and especially in Korea, New Zealand and Brazil.

- *From microeconomic to macroeconomic performance.* For business innovation to translate into better macroeconomic performance, structural change is required to shift resources from non-innovative towards innovative firms irrespective of the industry. In successful countries the government facilitates such processes by providing favourable framework conditions and specific support to induce more companies to enter the "innovation game" in the first place, and to provide incentives to already innovative companies to invest even more in innovation. Firms that receive financial support from government or engage in co-operation (with other firms and/or public research institutes) invest more in innovation.

Most countries, including the largest emerging economies, have adopted more ambitious innovation policies

The importance of innovation is recognised across the OECD. Most importantly a number of emerging economies (China, India, Russia, Brazil and South Africa, but also Chile, Mexico, Turkey and new EU member countries) are stepping up their efforts to complement their traditional comparative advantages with new ones based on own R&D and innovation.[1] Success in creating their own R&D base will not only enable these countries to boost their competitiveness directly, but will also allow them to maximise the benefits from monitoring, accessing and using knowledge created through massive investment elsewhere in the world.

1. See *OECD Reviews of Innovation Policy:* South Africa (OECD, 2007a); Chile (OECD, 2007b); China (OECD, 2008); Mexico (OECD, 2009b); Russian Federation (OECD, 2011).

A large body of literature provides empirical evidence on the positive links between scientific, technological and innovative capacity and innovation-related investment (technological or not) on the one hand, and productivity gains, international competitiveness and economic performance on the other (Box 1.1).[27]

In light of the limitations to the current growth pattern, S&T capacity to foster innovation and better respond to social challenges should complement stable macroeconomic policy and sound framework conditions and help ensure a more sustainable growth path less susceptible to external shocks. On such a path, economic growth and development would be driven by productivity gains resulting from innovation-related investment, including in human capital, by technological diffusion and by the competitive advantages of a structurally diversified economy.[28]

1.5. Peru's innovation performance

Weaknesses of the information system

The assessment of innovation performance requires regularly updated qualitative and quantitative information. As document prepared as a companion to the OECD Innovation Strategy (OECD, 2010b) notes, assessment capabilities are an essential component of policy making: "Sound measurement of innovation is crucial for policy making. It helps policy makers to evaluate the efficiency of their policies and spending, to assess the contribution of innovation to achieving social and economic objectives and it legitimises public intervention by enhancing public accountability."[29, 30]

In Peru the basic quantitative and qualitative information that is the basis for mapping and monitoring the performance of the innovation system as a whole and its main actors in business, higher education and public research is very limited in scope, regularity of updating and reliability. In OECD and most comparable Latin American countries, statistical indicators of inputs to science, technology and innovation (STI) activities are systematically compiled according to international standards[31] on a regular basis using surveys or administrative registries. In Peru they are not; they were last compiled in 2004 in the context of the Innovation Survey ENCYT 2004 carried out under the auspices of CONCYTEC (CONCYTEC, 2010).[32]

Information on the distribution of R&D or S&T expenditures is only available by sector of performance and not by sources of funding.[33] With some exceptions, it is difficult to use budgetary data to compile appropriations to institutions that perform or fund such activities in either the public or private sector. The lack of comprehensive information on the funding of STI activities severely constrains the ability to monitor evolution over time. However, it is necessary to do so to assess the impact of support policies and instruments on the achievement of policy objectives, such as the leverage of public support on private S&T expenditures or the intensity of interaction between enterprises, universities and other research institutions. This type of information, along with qualitative information, would also be necessary to deal with the chronic problems of uncoordinated policies and a policy approach that leads to overlapping responsibilities among implementing institutions.

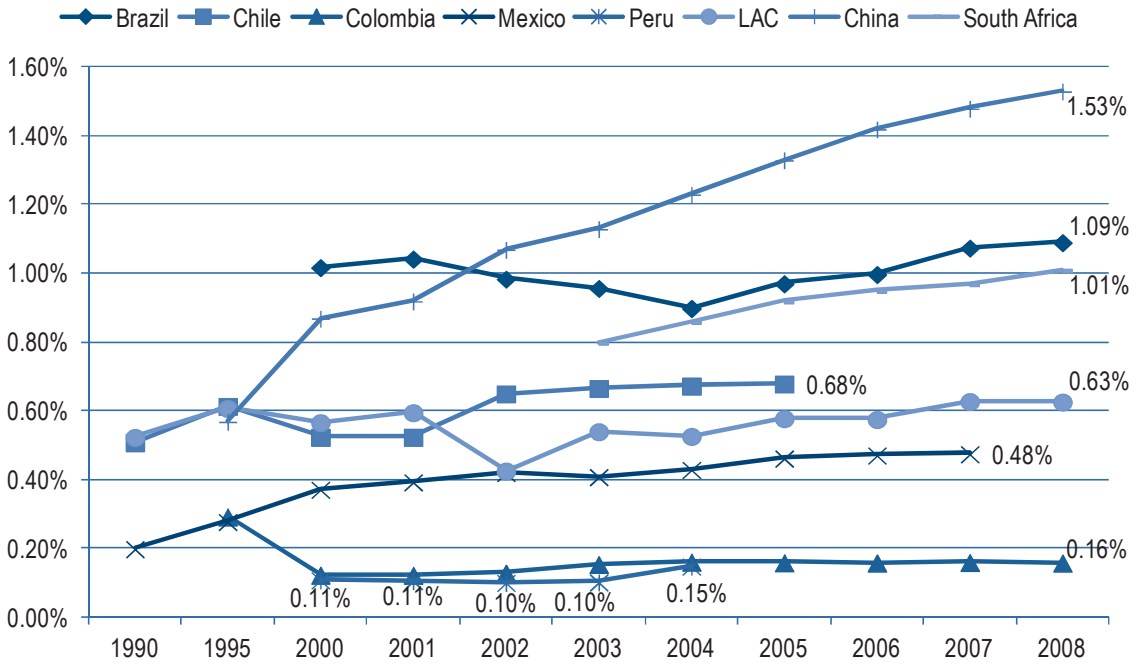
Although the development and distribution of human resources involved in STI activities across institutions and sectors is fundamental to capacity building, information about the volume[34] and qualifications of these resources is scarce and may not always be reliable, as in the case of the number of researchers, engineers and technicians actually engaged on a full- or part-time basis in S&T activities in either public research and technological institutions[35] or in the business enterprise sector. The lack of relevant information is detrimental to the formulation of policies based on reliable assessments of actual and prospective mismatches between supply of and demand for skilled personnel and mobility of such personnel between institutions. Standard output indicators on scientific publications and patents are better covered, as the information is readily available and collected by various indexing institutions for the former and patent offices for the latter.

Benchmarking innovation performance

A persistent lag in R&D and innovation inputs and skewed distributions across sectors of performance

Compared with other major Latin American and emerging countries such as China and South Africa, Peru suffers from an important and persistent lag in R&D intensity, measured as the ratio of gross domestic expenditure on R&D (GERD) to GDP (Figure 1.7). While GERD increased notably from USD 153 million to USD 260 million between 2003 and 2004 the strong upward trend has not been maintained in subsequent years. Since 2005 GDP growth is likely to have outpaced GERD, leaving the R&D intensity of the Peruvian economy below 0.15%.[36]

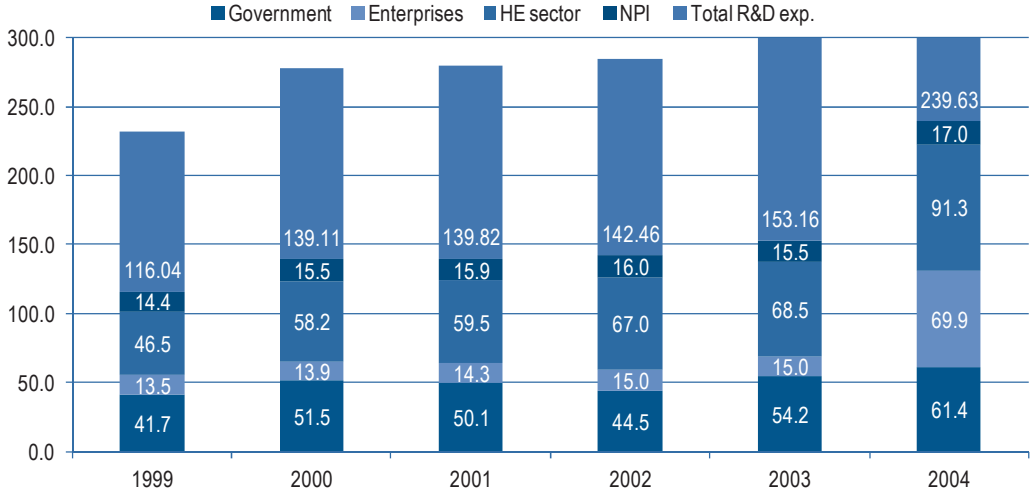
Figure 1.7. R&D intensity, Peru and selected countries, 1990-2008



Sources: RICYT; IDB (2010a); OECD Main Science and Technology Indicators (MSTI) database.

In Peru the distribution of R&D by sector of performance was heavily skewed towards the academic and the government sectors up to 2003 (Figure 1.8). The significant increase in the volume and share of business R&D in 2004 may reflect an improvement in the innovation climate due to better growth prospects and to the government's S&T policy initiatives of the beginning of the decade.[37] However, the share of business R&D remains very low not only compared to OECD countries and emerging economies but also to other major Latin American countries (except Colombia and, more recently, Argentina) (Table 1.4). [38] The volume of business R&D may be underestimated, but this would not change the overall picture.[39] Unfortunately, it is not possible to know whether the surge of business R&D expenditures observed in 2004 has continued and if so, whether it corresponds to an increase in investment by firms or by other sources of funding.[40]

Figure 1.8. R&D expenditures by sector of performance, 1999-2004 (USD millions)



Source: RICYT.

Table 1.4. Distribution of R&D expenditures by sector of performance, Peru and selected countries, 2004-08

	Business sector		Government		Higher education		Private non-profit	
	2004	2008	2004	2008	2004	2008	2004	2008
Peru	29.2	n.a.	25.6	n.a.	38.1	n.a.	7.1	n.a.
Argentina	33.0	33.0*	39.7	38.9*	25.0	28.8*	2.3	1.9*
Brazil	40.2	n.a.	21.3	n.a.	38.4	n.a.	0.1	n.a.
Chile	46.1	n.a.	10.2	n.a.	32.0	n.a.	11.7	n.a.
Colombia	23.4	22.5	6.3	4.3	54.3	50.2	15.9	19.1
Mexico	46,6	47.4*	24.1	25.2*	28.2	26.1*	1.1	1.3*
China	68.8	72.7	23.0	18.3	10.2	8.5	-	-
South Africa	56.3	57.7*	20.9	21.7*	21.1	19.4*	1.7	1.2*
OECD	67.6	69.8	12.1	11.2	17.7	16.8	2.5	2.4

*2007.

Sources: RICYT; IDB (2010a); OECD Main Science and Technology Indicators (MSTI) database.

In Peru information about the volume, evolution and sectoral distribution of human resources engaged or trained in S&T activities (*e.g.* researchers, engineers and technicians) is almost non-existent. In that area, the little statistical information available for 2004 (headcounts, not full-time equivalents) indicates a lag *vis-à-vis* Latin American and other developing countries that have stepped up their human capacity building in the last decade (Table 1.5).

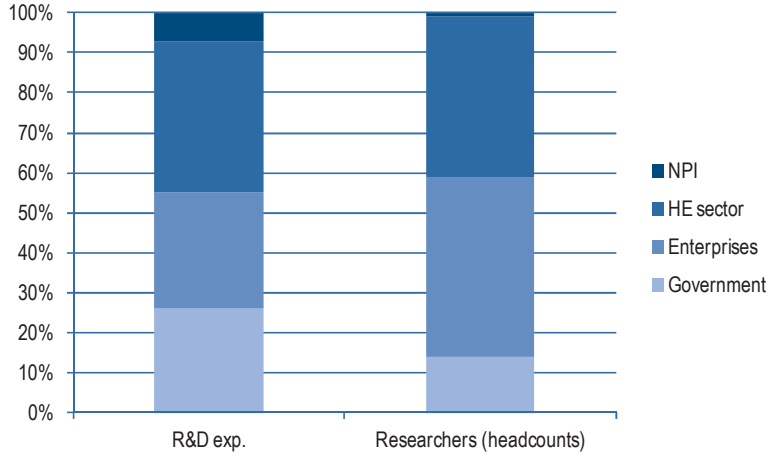
Table 1.5. Total full-time equivalent researchers per 1 000 labour force, Peru and selected countries, 2004-08

Peru*		Brazil		Chile		Colombia		Mexico		China		South Africa	
2004	2008	2004	2008	2004	2008	2004	2008	2004	2007	2004	2008	2004	2007
0.24	n.a.	1.06	1.33	2.03	n.a.	0.31	0.36	0.93	0.88	1.2	2.1	1.2	1.5

* For Peru the number of FTE researchers is estimated using the average FTE/headcount ratio for Latin American countries.
Sources: RICYT; OECD Main Science and Technology Indicators (MSTI) database.

A comparison of the distribution by sector of performance of R&D expenditures on the one hand and researchers on the other (Figure 1.9) reveals a peculiar pattern. If the data compiled by RICYT on the basis of CONCYTEC sources are reliable, the situation in Peru is characterised by investment per researcher almost three times higher in the public than in the business sector.[41] A possible explanation could be a gross over-statement of government research expenditures owing to high administrative and other overhead costs in public research institutions while the actual number of researchers in such institutions is more appropriately measured.[42]

Figure 1.9. Distribution of R&D expenditures and researchers by sector of performance, 2004



Source: RICYT.

Low output of scientific and innovation activities

Although the output of scientific activities, as measured by the number of internationally indexed scientific publications authored by Peruvian researchers, has improved significantly since the beginning of last decade, Peru's record in this area remains very poor compared to other countries of the region. This is true not only in absolute terms (Table 1.6) but also in terms of the productivity of the scientific research system as measured by publications per year per researcher or R&D expenditures. This low productivity may be the result of factors such as inappropriate incentives in the academic sector, lack of critical mass in research programmes and low domestic and international connectivity of the national scientific system.

Table 1.6. S&T publications, Peru and selected countries, 1995-2007

	1995	2000	2005	2007
Peru	65	79	134.4	153.4
Brazil	3 436	6 407	9 897	11 885
Chile	888	1 115	1 559	1 740
Colombia	162	331	401	489
Mexico	1 937	2 970	3 932	4 223
China	9 061	18 479	41 604	56 806
South Africa	2 351	2 221	2 395	2 804

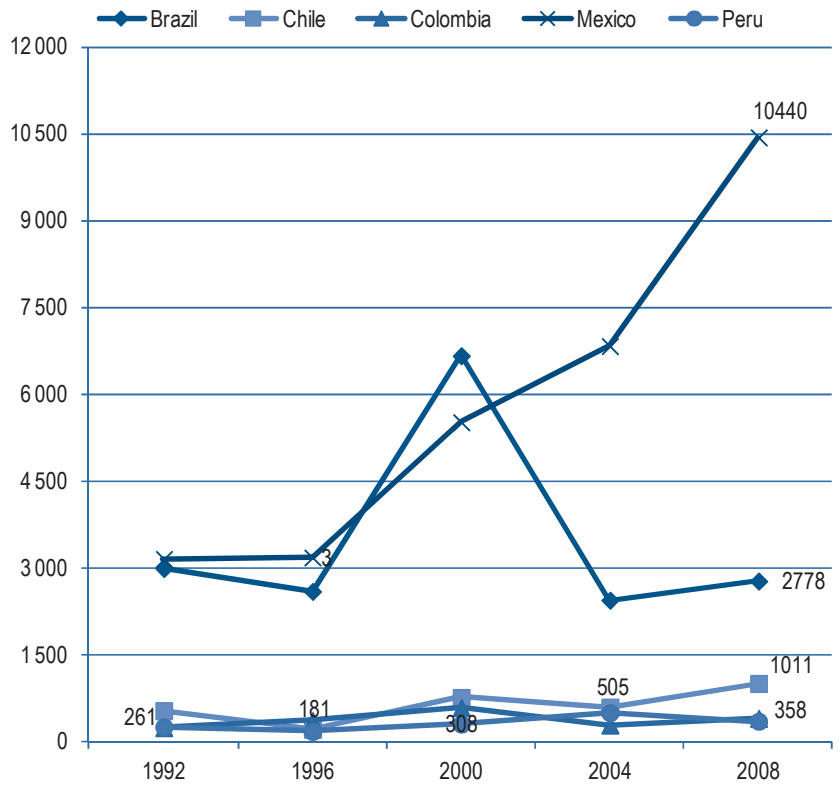
Source: National Science Foundation Science and Engineering Indicators.

Applications for or registration of patents and utility models represent only partial indicators of innovation output for a number of reasons, *e.g.* the existence of other modes of protection of property rights (such as trade secrets), costs associated with applications and protection, or limited knowledge about the importance and/or management of intellectual property rights.[43] The number of patents granted by the National Institute of Competition and Intellectual Property (INDECOPI) has increased slightly since the end of the last decade but remains very low compared to other Latin American countries (Figure 1.10).

The record of Peruvian inventors appears even weaker when two other indicators are used to assess patenting performance. The first is related to the international value of patents; this can be estimated by patents filed in developed countries' patent offices such as the United States Patent and Trademark Office (USPTO). Here again Peru fares poorly (Table 1.7).

The second is the ratio of residents to non-residents in patent applications or patents granted. In Peru the ratio has been very low with a downward trend over the last 30 years, varying from a maximum of close to 10% in the mid-1990s to a minimum of less than 3% in 2008. Peru's weak inventiveness is thus exacerbated by domestic innovators' low propensity to patent This creates a kind of vicious circle that should be addressed through complementary policies. INDECOPI must play its part more forcefully than it currently does in the direction of public research institutions and enterprises.

Figure 1.10. Patents granted, Peru and selected Latin American countries, 1992-2008



Source: RICYT, IDB (2010a).

Table 1.7. USPTO patents, Peru and selected Latin American countries, 1996-2009

	1996-99	2000-04	2005-09	1996-2009
Peru	**12**	**17**	**9**	**38**
Brazil	290	540	492	1 322
Chile	37	65	82	184
Colombia	26	46	34	106
Mexico	217	422	316	955

Source: US Patent and Trademark Office.

Notes

1. Between 2000 and 2010, total exports increased more than fivefold and the stock of FDI by a factor of 3.7. In 2010 total exports amounted to USD 35.6 billion (of which USD 21.7 billion from the mining sector), and the stock of FDI reached USD 41.7 billion.
2. 2008 was the only year in which inflation exceeded 5%, 2 percentage points above the monetary policy target.
3. The rate of private investment dropped to 15.1% in 2009 in the aftermath of the financial crisis, and picked up to 19.0% in 2010.
4. As measured by household surveys conducted by INEI.
5. Labour productivity growth mainly concerns full-time salaried workers in the formal sector. Estimates for the economy as a whole show less growth of labour productivity in the current decade and even a decrease in some sectors (Chacaltana and Yamada, 2009).
6. Under the new Ministry of Foreign Trade and Tourism, MINCETUR, created in 2002, and its export promotion agency PROMPERU, which absorbed its predecessor, PROMPEX, set up in the mid-1990s.
7. An agreement with Japan is currently under negotiation.
8. Non-transformed natural resources in agriculture, fishing, mining and energy sectors.
9. The share of the mining sector increased from 46% to 61% during the same period.
10. For an analysis of the limited FDI technological spillovers in developing countries, see Padilla-Peréz and Martínez-Piva (2009).
11. As a reference, US firms with fewer than 10 workers account for 54% of the total (IADB, 2010b).
12. INEI (2006), National Household Survey (ENAHO).
13. Excluding independent and household workers.

14 Besides these small formal firms, there is a huge mass of informal enterprises, estimated at over 2.3 million or about 72% of total enterprises.

15. This is typically a case in which the trade-off between growth of productivity and growth of employment is overcome through a dynamic process of resource reallocation (World Bank, 2010).
16. Such as BCRP (2008), Abusada and Cusato (2007), (GRADE, 2010).
17. There are different methods for calculating the contributions of capital, labour and TFP to growth, depending among others on the accounting of educational quality and capital depreciation. Other analyses of the evolution of TFP in Peru over similar periods but with different periodisation (*e.g.* VeraTudela, 2010; World Bank, 2010) find higher TFP contributions in the present decade. However, these higher estimates do not modify the basic argument.
18. Estimated at over USD 37 billion in 2008 by the Peruvian Institute of Economy (GRADE, 2010).
19. With some notable but rare exceptions in some universities and professional training institutions.

20. For an analysis of the limited technological spillovers from FDI in developing countries, see Padilla-Peréz and Martínez-Piva (2009).

21. Even if Peru's international rankings based on synthetic indices pertaining to entrepreneurship conditions has improved in recent years (WEF, 2010a).

22. Presently 22 out of the 34 OECD countries have an R&D tax incentive scheme (OECD, 2010c).

23. "Mypes" Law.

24. According to the World Bank/IFC *Doing Business 2010 Report* Peru improved its "worker employment" ranking from 116 in 2009 to 112 in 2010 among 183 countries. It is a much better 39th on employment rigidity, but this is still below the Latin American average.

25. Such as the OECD/PISA programme (OECD, 2010d).

26. See in particular World Bank (2005, 2011); Tello and Tavara (2010); Teubal (2002); and Haussmann and Klinger (2008).

27. Major OECD studies (*e.g.* OECD, 1998, 2005a, 2009a), have contributed to an emerging consensus among policy makers regarding the growing impact of innovation on economic performance. In 2007, recognising the critical importance of this policy area, the OECD Council at Ministerial level mandated the Organisation to develop an Innovation Strategy to help member countries to devise more efficient policies to strengthen innovation as an engine of growth. This resulting report was published in the spring of 2010 (OECD, 2010b). Since then initiatives have been taken to adapt the analytical framework of the Innovation Strategy and its recommendations to the specific characteristics of developing countries or regions.

28. Such a path has been successfully followed for several decades by countries with resource endowments as diverse as Korea, Finland and Norway and, more recently, large emerging economies such as China and Brazil, as well as smaller ones like Chile. These countries, unlike Peru, have increased their public and private resources in STI investment in the last decade, some of them by a significant margin (OECD, 2007a, 2007b, 2008a).

29. *Measuring Innovation: A New Perspective* (OECD, 2010e) goes beyond providing international benchmarking based on indicators traditionally used to monitor innovation, introducing new indicators that describe the broader context in which innovation occurs based on their policy relevance and measurability.

30. Changing innovation patterns and determinants also lead to evolving policy requirements for new indicators (OECD, 2007c).

31. In particular standards defined in the OECD Frascati and Oslo manuals (OECD, 2002a and OECD/Eurostat, 2005).

32. The survey sample included 4 912 enterprises, of which 420 were mega, 1 835 large, 1 743 medium and 914 small. The survey notes that results should be interpreted with caution as they may suffer from reliability problems due to sampling methods. It is likely that reliability is affected by occasional misunderstanding of standard definitions of R&D and innovation activities on the part of respondents. However the relative order of magnitudes by size class is most probably on the mark.

33. The ENCYT survey does not include available statistics on R&D or S&T expenditures by source of funding.

34. Notably in full time equivalent (FTE).

35. In these institutions the distinction between S&T and administrative personnel is not always clear.

36. A point of comparison is the evolution of government expenditures on S&T activities as a proportion of GDP, which decreased from 0.95% to 0.71% between 2003 and 2009 (GRADE, 2010).

37. Much of this apparent increase may reflect measurement problems given the low reliability of S&T statistics and indicators due to sampling biases in R&D surveys.

38. Peru is ranked 113th out of 133 countries on enterprise R&D spending by the World Economic Forum (WEF, 2010a), far below its 73rd rank in the global competitiveness index.

39. According to interviews with business executives during the OECD field mission, many companies may record R&D investment under a different heading for taxation purposes.

40. According to the ENCYT survey, in 2004 the proportion of R&D performed by enterprises financed by their own funds was around 93% for mega and large firms, 71% for medium-sized firms and 79% for small firms (CONCYTEC, 2010).

41. Even accounting for the fact that researchers are measured in headcounts and not in FTE standards.

42. A more likely (and possibly complementary explanation) is an inconsistency in the measurement of S&T personnel across institutions in surveys and administrative records.

43. This factor is pervasive in Peru and particularly affects IPR protection of innovations and applied knowledge related to the exploitation of the country's biodiversity.

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Chapter 2

Innovation: The main actors

The composition of a country's innovation system and the quality of interactions between the main actors in innovation have major implications for innovation performance and influence the mix and balance of policies needed to improve the overall innovation performance. Deriving appropriate policies therefore requires a systemic approach. With this perspective in mind, this chapter provides an overall characterization of the innovation and research activities of the business sector, public research institutes and the higher education sector, complemented by an assessment of intermediary institutions. It begins with business firms which are the central actors in advanced innovation systems, but in order to play this role they first need to build and develop the necessary capabilities in the process of development. The sectoral dimension plays an important role in this context. Next, attention is drawn to the system of public research institutes, including its current state, governance and funding, as well as its prospective role. It next turns to the higher education sector. A final section covers the relatively young set of intermediary institutions which play a role in linking the research sector and industry.

2.1. The business sector

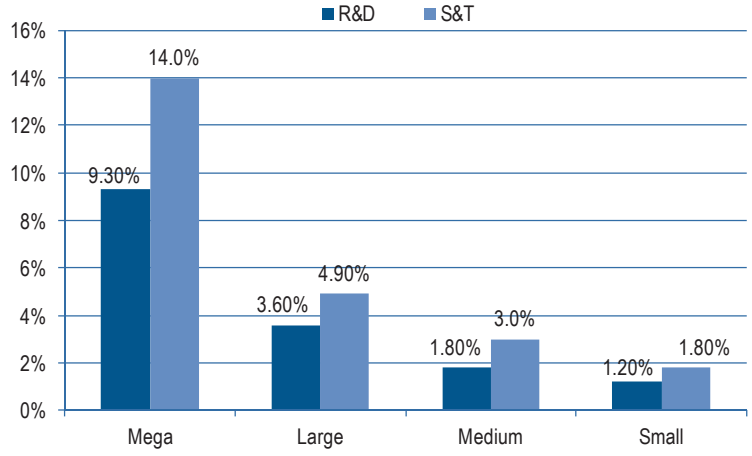
General patterns of innovation activities

Despite the methodological and sampling limitations of the 2004 National Science, Technology and Technological Innovation Survey (ENCYT) carried out in 2004 under the auspices of CONCYTEC already noted in the preceding chapter, its results allow to highlight the following salient features of Peruvian firms' R&D and innovation performance:

- The highly skewed distribution of research and development (R&D) and science and technology (S&T) activities by size classes shows that Peru's very heterogeneous industrial structure is reflected in its innovation-related activities (Figure 2.1).

Figure 2.1. Enterprises carrying out R&D and/or S&T activities, by size[1]

Percentages



1. Mega firms: more than PEN 50 million turnover; large: PEN 2.5-50 million; medium: between PEN 500 000 and PEN 2.5 million; small: 100 000-500 000).

Source: ENCYT (2004).

- Given the overall size distribution of enterprises in Peru and assuming that it is reflected in the ENCYT survey, it would appear no more than 2% and 1.5% of all enterprises carry out S&T and R&D activities, respectively, and that the distribution by size is highly skewed. The innovation survey, which also captures non-R&D-based innovation, therefore confirms that the vast majority of Peru's firms have little propensity to undertake any type of innovation and that, as is generally the case in developed and developing countries alike, innovation capacity decreases with firm size (OECD, 2010a).[1] It is to be noted that in Peru these disparities according to size have increased between 2001 and 2004.

- The type of R&D activity carried out is heavily weighted towards experimental development projects to adapt machinery or improve and optimise processes (in mining, food and manufacturing); field tests for new varieties and improving product quality, sanitary conditions, irrigation and post-harvest technologies in the agricultural sector; and the search for new design or fashion trends and new inputs and capital equipment in the leather, shoe, textile and apparel industries (Kuramoto and Quispe, 2009). It is noteworthy that mega-enterprises engage relatively less in basic R&D than large ones, probably because they include a higher share of multi-nationals, which source R&D in their country of origin (Table 2.1).

Table 2.1. Distribution of type of R&D project by size of firm

Percentages

	Basic research	Applied research	Exp. development
Mega	7	39	54
Large	17	39	44
Medium	3	42	55
Small	5	40	55

Source: ENCYT (2004).

Table 2.2. Distribution of innovation expenditures by size of firms and type of expenditures (%)

	R&D	Machinery and equipment[1]	Acquisition of technology	Engineering and design	Training	Management and organisation
Peru (2004)						
Mega	5.7	54.6	11.9	13.1	2.0	12.6
Large	1.8.	67.0	15.5	15.9	2.5	9.2
Medium	4.1	65.9	7.6	3.6	13.4	3.7
Small	1.7	37.8	3.3	0.3	1.3	55.6
Mexico (2001)	8.5	66.2	7.5	8.3	2.7	6.8
Mexico (2006)	42.5	39.7	8.9	3.6	2.8	2.5
Chile (2001)	10.7	81.8[2]	2.8	-	4.6	n.a.

1. Including ICT software. 2. Includes engineering and design.

Source: ENCYT (2004) for Peru, CONACYT for Mexico, Innova for Chile.

- Innovation encompasses a broad range of activities that go well beyond in-house R&D to include expenditures on R&D external to the firm, use of capital goods that include embodied updated technology, information and communication technology (ICT) hardware and software, acquisition of technology through licensing and consulting, technological training, engineering and industrial design as well as non-technological innovation in such areas as organisation and marketing management.[2] In Peru, innovation expenditures concentrate on acquisition of machinery and equipment; this shows the importance of the purchase of embodied technology in innovation projects, especially in large and medium enterprises (Table 2.2). Small

and medium-sized enterprises (SMEs) spend proportionally less than mega and large ones on technological training, engineering and design. Mega enterprises devote a larger share of their expenditures to R&D. Compared to Chilean and Mexican firms, Peruvian ones devote a smaller share of innovation expenditures to investment in R&D.

- There are important discrepancies across firms as regards the distribution of R&D and overall innovation expenditures by sector (Table 2.3). In mega enterprises, over 70% of R&D investment is concentrated in four sectors: food industry, commerce and services, utilities and energy, but investment in innovation is highest in the mining industry mainly because of the importance of acquisition of machinery and equipment. In large enterprises, about two-thirds of R&D expenditures are in mining and around 8% in energy but the largest investment in innovation is in commerce and services. In medium-sized enterprises both R&D and innovation investment is concentrated in S&T services, mining and energy. Surprisingly while a quarter of total R&D expenditures goes to the mining sector it has a much smaller share of innovation investment (2.9%). Finally the little R&D carried out by small firms is essentially performed in ICT and S&T services, the wood industry and agriculture and fisheries, but commerce and services have more than three-quarters of innovation expenditures. The share of R&D expenditures in wood, agriculture and fisheries is significantly higher that the corresponding shares in innovation (1.8% and 0.5 %, respectively).

Table 2.3. Distribution of R&D and innovation expenditures by size of enterprise and sector, 2004

	Mega		Large		Medium		Small	
	R&D	Innov.	R&D	Innov.	R&D	Innov.	R&D	Innov.
Agriculture and fisheries	7.0	-	6.7	5.7	4.4	5.5	9.2	-
Food industry	**46.5**	8.8	4.5	12.4	6.0	-	-	-
Mining	7.1	**37.4**	**66.3**	14.5	25.0	-	-	-
Utilities	11.7	6.7	-		-	-	-	-
Commerce and services	12.9	6.3	-	**20.9**	-	19.2	9.6	**78.7**
Transport and communication	-	24.2	-	5.3		9.9	--	-
S&T and ICT services	-	-	-	6.2	**51.5**	**20.4**	**49.4**	11.5
Wood industry	-	-	-	-	-	5.9	29.4	-
Energy	7.9	-	7.7	11.5	10.1	7.6	-	-
Others	6.9	16.6	14.8	23.5	3.0	31.5	2.4	9.8
Total	100	100	100	100	100	100	100	100

Note: Expenditures that account for less than 5% are not reported.

Source: ENCYT 2004.

- As highlighted in previous chapter, business R&D expenditures increased significantly in 2004 reaching USD 70 million as compared to 15 million in the two preceding years (see above Figure 1.8). This increase probably due to new investment opportunities opened by growth prospects, an improvement in the innovation climate facilitated by government initiatives to promote competitive-

ness and, to a more limited scale, to increase public support to R&D and technology development. In 2004 more than 90% of the R&D expenditures of mega and large firms were financed by own funds; the share from government sources was a marginal 0.1% (Table 2.4). In contrast, according to the ENCYT survey, the government apparently funded close to 24% of medium-sized enterprises' R&D. As mega and large firms probably account for between 85% and 90% of total private-sector investment, it can be assumed that the share of business R&D financed by government is very low both in relative terms and in comparison with other countries (Table 2.5). The business sector's response to the FONDECYT-PROCOM funding programme created in 2004, to innovation funds such as FINCYT and, more recently, FIDECOM, and the relatively high number of project proposals submitted to these funds provides evidence of strong demand for public sources of financing of business R&D and innovation projects and existing capacity to develop them.[3]

Table 2.4. Sources of financing of R&D activities by size of enterprises (%), 2004

	Mega	Large	Medium	Small
Own funds	92.1	93.7	70.7	79.0
Other firms (domestic)	7.8	3.5	3.0	12.0
Other firms (foreign)	0.0	0.8	0.0	0.0
Government	0.1	0.1	23.9	2.8
Other institutions*	0.0	1.8	2.5	6.2
Total	100	100	100	100

*Including NGOs.

Source: ENCYT (2004).

Table 2.5. Percentage of business expenditures on R&D financed by government, selected countries, 2008

Argentina[1]	Mexico[1]	China	South Africa[1]	Norway	Korea	Spain[1]	OECD[1]
4.7	6.0	4.3	21.7	9.8	5.9	16.3	6.6

1. 2007.

Source: OECD Main Science and Technology Indicators (MSTI) database.

- In 2004, Peruvian firms had relatively few links with other institutions to develop collaborative innovation activities, to contract out scientific and technological knowledge or to develop technically upgraded products in the framework of supply chains. In particular, they had minimal collaboration with foreign institutions. For mega enterprises the main links were with universities (5.2% of innovation projects), other enterprises (4.6%), and training institutions (3.6%). Collaboration by firms of all sizes with public research institutes was practically nil. The lack of collaboration with domestic and international institutions hinders the development of enterprises' innovation capacity, a problem which FINCYT and FIDECOM have started to address.

Specific structural features

Beyond the general panorama that can be drawn from the 2004 innovation survey, and on the basis of other sources of quantitative and qualitative information,[4] it is possible to draw some additional highlights on some structural aspects of business innovation Peru that qualify and sometimes question the results of that survey.

A first structural feature is that innovative activities at firm level reflect the wide heterogeneity of the productive landscape whose components evolve according to different dynamics:

- On the one hand, some champions in specific sectors, constituted by groups of firms in specific sectors whose productivity is in line with international levels. These groups are generally led by mega or large firms that are relatively well connected to international networks, markets and sources of technology and financing. They are mainly in or related to export-oriented industries well integrated in global value chains (*e.g.* mining, non-traditional agribusiness) or in activities catering for the domestic market with a strong presence of foreign companies (financial services, telecommunications, retail). Because these firms have been exposed to world competition they operate according to the standards and requirements of international markets. They adopt more advanced, up-to-date, and even cutting-edge technologies and managerial practices, and recruit higher skilled human capital (as in the mining industry). In contrast with their stronger orientation and links to external markets, both in terms of product destination and source of the technologies, these more dynamic companies seem to generate low spillovers to domestic SMEs. Moreover, given their strong dependence on external sources of technology, they have also made little demand on local technological centres, research institutes and universities and, with some exceptions, have rarely engaged in collaboration on research and innovation with these institutions.
- On the other hand, these "islands" of higher productivity enterprises coexist with a fragmented universe of smaller and micro firms that have very low productivity and inadequate and obsolete technologies, are usually labour-intensive, lack access to competitive financing, have weak managerial practices, and a low-skilled labour force. These firms generally operate in less dynamic, slow-growth domestic markets (mainly traditional agriculture, small-scale commerce and personal or consumer-oriented services and transport), in short value chains, with low levels of productivity but often facing unfair competition from the informal sector with artificially low cost structures (almost 75% of micro companies). Generally, these smaller firms cater to less sophisticated and demanding consumers and have products and services of poorer quality and safety, with a significant presence of counterfeit products.

Second, innovation studies conducted at sectoral level confirm that innovation activities in Peruvian firms are positively correlated with size (23% of micro and 76% of large manufacturing companies are involved in some innovation activity) and with export orientation. However, innovation activity seems to be higher at the sectoral level than what is indicated in the ENCYT survey. For instance in a survey conducted on the shoe industry, almost 95% of firms interviewed declared innovative activities, of which 77% in R&D (more than 20 times what is reported by large firms in ENCYT), product innovation (89%) or process innovation (79%); however, only 10% seem to correspond to novel innovation and involve some patenting activity (Kuramoto, 2009). Also, in the agro-

export industry, almost 90% of firms studied declared having introduced innovations during 2005-09 (Huarachi *et al*., 2010).

These discrepancies are difficult to interpret. They give some support to the view that R&D and innovation expenditures are under-reported for tax reasons (Box 2.1). More likely, however, they shed light on the sensitivity of results to variations in the methodologies used in surveys and to the reliability of respondents as regards their interpretation of innovation activity.[5] This draws attention to the importance of regular innovation surveys on a sound methodological basis such as those in most OECD countries and all European Union members.[6]

Box 2.1. Fiscal regime for innovation investment

The Profit Tax Law (*Ley del Impuesto a la Renta*) does not include any fiscal incentives for enterprises' investment in R&D or innovation.

However, if innovation projects satisfy certain conditions this investment can be accounted for as expenditures benefiting from 100% depreciation.

According to Article 37 of the tax code these conditions do not expressly pertain to innovation and enterprises have to demonstrate that their expenditures devoted to innovation are "reasonable and necessary to produce and maintain a source of profit".

Owing to the loose definition of these conditions and the uncertainty of innovation-related investment, problems may arise during tax controls or audits by the fiscal administration. Heavy penalties may be imposed if innovation expenditures are deemed not to meet the conditions of the Tax Code. They include: *i)* retroactive tax on increased profits that reincorporate ill-classified expenditures plus interest payments; and *ii)* a penalty that can amount to 50% of the omitted tax.

Uncertainty and the risks associated with possible judgment of misclassification by fiscal auditors act as a strong disincentive for enterprises to account innovation investment as current expenditure.

A lagging digital economy

Another point that illustrates the weaknesses in technology adoption capabilities and diffusion among Peruvian firms, one which could be a strong constraint on innovation and productivity growth in the near future, is the limited use of information and communication technologies. Two of the main international rankings, the *Global Information Technology Report* 2009-2010 of the World Economic Forum (WEF, 2010b) and the *Digital Economy Ranking* 2010 of the Economist Intelligence Unit (EIU), show that Peru lags behind in this field and has dropped back in recent years to 53rd out of 70 countries, and 92nd out of 133 countries (8 positions back since 2008), in the EIU and WEF rankings, respectively, and 90th in the extent of business Internet use, far behind its competitiveness rank (78th).

ICTs do not only represent a family of technologies among others options; they are powerful and ubiquitous enabling technologies. They have a positive impact on productivity through their incorporation in new production processes; they dramatically facilitate – or delay when not available – rapid access to sources of knowledge and information about better technological and managerial practices; they increase connectivity with ever more Internet-demanding local and global consumers and markets. Because of network effects, the positive impact of ICT adoption and diffusion go beyond those that can be observed at the individual firm level.

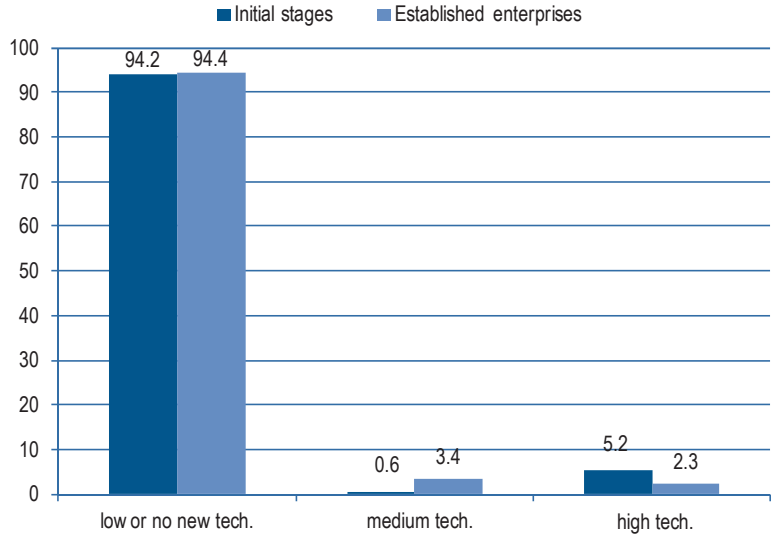
The fact that a large fraction of Peruvian firms have not been able to invest sufficiently in ICT not only affects their individual productivity but also hinders the development of production networks based on information and technology diffusion within value chains.

Entrepreneurship and innovation

The overwhelming proportion of very small firms and the problems it entails for increasing productivity and fostering innovation across the economy are also correlated with certain features of the dynamics of entrepreneurship in Peru and reflect the failure of small companies to grow and become more efficient. Indeed, while Peru has the fifth highest rate of early-stage entrepreneurial activity,[7] according to the Global Entrepreneurship Monitor (GEM, 2010) it also has one of the highest rates of discontinuation of businesses (fourth highest in GEM, 2009).

This suggests that Peru has relatively favourable conditions and significant entrepreneurial potential for creating new businesses or firms (the positive side), but severe constraints for scaling up and reaching the levels of efficiency and productivity necessary to remain competitive and stay in business. This is reinforced by the fact that new firms in Peru do not aim for high growth (most expect to remain micro companies with fewer than five workers), are less innovative (in terms of the novelty of their products and processes), are concentrated in sectors with low productivity and are not technology-intensive (Figure 2.2).[8]

Figure 2.2. Percentages of initial and established enterprises, by technological level, 2008



Source: GEM (2009).

Among the main constraints on entrepreneurship and the growth and consolidation of new companies, and in particular new technology-based firms, are excessive regulation of firm entry and exit,[9] the lack of education/training in entrepreneurial skills, and the quasi-absence of capital markets for new and growing firms (private equity funds, seed and venture capital, equity (Box 2.2).

Box 2.2. Venture capital industries in Peru, Mexico and Chile

Peru

Peru's venture capital industry is still under-developed compared not only to developed countries but also to regional standards. Peru ranked 12th out of 16 countries in the 2010 LAVCA scorecard on the business environment for private equity and venture capital.[1] Peru has improved modestly in recent years, but remains far behind Chile, which leads the regional ranking, Brazil (5th), Mexico (6th) or Colombia (8th).

Although several private equity (PE) funds were established during the 2000s with the active participation of institutional investors, such as the pension funds and banks, to invest in medium and large enterprises, Peru has virtually no venture capital (VC) funds to finance the creation and early-stage development of firms. By 2008, there were only five investment funds (PE/VC) operating in Peru, with assets of USD 173 million, none of which included VC funds. The funds have financed no more than 20 companies.

Up to 2008, there were no programmes, policy instruments or public institutions promoting the VC industry. Some recent modest improvements in the regulatory framework have eased allocations of Peruvian pension funds to alternative investments.[2] In 2009 around 20 executives of the largest Peruvian enterprises joined forces to launch a business angels association (INVERTIR) to finance promising new innovative enterprises. This initiative is supported by the Inter-American Development Bank (IDB).

Mexico

The venture capital industry in Mexico, along with that of Brazil, is one of the most dynamic in the region and one that has received more government support. It is estimated at USD 4 billion, of which nearly USD 400 million for VC funds, with 31 PE/VC funds in operation by 2007 (21 of which were private equity funds). Nacional Financiera (NAFIN) has played a key role in boosting the growth of PE/VC funds since the mid-1990s through its venture capital programme. NAFIN also has a programme to encourage business angels and entrepreneurs. The Ministry of Economy has channelled substantial resources to incubators, consulting services and other activities supporting SME development. Through its Business Promotion Department it operates a business incubator, a seed capital programme and a business accelerator programme.

Chile

The size of the Chilean venture capital industry (PE/VC) was estimated at USD 350 million in 2008, with about 15 funds in operation. Policy initiatives to foster the development of venture capital in Chile have focused on capital market regulations since the early 1990s. Successive reforms (MKII and MKIII) have strengthened the regulatory and tax framework by introducing a series of tax incentives and easing the participation of institutional investors (domestic and foreign) and also of CORFO in VC funds (before MKII reform in 2007, CORFO was only authorised to lend to those funds).

Additionally, active government policies and programmes to develop the VC market and promote entrepreneurship, operated through CORFO, cover different stages, including support for: business incubators and seed capital for early-stage entrepreneurship and supporting corporate venture (or spin-offs); organising networks of angel investors; and capital contributions to VC funds (up to 40%).

1. Scorecard of the Latin American Venture Capital Association (LAVCA) in co-operation with the Economist Intelligence Unit (EIU), MIF and CAF.

2. As a new 2.5% cap was approved by the country's banking superintendent in early 2010.

Source: Based on LAVCA (2010), OECD (2007b) and information provided by INVERTIR, a Peruvian network of business angels, *www.invertir.org.pe/contmenu.asp?conid=15*.

In this context, the classical synergy between entrepreneurship, innovation and productivity, closely connected through the Schumpeterian process of destructive creation fuelled by a constant renewal of firms through entry and exit, and conducive to increase the productivity of the economies, seems to be too ill functioning in the case of Peru.[10] Improving conditions that encourage and nurture entrepreneurship with high-growth (not necessarily high-technology) potential, the so-called "gazelle" entrepreneurship based on innovative strategies, rather than promoting the proliferation of "dwarf" firms can help Peru achieve a virtuous circle of entrepreneurship, innovation and higher productivity.

Innovation at the sectoral level

Additional insight on innovation activities in Peruvian firms can be gained from innovation studies available at the sector level in manufacturing, mining and the agro-industry (e.g. CIES, 2010; Kuramoto and Quispe, 2009; Kuramoto and Torero, 2004) complemented by information provided by business sector representatives to the OECD.

These studies confirm that innovation activities in Peruvian firms are positively correlated with their size and export orientation. They again show that the preferred source of innovation has been the adoption of technologies from abroad, mainly embodied in imported equipment and machinery, or the hiring of international experts, although firms are reporting incipient and growing internal R&D. In some industries, technical services provided by specialised entities such as the technological innovation centres (CITEs) are also mentioned as important sources of innovation for some sectors.[11]

They also confirm that R&D as reported by firms is carried out mainly at an experimental level, for adapting machinery or improving and optimizing processes and mechanization of operations (as in mining, food and manufacturing industries), field test for new varieties and improving product quality, sanitary conditions, and irrigation and post-harvest technologies (agriculture, pisco and aquaculture), as well as routine search of new design or fashion trends and new inputs and capital equipment (in shoe, textile and apparel).

Regarding the main obstacles to innovation reported by firms, the most commonly mentioned concern technology transfer and the S&T infrastructure provided by existing institutions and the availability of skilled personnel for innovation management. Although firms value the activities of CITEs, they feel that they should expand the number and scope of their activities. The supply available from intermediary public or private institutions appears to lag behind the demand from firms.

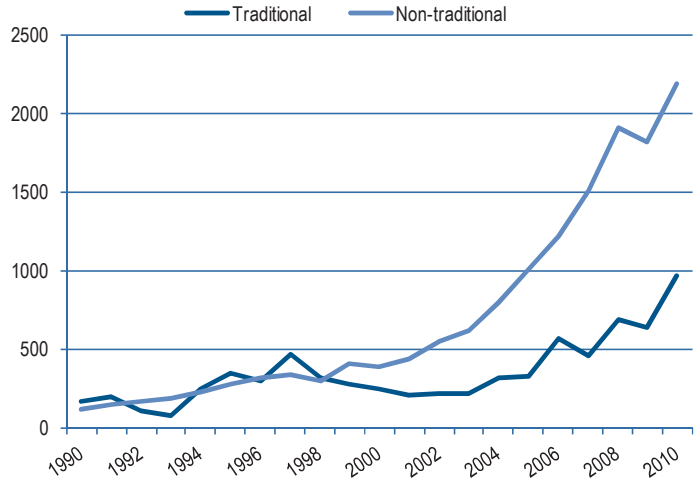
These case studies also illustrate the fact that in Peru the development of clusters – heavily based on natural endowments (mining, fishing, agribusiness, tourism, jewellery and apparel) – has been relatively limited and has generated very low spillovers to and synergies with local industry, especially SMEs, and the innovation system. Apart from efforts carried out in the framework of the value chain programmes promoted by PRODUCE, Peru has not implemented policies to encourage supplier clusters that could benefit from technological spillovers from foreign investment. The cluster development efforts under way have suffered from poor co-ordination between the private and public sectors and a lack of collaboration by actors and supporting institutions (Porter, 2010).

Non-traditional agro-industrial exports

The lack of real diversification or transformation of Peru's export structure has one clear and significant exception: the emergence of non-traditional agricultural and agro-industrial exports. Over the last three decades, these have risen to USD 2.18 billion in 2010, close to 2.5 times the level of traditional agricultural exports (see Figure 2.3).[12]

This very successful export diversification and self-discovery process was the result of a combination of strong natural comparative advantages (mainly excellent agro-climatic conditions) and a significant innovation effort. It meant the introduction and expansion of new products and markets, the entry of new firms, and experimental research and the adoption of new techniques and process technologies developed abroad (in irrigation, crop management, post-harvesting, sanitary control, storage and packing) to produce high-quality, niche (gourmet) and higher value-added products, in line with consumer trends in sophisticated food markets.[13] In products such as asparagus, mango, organic coffee and paprika, Peru has become a leading world exporter.

Figure 2.3. Surge in non-traditional agricultural exports, 1990-2010



Source: BCRP.

Around 90% of firms in the agro-export industry reported having introduced innovations during 2005-09. In terms of their novelty, these involved the introduction of products new to the firm (85%), to the local market (57%), to the world market (60%) and technologically improved (68%). On average, almost half of the firms (51%) also reported having introduced world-level process innovations, in most cases involving collaboration with partners abroad (clients, brokers, distributors) (Huarchi *et al*., 2010).

Many entities and producer and exporter organisations were involved in these developments, and their interaction, as well as public-private collaboration, was crucial to ensure the success of these innovative strategies. These involved international co-operation (universities and technical agencies in the United States and Spain; Chilean experts), co-operation with local universities, and various CITEs for experimental research (asparagus, mango and aromatic herbs), technology transfer and technical assistance. The support of SENASA and PROMPEX (the predecessor of PROMPERU), the Peruvian agencies in charge of certification and sanitary control in agriculture and of

export promotion, respectively, was crucial for improving sanitary conditions (in particular, fruit fly control and export certification). This is an essential for agriculture competitiveness, for developing external markets and promoting exports, and for supporting the creation and strengthening of export associations.[14] Finally, the availability of critical S&T and logistical infrastructure and the co-ordination needed to provide these public goods, was decisive for the viability of these new export activities.

However, beyond these achievements, there is much room to improve co-ordination among the public and private actors involved in this incipient system of agro-industry innovation. To maintain innovation momentum in the next stage of its development, the agro-export industry will need to move towards more systemic management of inter-firm networks and an inter-agency approach.

Cotton textile and clothing industry

The Peruvian textile and apparel industry [15] is one of the country's largest sources of employment (7% of the labour force). The quality of its natural fibres has long been appreciated, and the extra long staple cotton has been a source of comparative advantage in demanding and sophisticated world markets. The continuous updating of technology has allowed Peruvian textile companies to increase their productivity and international competitiveness; textile exports have risen four-fold since the mid-1990s to over USD 2 billion in 2008.

This rapid growth, boosted by the free trade agreement signed with the United States in 2006, was accompanied by significant diversification in terms of exporting firms (some thousand new exporters) and products exported and destinations, although the United States is still the main market. With the opening of new markets[16] Peruvian companies have been able to grow and achieve the economies of scale necessary to offer competitive prices. The textile industry has become very export-oriented; almost 90% of local production is exported and represents roughly a third of Peru's total non-traditional exports.

Not only has the opening of the Peruvian economy in recent decades allowed the development of new markets for textiles exports, it has also facilitated local firms' access to up-to-date technology embodied in capital goods from abroad. This has had a positive impact on productivity levels and the industry's competitiveness. The introduction of imported equipment and machinery has been the main source of innovation in the textile and clothing industry, and is highly correlated with individual export performance at the firm level (Morón and Serra, 2010). The acquisition of capital goods has been complemented by changes to improve plant capacity, the efficiency of processes and product quality.

Another relevant and effective channel for soft technology transfer in the Peruvian textile and clothing export industry has been the training and expert advice provided by programmes managed by PROMPEX for small businesses looking to introduce their products in international markets. One is the Best Practices Marketing and Manufacturing Programme (BPMM), which helps small businesses improve the quality and presentation of their products through training.

After the surge of exports resulting from the combined effects of trade openness and capital imports further channels Peru's textile and apparel industry will have to continue to invest in technological and non-technological innovation (*e.g.* design and marketing) and in human resources to face increasing competition from China and other Asian countries.[17] This will mean increasing the role of the three CITEs involved in the sector.

Mining

The boom in foreign direct investment (FDI) in Peru in recent decades has had a strong impact on output growth in several industries and has helped to modernise them and boost productivity. [18] The mining sector has the largest stock of FDI at close to USD 4 billion in 2009. Mining is also the leading export industry. Output and exports have grown explosively over 1980-2000 (copper output has increased by 55%, lead by 45%, zinc by 80%, silver by 60% and gold by 1 479% making Peru the world's eighth largest producer). Mining sector output as a proportion of GDP almost doubled from 2.9% to 5.2%. Large firms run or co-managed by global mining companies have adopted state-of-the-art mining technologies and exhibit world-class levels of productivity. The sector as a whole has benefited from significant transfers of technology via imports of know-how, licensing, capital goods and equipment.

Nevertheless, this dynamism has little impact on the rest of the local industry and innovation system. Most of the technology (engineering, equipment and machinery) and specialised technological services are imported. R&D activities are mainly performed abroad and there is little interaction with public research institutes, in particular INGEMMET.[19] Overall, despite its magnitude and dynamism, the mining sector has not leveraged the development of domestic, technologically intensive manufacturing and service firms in upstream and downstream industries. Moreover, because of its low pervasiveness, mining technology has had little diffusion effects on the rest of the Peruvian economy. This situation illustrates the fact that without proactive actions that involve collaboration between, and complementary actions of, the public and the private sector to foster at the same time the technological capabilities of the sector and technology spillovers opportunities to strengthen the innovation system opened by a leading, technologically strong and dynamic sector are missed. The example of the Chile's cluster programme in the mining sector gives some indications on how to develop public/private collaboration to address such an issue (Box 2.3).

Mining firms in Peru differ in size and technological capabilities. Large multinational subsidiaries exploit large deposits and mineral-processing plants, using cutting-edge technology, and solve technological problems by relying on expertise outside Peru, usually in their home countries. Medium-sized firms use mature technology and there is some evidence of applied research inside firms. Small-scale, artisanal operations use obsolete technology.

The mining industry suffers from a lack of relationships among the various actors, which impedes the adequate creation, transfer, adoption and diffusion of knowledge. An exception to the generally poor linkages between the mining sector and local S&T institutions is given by the active relationship developed by TECSUP, a private higher technological institute, which provides mining companies with mineralogical and hydrometallurgical testing and analysis services and meets a demand not satisfied by INGEMMET. TECSUP has gained considerable experience in the testing of metallurgical processes, especially those involving leaching, and has shown it can work effectively with mining companies. It also has a good track record in the formation of skilled human capital for the mining industry.

Incentives to promote innovation in the private mining sector seem to be lacking. While there are tax incentives for exploration or new investment, the system does not provide incentives for firms to perform R&D. The only, but substantial, incentive for technological change in the mining sector is exemption from tariffs on equipment.

Box 2.3. Chile's cluster programme: The Mining Cluster

Based on recommendations issued by the Chilean National Innovation Council for Competitiveness (CNIC), the mining industry was selected as one of the five cluster programmes promoted by the Inter-ministerial Committee on Innovation. The other four clusters were agro-food, aquaculture, special interest tourism and off-shore or global services, areas in which Chile has significant competitiveness in world markets and huge growth potential, but also challenges to diversify to more value-added products and services, as shown by studies supervised by CNIC.

The cluster programmes were conceived as pro-market mechanisms to improve public-private collaboration and to address market co-ordination failures, in order to tackle competitive issues and challenges faced by promising clusters (in areas such as infrastructure, training, regulation, standards, collaborative R&D, development of SMEs). In the cluster programmes, industry, academia and government leaders agree on roadmaps for action, as guidelines for focusing and prioritising policy instruments, budgets and public-private efforts, and follow the implementation and make the necessary adjustments.

Global and domestic mining companies that are among the largest in the world operate in Chile with projected investments (through 2017) of USD 57 billion and annual expenditures in goods and services of USD 14 billion. Approximately 4 000 companies provide goods and services to the mining sector and are increasingly active in export markets for goods and technological services.

The mining cluster programme has worked to: *i)* increase collaborative R&D to address strategic issues for the Chilean mining Industry; *ii)* speed up the development of world-class suppliers of mining technology services and equipment and foster a competitive chain supply base, especially among SMEs; and *iii)* improve human capital for the mining industry, to fill gaps and meet the requirements of a more knowledge-intensive industry.

Consensual priority setting and co-ordination among actors in these areas has led to precompetitive R&D projects, increased resources from matching funds for R&D and innovation support programmes, and FDI in technology-intensive activities which have had a growing impact on the development of the mining cluster and on the productivity and sustainability of the industry. An important demonstration effect has led to increasing involvement of the private sector in innovative initiatives.

Among the main results are: the creation of several R&D consortia involving domestic and foreign firms in cutting-edge areas such as bio-leaching, robotics, information technology (IT) applications and sensors for mining operations, for a total private-public investment of nearly USD 50 million; the establishment in Chile of assembly plants and R&D facilities of several international suppliers of mining equipment and services, with the support of InvestChile, the Programme for Attracting Investment in High Technology of CORFO[1] and finally, the programme for developing world-class suppliers, initiated in 2008, with the support of CORFO, aimed at facilitating the upgrading of capabilities in local suppliers with potential to become global companies, and taking a strategic collaboration approach in critical areas for mining companies.

1. Chilean Economic Development Agency.

Source: CNIC, Ministry of the Economy of Chile, CORFO and Consejo Minero.

Framework conditions for innovation in the business sector

Important shortcomings in framework conditions impinge upon the innovation performance of the business sector:

- *Competition regime and informality.* Competition is one of the most important drivers of innovation in market economies. The Peruvian competition regime is formally up to international standards but enforcement of competition laws could be improved, notably by increasing the resources of INDECOPI (OECD/IDB, 2006). Small formal enterprises in traditional sectors suffer from unfair competition from informal ones (which represent almost 72% of total companies), because of the latter's artificially low cost structures. Efforts to streamline the informal sector, to ensure fair competition and the right incentives for and rewards from innovation are necessary to improve the business innovation climate.
- *Intellectual property.* While INDECOPI has a satisfactory track record in patent examination and registration, weaknesses in enforcement of IPR and diffusion of an intellectual property culture as well as corruption hazards remain important disincentives for innovation in the business sector.
- *Barriers to entrepreneurship.* While improvements have been made to lessen regulatory obstacles to entrepreneurship, there is too much red tape in terms of time and costs to open or close a business (WEF, 2010a). This, added to the difficulty of obtaining seed capital, may affect the rate of creation of innovative start-ups in manufacturing and services alike.
- *Difficulties for new and growing firms to access capital.* The venture and seed capital industry is shallow in Peru, and the so-called angel capital is just emerging. Without this alternative source of high-risk financing, well-developed in more advanced countries, these firms, and particularly innovative start-ups, which often lack the collateral to benefit from loans and/or guarantee schemes, have little chance of financing from the traditionally conservative banking system, which is inherently adverse to financing intangibles. Consequently these firms are unable to survive the "death valley" of unprofitable investment in their first years of existence, being poised to disappear or remain forever small.
- *Tax regime for investment in R&D and innovation activities.* As this regime is unclear it leaves the tax authorities room for discretionary interpretation of whether such investments are expenditures that can be written off against profits (see above Box 2.1).
- *Institutional obstacles to transfer of public funds to the private sector* for investment purposes. The National System of Public Investment (SNIP) has to validate such investment against criteria that are not adapted to intangible investment such as R&D-related expenditures (see Box 3.2).
- *Infrastructure development.* According to the Instituto Peruano de Economía (GRADE, 2010) Peru suffers from a deficit in public infrastructure estimated at over USD 37.7 billion in 2008. Inadequate and inefficient infrastructure, especially in land and maritime transport as well as in logistics and communication, limits overall efficiency and restricts innovativeness in areas that are heavily dependent on export markets.

- *Labour market regulations* can be obstacles to the recruitment and mobility of skilled human resources and inter-institutional co-operation on innovative activities. Moreover, as pointed out by Hausmann and Klinger (2008), the fact that manufacturing activities have not become internationally competitive, in spite of a rising urban population with improved educational attainment but employed in low productivity activities in the informal sector, may be partly due to labour regulations.
- *Shortage of technical skills* for technology absorption and innovation management (across the board, but especially in SMEs). Training in managerial skills is not included in Peruvian business, administration or engineering curricula, as it is in more developed countries. As there is no culture of innovation in the business sector, this lack of skills increases the perception of risk and prevents firms from engaging in innovation. Moreover, despite progress made over the present decade by institutions such as SENATI and technological institutes such as TECSUP, technical training capacity needs to be scaled up to develop the required quality and quantity of skilled human resources to improve firms' technology absorptive capabilities and support incremental innovation, which is most common in low- and medium-technology industries and SMEs, and which takes place mainly in the workshop.
- *Lack of collaborative practices* and culture within the business sector and weak links with research institutions/universities. Low levels of social capital in Peruvian society raise the transaction costs of co-ordination compared to more developed countries. With few exceptions,[20] collaborative action among firms in the business sector is rare as Peru lacks a culture of industrial collaboration. Initiatives that stimulate collective action, either in consortia or alliances or with universities or research/technological institutions, are just emerging (*e.g.* the FINCYT contest for projects).
- *Shortage of private intermediary institutions* to act as "technology brokers" for knowledge transfer and provision of technology upgrading or technological infrastructure services. The CITE network plays a positive role in this respect, although its coverage remains limited. The development of private intermediary institutions should be encouraged as such institutions can facilitate collective action among firms and linkages with technological and research centres and universities, vocational training bodies, and providers of technical services (standards, certification, metrology services, testing labs, design services, among others).
- *Lack of awareness of the value of innovation.* Given the absence of an innovation culture, especially in the business sector, significant public efforts to present the positive results obtained by innovators, entrepreneurs and collaborative action can create demonstration effects in the business community, momentum and greater awareness of and confidence in the value and feasibility of innovation. This learning process should be part of the building of innovation capacity.

2.2. Public research institutes

Three arguments are generally given to justify the existence of public research institutes (PRIs): *i*) they can generate knowledge that is considered a public good; *ii*) they can address market failures related to knowledge appropriation that adversely affect the generation of knowledge in the private sector; and *iii*) they can address systemic failures that hinder the development of interactions between institutions involved in R&D and innovation. In most countries PRIs have been developed with missions justified by these three types of arguments. In principle, this has also been the case in Peru, with however some important qualifications pertaining either to the nature of the missions entrusted to some of them or to the ways that their missions have been fulfilled.[21]

The current situation

In Peru most of Public Research Institutes were created in the 1970s in an attempt to establish an institutional framework favourable to the development of S&T capabilities in areas in which technological development was deemed essential for the country's socio-economic development.[22] Established under sectoral ministries, their main missions were initially to carry out mostly applied research and to develop technology diffusion and transfer activities to the productive sector; to provide ministries with the services and information necessary to comply with their regulatory functions in the areas of natural resources and the environment; and to supply public S&T infrastructure, especially in the area of standards and metrology.

Over time, some institutes have been dismantled,[23] new ones have been created, and many have seen the scope of their activities evolve. This has sometimes led to greater emphasis on regulatory missions than on S&T development and diffusion. For a number of them with some notable exceptions, this evolution has given rise to an inflation of administrative and managerial activities at the expense of their initial S&T capacity building missions.

Unlike the situation in most other countries, Peru's PRIs are a heterogeneous group. They differ in terms of history, mission, size, governance, management and financial structures, and, last but not least, performance.

Formally, according to their legal status, there are presently 16 PRIs in Peru. However, on the basis of internationally accepted definitions of PRIs, *i.e.* public institutes whose main mission is to engage in research, technological development and technology diffusion (OECD, 2002a), probably no more than ten Peruvian institutes would qualify (Table 2.6).[24]

Peruvian public research institutes in principle enjoy a large degree of autonomy. Institutionally, they are decentralised bodies of sectoral ministries, which appoint the presidents of institutes under their supervision. Through their budget allocation, and with the approval of the ministry of Economy and Finance (MEF), sectoral ministries provide PRIs with institutional funding to carry out their core activities. In principle, ministries should play an important role in defining their priorities and evaluating their performance. However, with few exceptions, sectoral ministries have little interaction with their PRIs. PRIs often engage in direct negotiations with the MEF to obtain institutional funding. Ministries rarely intervene in the definition of research priorities and do not conduct any formal evaluation.

Table 2.6. Public research institutes[1]

Institute	Ministry	Created	Main research focus	Budget 2003 (million current USD)	Budget 2009 (million current USD; share of institutional funding)	Number of personnel 2009/10
National Commission for Aerospace Research and Development (CONIDA)	Defence	1974	Geomatics (information applications satellite); astrophysics; scientific instrumentation	n.a	1.10 (100%)	75
Peruvian Amazon Region Research Institute (IIAP)	Environment	1981	Amazonian biodiversity and cultural diversity; water resources; climate change and environment; forest management and environmental services	3.24	4.63 (77%)	219
Peruvian Maritime Institute (IMARPE)	Production	1964	Oceanography; aquaculture; fishing (extraction methods); environmental quality; marine biodiversity	8.67	12.19 (90%)	163
Peruvian Geophysical Institute (IGP)	Environment	1947	Volcanology; seismology; climatology; numerical climate prediction; geophysics	2.48	2.45 (n.a.)	159
National Geographical Institute (IGN)	Defence	1944[3]	Products and services: maps; geodesy; photogrammetry; cartography	0.87	1.51 (42%)	272
Geological, Mining and Metallurgical Institute (INGEMMET)	Energy and Mines	1979	Provision of technological services regulatory function (granting and monitoring of mining concessions; water certifications)	5.28	12.45 (98%)	279
National Institute of Statistics and Computer Science (INEI)	Office of the President of the Council of Ministers	1975	Research: living conditions; labour markets, employment and income; social programs; statistical tools. Products: economic information (prices, production, national accounts, etc.); social information (poverty, living conditions, environmental statistics)	n.a.	31.93 (-)	n.a.
National Institute of Agricultural Research (INIA)	Agriculture	1992	Genetic resources and biotechnology (livestock and plants); water resources; Andean cultivation; forest management; provision of technological services	12.1	23.35 (83.7%)	1217
National Institute for Telecommunications Research and Training (INICTEL-UNI)	ICT	1973	Satellite communications, digital terrestrial television; network technologies, fixed and wireless broadband technologies	4.14	4.53 (77%)	163
National Institute of Health (INS)	Health	1936[4]	Diagnostics methods; nutrition; Intercultural health; regulatory function: quality control of medicines; health food, products; occupational health	19.55	29.79 (93%)	900
Peruvian Nuclear Energy Institute (IPEN)	Energy and Mines	1975	Functional composite materials; characterisation of archaeological material; radiopharmaceuticals biomaterials; provision of high-technology products and services	7.81	8.78 (85%)	259
Fisheries Technological Institute of Peru (ITP)	Production	1979	Sustainability of fishery resources; fishery resource processing; provision of technological services	3.69	5.06 (33.3%)	240
National Agricultural Health Service (SENASA)	Agriculture	1992	Regulatory: Agricultural health and safety; organic products; food safety	20.48	38.63 (-)	n.a.
National Meteorological and Hydrological Service (SENAMIH)	Environment	1969	Glacier watershed basins and climate change; technological and information services	6.28	9.35 (-)	n.a.

1. CONCYTEC, INDECOPI, the National Service for State-Protected Areas are not included in this list as they do not perform research or technological development. In principle SENASA and the National Geographic Institute should not be considered as a research institutes. 2. As the National Resources Institute. 3. As the Military Geographical Institute. 4. As the Institute for Public Health and Hygiene.

Source: Adapted from GRADE (2010), and Lemola *et al*. (2011).

Nonetheless, PRIs' autonomy is constrained in several ways and their margins of manoeuvre are in fact limited. First, their limited resources go first to fixed expenditures and there remain few resources for new research programmes or projects that would require hiring new staff or expenditure on new S&T infrastructure. Second, prevailing labour laws and regulations make it difficult to develop human resource management practices based on the search for, and incentives given to, qualified and motivated staff. In many instances the most qualified staff can only be recruited under temporary contracts less rewarding that those of staff enjoying a more permanent status.[25] Under such circumstances it is difficult, to say the least, to develop a dynamic research strategy.

By far the major source of PRI funding is institutional funding from budgetary appropriations agreed with MEF. The institutes that had the most important increases from this source between 2003 and 2009 are INGEMMET, INIA and SENASA, up by 136%, 93% and 88%, respectively. Additional resources may come from grants awarded by innovation funds (FONDECYT and FINCYT) for approved competitive projects and from the provision and sale of technological services. A very few PRIs get some funding from bilateral or multilateral co-operation agencies (*e.g.* IIAP, INS and IGP). Three institutes have other sources of institutional funding from parafiscal levies collected from enterprises in certain sectors.[26]

An assessment of ten PRIs in 2002 (Mullin Consulting, 2002) in the context of consideration of a possible IDB loan, which eventually gave rise to FINCYT, concluded that the PRIs' performance was very weak overall not only in R&D but also in the promotion of innovation and technological change in the productive sector, even though they did not appear to be hindered by legal or regulatory obstacles to the development of co-operative activities with, or provision of technological services to, enterprises.

Regardless of some reforms and positive developments in a few PRIs, the general situation has not changed and has even worsened in certain cases (Lemola *et al*., 2011). In the last decade, the institutes have suffered from stagnation of public funding and increasing challenges in terms of generating high-quality research, producing results relevant to users, and attracting competent staff. Among the structural problems affecting the PRIs' performance are the following:[27]

- Personnel management in PRIs is regulated by the very rigid Public Administration Career Law, which makes it difficult for institutes to respond to the changing demand for human resources. It is practically impossible to hire and fire people to adjust to changing scientific and technological environments. During 2002-08, PRIs were not allowed to hire new researchers or to promote employees because of budget constraints.[28] Furthermore, the law bans researchers from receiving salaries from more than one source at any one time, so that collaborative research with other institutes and/or private industries is very difficult. Promotions are generally based on administrative performance rather than on research productivity. Highly skilled personnel have more incentives to leave the system than to remain. The scientific community has recognised these problems for some time and has been discussing the need to replace the current system by a new "Researchers' Career Law" or a modification of the current law to account for the nature of researchers' work in terms of the criteria for promotion, mobility and reward for collaborative activities.
- PRI's research agenda have often been mostly driven by the research institutes themselves with weak interactions with CONCYTEC, sectoral ministries and the productive sector. It is legitimate for research institutions to have a certain degree of autonomy in determining their research agenda. However, given limited resources

and management constraints and the absence of scientific boards or research councils, their agendas are often static and based on narrow institutional interests rather than collective needs or demand from potential users in the productive sector.

- Inflation of managerial and administrative tasks has come at the expense of R&D and technological activities, owing to the combined effects of absence of incentives for qualified researchers, lack of autonomy in personnel management and bureaucratic inertia in the absence of performance-based evaluations. It has been estimated that in the past few years no more than 18% of PRIs' budgets has been used for R&D (Sagasti, 2009).[29] At INIA, administrative staff account for about 60% of total employees, and 70% of the total budget is spent on administrative costs (GRADE, 2010).[30] This imbalance is compounded by the small number and proportion of highly qualified S&T personnel in total professional staff.[31]
- The public research institutes, as publicly funded bodies, do not claim ownership of their inventions and rewards for inventors are therefore insufficient. In the current situation, researchers have no incentive to develop new technologies, and there is no mechanism to share the benefits of joint research among agencies.
- Some PRIs perform both regulatory functions and commercial activities on regulated products (*e.g.* INIA and ITP). This may create conflicts of interest and competition distortions.

Against this generally bleak background some PRIs (*e.g.* INS, IGP and IIAP) have managed to demonstrate quite good performance in terms of international standards of scientific achievements or technology transfer to the productive sector (*e.g.* INICTEL) and/or in terms of a better adaptation of their governance and management structures to the nature of R&D activities they carry out according to their mission. It is no surprise that these better performing PRIs are those that have managed to benefit the most from international collaboration and/or funding (Box 2.4).

Strategic vision for PRIs

An overview of the main factors that affect the performance of PRIs highlights the fact that a number of them have entered in some kind of vicious circle wherein the low efficiency of resources devoted to R&D activity contributes to a scaling down of the ability of engaging them. In turn, this raises critical mass problems which further affect efficiency.

It is probably true that more resources should be allocated to public research in order to foster the generation and diffusion of knowledge to meet social needs and enhance the innovation capacity of the productive sector. However, currently, the conditions required to ensure that additional resources can efficiently contribute to fulfil the missions entrusted to PRIs are far from being met in a satisfactory way. An active redesign of the entire Peruvian PRI system may therefore be needed in order to redefine the missions of the institutes, strengthen their S&T competencies and build new systems of governance.

Box 2.4. Examples of achievements in some research institutes

Despite financial and bureaucratic constraints, both IIAP and IGP have managed to increase the capacity, commitment and motivation of their staff, improve the institute's scientific quality, attract national and international funding, and engage in international co-operation. Both institutes have worked to lengthen the timeframe of their activities towards future needs and opportunities in their scientific and technological fields.

1. Research Institute of the Peruvian Amazon (IIAP)

The Amazon territory and its natural resources represent an invaluable opportunity for the future development of Peru.

The IIAP, created in 1979, is a decentralised institution under the Ministry of the Environment. Its main functions are: *i)* the generation of scientific and technological knowledge for the sustainable exploitation of the Amazon region's natural resources and biodiversity; *ii)* the diffusion and application of this knowledge to broaden development opportunities based on innovation, with positive effects on employment and poverty reduction; and *iii)* the build-up of the region's S&T absorptive capacity, the training of human resources and the innovative use of local knowledge. The institute has a total of 219 staff of whom one-third are researchers, including 12 PhDs and 22 at master's level.

In 2009 the IIAP began a process of governance reform and institutional restructuring. To ensure better involvement of a variety of stakeholders in the definition of its strategic objectives and the focus of its S&T activities as well as to foster collaborative activities, it has created a Council with representatives from local communities, national and regional governments as well as from universities and the private sector. The Council elects its Board, which is the highest management body of the Institute. The Board is composed of five members elected for three years who can be re-elected only once.

IIAP's Strategic Plan for 2009-18 consists of six research programmes which cover the interests and needs of the key sectors and stakeholders: Amazon biodiversity research, climate change, integrated forest management and environmental services, conservation and use of water resources, cultural and economic diversity of Amazon, and Amazon biodiversity information. In spite of persistent economic uncertainties, implementation of these programmes has started well.

The IIAP has developed international scientific co-operation with research institutions from other Latin American countries with similar interests in the Amazon Basin (*e.g.* Brazil, Colombia and Ecuador) as well as with research institutions or universities of developed countries (*e.g.* Finland, France, the United Kingdom and the United States). The IIAP has also benefited from research grants from foreign or international sources of financing of R&D projects.

2. Peruvian Geophysical Institute (IGP)

Peru is characterised by intense seismic activity and by the large present and potential effects of atmospheric variations and climate change which can have a significant impact on its extremely diverse regional ecologies.

The IGP, formally created in 1962,[1] is a decentralised institution operating under the Ministry of the Environment. Its mission is to acquire, preserve and disseminate knowledge about the geophysical environment, with an emphasis on basic and applied research focused on understanding the geophysical and socio-economic causes of natural disasters and climate change and the mitigation of their effects on Peruvian regional ecologies.

The IGP has a staff of 159, of whom 64% work in research (including 12 PhDs). This profile is comparable to that of similar institutes at the international level. Like most of the world's high-level research institutions IGP has important postgraduate training activities. Along with the National Institute of Health, the IGP is the Peruvian research institution with the best record of scientific excellence and performance in terms of internationally indexed publications and citations statistics.

From the outset IGP has engaged in international collaboration with similar institutions in developed countries, notably in the area of seismology and climatology. It has been quite successful in attracting foreign scientists and getting research grants from international funding sources.

1. The IGP replaced and expanded upon the Huancayo Geophysics Observatory established in the beginning of the 1920s. When it was launched the IGP benefited from the support of US research institutions.

Source: Case studies prepared for the diagnosis of PRIs commissioned by FINCYT (Lemola *et al*., 2011) and information provided by IIAP and IGP during the OECD fact-finding missions.

Box 2.5. Public research institutions: Trends in ongoing reforms in OECD countries

The institutional settings, governance structures and modes of financing of public research institute in OECD countries are quite varied. However, there are some common trends.

Governance structures and institutional settings

- Governments have engaged in more strategic planning and monitoring of PRIs.
- The practice of multiannual "performance agreements" between PRIs and ministries or agencies to which they are attached has generalised.
- Institutions have been granted a higher degree of autonomy.
- In a number of countries, the role of intermediate structures (*e.g.* research councils) in priority setting and funding have been strengthened.
- Participation of representatives of the business sector on PRIs' Boards is more common.
- The balance among institutions performing public research is changing, with a stronger role for universities.

Priority setting

- The evolution of missions entrusted to PRIs and the diversity of stakeholders who benefit from the results of their research has shifted the balance between top-down and bottom-up priority setting procedures.
- Methodological tools such as research and technology foresight exercises are becoming more widespread.
- Research priorities for both fundamental and applied research are increasingly set in multidisciplinary research areas.

Funding

- Funding of public-sector research (PRIs and universities) has generally increased, but new funding is often allocated to new thematic priorities or new schemes (*e.g.* centres of excellence).
- The proportion of funds allocated to PRIs through competitive grants has increased relative to institutional funding.
- The allocation of institutional funding to individual PRIs is increasingly determined by evaluation exercises based on qualitative and quantitative performance indicators, which are based on performance agreements when they exist.
- Business funding of public research is increasing, notably in the framework of public-private partnerships in jointly determined S&T areas.

Source: OECD (2003a).

Such a redesign is a demanding task which requires, as a point of departure, a common long-term vision with certain strategic milestones. It will take time and require political determination and the committed involvement of key stakeholders. However, if a reform of the PRI system is engaged according to best practices and implemented with the necessary incentives to reach a consensus and have demonstration effects, performance improvements can be achieved in a relatively short time frame. The following should be among the main targets of a PRI development strategy:

- The quality and performance as well as the R&D intensity of the institutes must be raised to a good international level.
- The institutes must be more capable than they are today to improve the knowledge base of public policy making and to help public authorities better focus their activities and financial resources.
- Co-operation and integration of the institutes must be substantially improved and produce synergies that lead to new R&D and service opportunities.
- The institutes must be able to increase their financial resources from both public and private sources, as this can lead to growth of institute personnel and to improvements in research facilities.
- Legal and regulatory obstacles that hinder the development of linkages between institutes and users of their R&D and services must be alleviated.
- International networking of the institutes through joint projects and publications, exchange of information, and funding from foreign sources must be actively developed.
- The institutes must offer their employees a stimulating working environment and competitive salaries.

Many OECD countries have also undertaken major reforms to improve the performance of their public research institutes and adapt them to a more competitive research environment, the evolving complexity and diversity of actors in innovation systems, and more efficient conceptions of the management of public agencies. While taking into account the institutional characteristics of Peru, the redesign of its PRI system may be inspired by reforms in OECD countries and the trends that have led to them (Box 2.5).

Governance of PRIs

The institutes' current organisation and governance are more the result of their historical development than a considered analysis of their role, either individually or as a whole, in the Peruvian innovation system. Procedures for allocating research funds, setting research priorities and managing research institutions affect the type of research performed and the results achieved. Without proper governance, the economic and social benefits that Peruvian society increasingly demands from government investment in research cannot be achieved.

A basic issue is the incorporation of the institutes as a whole in the governance of the Peruvian innovation system. Given the current autonomous or semi-autonomous position of PRIs, their links to ministries are limited to budgetary and other bureaucratic procedures. However, even if the ministries played an active role, this would not necessarily meet the requirements of modern innovation policy. International experience suggests that even advanced sectoral governance tend to focus on specific, narrowly defined fields and to give insufficient attention to inter-sectoral co-operation and, more broadly, to the need to increase connectivity throughout the innovation system. Closely related to the need for broader co-ordination, is the concept of horizontality which refers to the crossing of boundaries between different policy domains and sectoral boundaries. The development of a horizontal policy involves putting a broader strategic approach above departmental/sectoral goals submitting the latter to overriding, thematic priorities.

An important common trend in many countries is to integrate research institutes by pooling resources under a common umbrella. The main motives are the recognition that S&T activities are increasingly interdisciplinary and economies of scale for the acquisition of costly equipment. The aim is to improve links among the actors of the innovation system (at the international level as well) and above all to use existing resources more effectively through collaborative projects and reduction of overlaps. Another international trend worth considering is merger or consolidation of PRIs, including partial privatisation or close association with university laboratories.

Financing issues

Financing is the most effective means of inducing changes in the orientation and performance of the institutes. However, there is no magic financing formula because of the variety of institutes' missions, research and technological specialisations and their positioning *vis-à-vis* other actors. What is appropriate for an institute providing services to industrial companies is not necessarily appropriate for agricultural research or for an institute involved in national infrastructure or nuclear energy research. At the same time, it remains possible to look for and apply general principles of innovation-friendly financing.

Peru's research institutes are mostly funded by relatively limited budget appropriations from the central government. Just a few have other sources of funding, such as INGEMMET, whose budget is covered by revenue from mining rights, IMARPE, 30% of whose budget is covered by fishing permits, and IIAP, which receives 3% of Canon Law oil revenues for half of its budget. The institutes that serve more dynamic economic sectors such as mining or agriculture have larger budgets, but these are small by international standards as well as in terms of domestic needs.

This lean funding base has been a structural constraint on more creative and risky research activities and long-term planning. With small budgets and uncertain perspectives, the institutes have focused on securing the position of existing staff. To this end, they have focused on obtaining funds from various sources. Sale of services has been a natural development for many. While this could be a positive and useful development, a difficult situation and modest demand have most often resulted in a short-term perspective, greater fragmentation of activities, lack of development of research and, all in all, lower levels of ambition and activity.

Internationally, there is a broad spectrum of financing models and practices. In some countries most PRIs are public agencies and get 60% to 80% of their financing from state budgets either as institutional funds or through research programmes or contracts. Increasingly, however, national programmes are subject to competitive funding.[32] There are also public research institutes that are more dependent on external financing from contract research or services to companies and other clients. In addition, there are semi-public and private arrangements supported by public funds. For years, there has been a general trend in many countries to lower the share of direct budget funding and increase financing from external sources. However, direct budget funding may also have grown in absolute terms.[33]

In Peru it is necessary to develop further efficient mechanisms for competitive R&D financing. International best practices indicate that national research and technology programmes based on open competition among research organisations are an efficient and successful way to bring healthy competition, flexibility and target orientation to R&D. The programmes of FINCYT are an important step in this direction. In addition, Peruvian

PRIs have to create incentives, channels and practices for the development of contract R&D and other information and technology transfer services. In some cases this may be a necessary condition for the development of other forms of financing.

The establishment of FINCYT has created a new source of funding for R&D projects in several institutes (Table 2.7). It should be noted that all funded projects have been in collaboration with other public or private institutions. This seems to indicate that FINCYT not only offers appropriate incentives to induce these centres to begin fulfilling (or to return to) the role for which they were created in the first place, but also encourages co-operation and connectivity.

An important point related to financing is the question of critical mass as it relates to R&D. This is an issue that has been long debated throughout the world. It is clear that in R&D, achievement of a high level of knowledge and competence requires sufficient human resources (in quantity and quality) and S&T infrastructure. However, the requirements for the optimal or minimal size of an R&D unit vary widely by fields of science and technology so that decisions have to be made on a case–by-case basis.

Table 2.7. Research institute projects financed by FINCYT

Institute	Individual projects	Projects with producers	Projects with non-producers
INIA	0	4	15
IIAP	0	4	8
IMARPE	0	4	5
INS	0	0	1
IPEN	0	1	1

Source: GRADE (2010) based on data provided by FINCYT.

Useful comparisons can be made between Peru's PRIs and those of other countries as regards missions, governance structures, financing and co-operation with other institutions. Box 2.6 describes Mexico's public research centres and their evolution towards more efficient functioning over the past decade, especially since the 2006 S&T Law.

Box 2.6. Mexico's public research centres

In Mexico public research centres (PRCs) are an important component of the national research system and perform around 23% of total R&D expenditures. There are two sets of PRCs: those supervised by the National Council for Science and Technology (CONACYT) which account for about one-third of PRC research activity and those supervised by sectoral ministries, mainly Energy, Agriculture and Health. Mexican PRCs have a large degree of autonomy in terms of budgetary management and, more recently, operational and human resources management.

The 27 CONACYT research centres are grouped into three main S&T areas: ten cover mathematics and natural sciences, eight conduct research in social sciences, eight are dedicated to innovation, technological development and diffusion activities related to the manufacturing sector, and one provides financial support for postgraduate studies. To ensure a close relationship between supply and demand of S&T services the centres are widely distributed across the country. In 2006 around 75% of their activities were conducted outside of the Mexico City metropolitan area.

…/…

Box 2.6. Mexico's public research centres *(continued)*

In 2006 total personnel of CONACYT research centres amounted to about 7 000 persons of whom 67% were research staff (FTE), including 30% of researchers (10% of total public sector researchers including academic ones). PRCs' scientific productivity has increased steadily since 2000 and in 2007 more than 2 000 scientific publications were authored by PRC researchers.

Besides conducting S&T activities, CONACYT PRCs also offer teaching programmes at the master's and PhD levels with an average of 7 000 students enrolled a year over the last decade.

Since the 2006 S&T Law, the PRCs' governing bodies can establish the conditions of appropriation and use of the results generated by their researchers in terms, notably, of revenue from intellectual property rights. They are also entirely free to engage in co-operative research and technology development projects or form technology-based firms with private firms. Similar conditions now also apply to many other non-CONACYT PRCs.

In 2007 the total budget of CONACYT PRCs was around USD 480 million or about 8.1% of total R&D expenditures and around a third of public R&D expenditures. Around two-thirds of their total budget comes from CONACYT institutional funding although the level varies considerably among PRCs. External funding comes mainly from selling products and mostly services to the private sector and from competitive research grants. In the framework of the increasing management autonomy granted to the PRCs which allows them to retain their earnings, the level of institutional funding received from CONACYT is tied to performance criteria that take into account research excellence and technology transfer activities.

CONACYT PRCs have formed an association that facilitates the development of a common strategic vision and co-operation activities among PRCs and gives them a voice in the overall governance of the Mexican innovation system.

Source: OECD Reviews of Innovation Policy: Mexico (OECD, 2009).

Strengthening collaboration with the productive sector

As specialised research laboratories, public research institutes can play an important and profitable role in innovation activities. They not only serve to connect different components of innovation systems but also nurture new connections that might not arise spontaneously. They can provide a vast array of information and consultancy-based services, ranging from foresight exercises to testing and quality accreditation, integration and recombination of cross-disciplinary information in order to identify new, potentially profitable areas of commercial product design and development. In the framework of contractual agreements they can engage in medium-term collaborative R&D and innovation projects with enterprises.

The Peruvian research system has no tradition of co-operation. The low level of interaction among the actors of the Peruvian innovation system noted in several studies (Mullin Consulting, 2002; Lemola *et al*., 2010; Sagasti, 2003) is also true of PRIs and affects their performance. In fact, co-operation among research institutes as well as between them and universities is the exception. Each institute and each research team in institutes and universities works in isolation. S&T infrastructure is not shared among teams, so that each team often purchases the same kinds of equipment. Sharing the equipment would free resources for purchasing equipment that is owned by none of the research teams. The same is true of the sharing of information on research activities and results. Legal, regulatory and bureaucratic obstacles also hinder collaboration.[34]

In addition, there is a lack of links between industry and PRIs. On the one hand, Peruvian companies have not faced the intense competitive pressures that would lead them to demand technological services or force them to innovate constantly and a significant portion of the business sector consists of companies with low levels of technological sophistication. On the other hand, industry and research institutions tend to have different research interests so that PRIs' governance structures and an adequate system of incentives are needed to encourage their co-operation. This is the case of successful PRIs and publicly funded technological centres in developed and emerging countries (OECD, 2002b).

This situation appears to be changing with the greater exposure of Peruvian companies to external markets. The signing of free trade agreements has generated commercial opportunities that can only be seized with high-quality products, efficient logistics which ensure on-time arrival of products, and marketing systems that are appropriate for the markets to which the companies seek access. This has generated increasing awareness among exporting companies of the importance of innovation, as well as of the fact that innovation involves establishing relationships with other agents.

The only initiatives explicitly designed to foster linkages within the innovation system are the innovation funds and technological assistance programmes. Both the INCAGRO and the FINCYT funds have provided incentives to encourage projects involving multiple agents. In INCAGRO projects, preference was given to work with organised producers in the agriculture sector, particularly for extension projects. In projects financed by FINCYT, the incentive is larger amounts of co-financing when projects involve several agents, such as groups of companies, or when they are partnerships in which a company or set of companies is associated with a university or research institute. For projects presented by associated entities, FINCYT provides co-financing of up to 80%.

Beyond such incentives in support of individual projects, more ambitious and comprehensive approaches to co-operation between PRIs and the private sector have become widespread in many OECD countries through public-private partnerships for pre-competitive R&D leading to innovation. Such partnerships are organised around medium- to longer-term R&D programmes determined either top-down when they focus on a government priority area or bottom-up when they are jointly defined by a consortium of PRIs and enterprises (Box 2.7). Experience shows that involvement in partnerships in the framework of programmes has positive effects for future collaboration on individual projects whether or not these are supported by specific incentives. In Peru such a public-private partnership approach could be usefully implemented in a multidisciplinary research programme for the exploitation of biodiversity resources.

Box 2.7. Public-private partnerships for R&D and innovation: a high-leverage public support instrument

An important conclusion of recent OECD work on the role of government in fostering knowledge-based growth is that greater use of public-private partnerships (PPPs) can enhance the contribution of science, technology and innovation policy to economic performance. PPPs for research and innovation offer a framework for the public and private sectors to join forces in areas in which they have complementary interests but cannot act as efficiently alone (risk sharing and mutual leveraging effects). They can fill some gaps in innovation systems more effectively than other policy instruments.

PPPs can usefully promote collaborative research in areas where innovation is deeply rooted in science:

- Major programmes to promote strategic R&D co-operation among universities, public research institutes and private firms have been launched or reinforced in many OECD countries since the late 1990s, following the pioneering examples of the Australian CRC and Swedish Competence Centre programmes (*e.g.* Kplus and Kind/Knet in Austria, the Innovation Consortiums in Denmark, the National Technological Research and Innovation Networks in France, the Technology Leading Institutes in the Netherlands, the AERIs programme in Mexico and the CENIT programme in Spain).
- PPPs are the best approach to building innovative networks in new multidisciplinary research fields, either as stand-alone initiatives (*e.g.* Genomics in the Netherlands) or as part of broader PPP programmes (*e.g.* nanotechnology, Gehomme and Genoplante networks in France, and the Kplus centre on bio-molecular therapeutics in Austria).

In addition to providing effective springboards for frontier and pre-competitive R&D in areas of strategic importance, PPPs can contribute to other objectives and yield broad benefits:

- Input, output and behavioural additionality. Cost-sharing arrangements and industry leadership within PPPs (as in the case of Spain's CENIT programme) translate into high leverage of public support on business R&D and innovation. PPPs also have a lasting effect on the behaviour of public and private researchers, by helping to build trust and personal networks that facilitate further formal and informal co-operation.
- New avenues for commercial spillovers from public research. PPPs provide participating firms with easier access to public research outputs and facilitate the creation of new technology-based firms, especially spin-offs from public research, as well as the mobility of human resources between the public and private sectors (*e.g.* Israel's Magnet programme).
- Linking SMEs with scientific research. Most innovative SMEs find it difficult to establish direct contacts with universities and public labs. PPPs can play the role of effective bridging institutions (*e.g.* ProInno in Germany).
- Increased synergies within and between regional innovation systems (*e.g.* Korea's Regional Innovation Centre programme). National PPP programmes can enhance co-operation between local innovative clusters in order to ensure critical mass and better exploit complementarities.

Whereas PPPs can potentially achieve what other policy instruments cannot, handling them is a delicate matter since the partners must engage in sustained co-operation with partners from different managerial cultures and with partly conflicting goals. OECD work points to the following critical factors for success:

- Long-term commitment from both government and industry, based on a shared vision.
- Efficient governance and steering mechanisms that ensure a sustainable balance between public and private interests, especially: *i)* balanced resources commitment by involved parties: *ii)* competitive selection of projects and participants; *iii)* secondment of research staff; *iv)* sharing of IP rights; and *v)* rigorous evaluation.
- Alleviation of obstacles related to inter-institutional mobility of staff with different status.

Globalisation and commercialisation

In a globalising world, the internationalisation of research is more and more important. For Peru, which lags behind the international level of research, active and targeted co-operation with research institutions of other countries in and outside the region is the best way to improve the quality of domestic research and catch up with more advanced countries. Some PRIs have sought international ties with foreign universities, research institutes and multinational companies, but too few have taken determined measures towards greater internationalisation.

Research alone does not necessarily add value to the national innovation system. To achieve research breakthroughs, research findings must be disseminated and used. Innovation requires the results of research to be transferred to industry, absorbed and then translated into new products, services and processes. This does not happen automatically.

A major global trend in universities and research institutes is the commercial utilisation and exploitation of research results. This comprises technology transfer, protection of IPR and related financial, organisational and legal issues and requires capabilities, processes, instruments and tools. Development of IPR management capabilities for technology transfer offices (TTOs) and technology licensing offices (TLOs) is an issue that needs to be addressed at Peruvian PRIs and universities alike following examples of practices that have been developed in other Latin American countries (Box 2.8).

Box 2.8. Policy framework for patenting by public research institutes and universities in selected Latin American countries

Andean countries

Andean countries have no specific regulation regarding university patenting and technology transfer from universities. Yet *Decision 486 of the Andean Community* (Bolivia, Colombia, Ecuador, and Peru), referring to the Industrial Property Law of 1995, states that "the entities that receive governmental funding for their research must re-invest part of their receipts and royalties derived from commercialisation of such inventions, with the purpose to generate continuous funds for research and encourage researchers by making them participants in the returns of innovation, according to the legislation of each Member Country."

Argentina

The 1995 *Law on Patents of Invention and Utility Models* gives joint ownership to the university and the centralised agency CONICET (Consejo Nacional de Investigaciones Científicas y Tecnicas), which manages employment and pays salaries for high-level university-based researchers in the country. TTOs of individual institutions may establish individual agreements with CONICET for the assignment and management of particular inventions. CONICET does not, however, have a general policy on handling joint inventions (Graff, 2007).

Brazil

The *2004 Innovation Law* (Law nº 10.973) provides rules and incentives for IP exploitation and collaborative public-private research relationships. A series of incentives was deployed (fiscal exemptions for R&D investment and collaboration, patenting, etc.) for such purposes, including the provision of the faculty to universities to commercialise and manage intellectual property (IP) from publicly funded research. The law also established the creation of TTOs (at each university, or shared with other institutions, when necessary) and includes a chapter that specifically regulates the acquisition of IP by research institutions from independent inventors. The law also states that universities and public research organisations are required to share revenue with inventors. Accordingly, inventors must receive between 5% and 33% of royalties or licensing income.

.../...

Box 2.8. Policy framework for patenting by public research institutes and universities in selected Latin American countries *(continued)*

Chile

Chile's Industrial Property Law contains a specific provision for universities which states that research institutions and universities have the faculty and eventual rights of IP derived from inventive and creative activity by employees or contractors leaving statutory roles at institutions to design modalities through which inventors/creators participate in the benefits derived from those activities. Hence no legal provision exists to require institutions to share revenues with researchers or to formally to engage in business creation, but these laws do not prevent them from doing so. Some universities have implemented their own policies. The Office for the Transfer of Research Results (OTRI) created in 2005 in co-operation with five universities and two major industry associations (ASEXMA and CPC) assists universities and PRIs to assist with patenting procedures management, and commercialisation of IP.

Mexico

The 2010 Innovation Law explicitly mentions the development of knowledge transfers and linking units (*unidades de vinculación*) as goals in innovation strategies and provides financial support for this purpose. With respect to inventor compensation, the law states that institutions can pay inventors up to 70% of the receipts derived from IP generated by their inventions. The impact of some of the new initiatives is constrained by the lack of expertise in managing and negotiating IP transactions at universities, and the lack of intermediary institutions that could bridge the gap. Some public-private initiatives are intended to fill this gap. At the end of 2010, a non-profit, public-private industry association, ADIAT (*Asociación Mexicana de Directivos de la Investigación Aplicada y el Desarrollo Tecnológico*), launched a national training programme for technology transfer managers *(Programa Nacional para la Formación de Vinculadores Tecnológicos*). With government sponsorship, training courses are taking place throughout the country.

Source: Zuniga, P. (2011), "Patenting by Research Institutions in Developing Countries: Policy Approaches and Practices", Background report on University Technology Transfer prepared for the WIPO Economics and Statistics Division, World Intellectual Property Organization (2011), Geneva.

Changes in the economic contexts of all countries have tended to weaken the effectiveness of the IPR system. New technologies, initially not covered by patent systems, have emerged, notably in software and biotechnology. But there are also opposite trends at work, notably in the area of biodiversity where the protection of Peruvian endogenous exploitable resources should be better ensured.

As markets have expanded, globalisation has made imitation and counterfeiting more rewarding and more feasible, as some countries have registered a significant increase in their technological capacities, without a corresponding development of their IPR system.

Monitoring and evaluation of institutes' performance

Evaluation has become increasingly important as a means to ensure efficiency of budgetary appropriations and resource allocation. Although because of the uncertainty of outcomes in research activities evaluation poses specific problems in many countries evaluation of research organisations, research and technology programmes and other policy instruments has proved to be an effective indirect way of steering and managing PRIs. The evaluations usually include priority setting and *ex ante* impact appraisal, monitoring of progress (interim evaluation), and *ex post* analysis of results and impacts. Their goal is to measure performance, support target or performance-based management and budgeting, enhance accountability and transparency, and improve communication of activities and outcomes of the institutes to policy decision makers and sponsors. This practice is being generalised in many OECD countries and even at regional levels within countries (Box 2.9).[35]

Box 2.9. Performance contracts for Catalan research centres

In 2003 the Catalan government, through its Ministry of Innovation, Universities and Firms, began using performance contracts with the public research centres it funds. All centres are now subject to such contracts. The objectives of the contracts are: *i)* to establish a new framework for the relationship between the Catalan government and the research centres, *ii)* to provide the necessary resources for the centre to achieve its goals, *iii)* to formalise participation of the Ministry of Innovation, Universities and Firms in the programming and objectives of the centre, *iv)* to support strategic planning and quality improvements, and *v)* to guarantee base funding to obtain competitive project funding.

The contracts include a set of monitoring indicators. They serve to determine goals and identify any important deviations from those goals over time. The contracts are reviewed annually. The performance indicators are weighted by objective, with 80% towards overall strategic objectives for the centre and 20% for specific objectives.

Catalan research centre objectives	Indicators	Weight
Strategic objectives		80%
1.1. To promote the capacity of the research centre to obtain competitive resources through the participation of the researchers of the centre in competitive calls and contracts with companies	- Income from calls for proposals - Income from contracts or agreements - Income from teaching - Income coming from patents	25%
1.2. To achieve a staff of critical mass as established in the strategic plan of each centre	- Senior staff - Junior staff - Post-doctoral staff - Pre-doctoral staff - R&D technical experts'	5%
1.3. To encourage the excellence of the scientific production by means of the publication of articles in specialised journals of acknowledged prestige	- Number of peer-reviewed publications in international scientific reviews	25%
1.4. To carry out training activities in collaboration with universities connected with the research of the centre	- Doctoral theses read or supervised by a researcher from the centre	15%
1.5. To boost patent registration or the creation of spin-offs from the research performed in the centre	- Number of patent applications by the centre - Number of spin-offs	10%
Specific objectives		20%
Each centre describes its own objectives	-	

Source: OECD (2010), *OECD Reviews of Regional Innovation: Catalonia, Spain*, OECD Publishing, Paris.

Improving Peruvian PRIs' performance requires not only major improvements in transparency and accountability, but also the implementation of a monitoring and evaluation system that can tie at least part of the institutional financing to performance.[36] Given the weak control currently exercised by sectoral ministries, MEF has taken over this responsibility by applying to PRIs its results-based budgetary allocation procedures (Programa Presupuesto por Resultados). However, even if this control mechanism is relevant to some types of government programmes, it is inadequate in its present form for good governance of institutions involved in research where tangible outcomes are by nature uncertain.[37] Monitoring and evaluation practices may vary but the overall principles should be common and agreed between the set of PRIs and the ministries or agencies through which their funding is allocated.

2.3. The higher education sector

A relatively weak record in primary and secondary education

In Peru basic education is mandatory from age 6 for six years of schooling at primary and five years at secondary level. Higher education institutions (HEIs) include universities and the technological high institutes (THIs)[38] that provide non-academic tertiary level training.

Over the last three decades Peru has made significant progress in increasing primary and secondary enrolment rates. In terms of adult literacy, average years of schooling, gross secondary enrolment, and tertiary enrolment rates, Peru is ahead of or on par with other Latin American countries (Table 2.8).

Table 2.8. Education indicators: Enrolment, public spending and adult literacy

Percentage

Indicators	Peru	High-income countries	Latin America
Adult literacy rate (% age 15 and above), 2007	90.47	97.44	90.71
Average years of schooling, 2000	7.58	9.07	6.18
Gross secondary enrolment rate, 2007	94.48	101.43	84.15
Gross tertiary enrolment rate, 2007	35.06	55.68	37.14
Internet access in schools (1-7), 2008	2.9	5.11	2.95
Public spending on education as % of GDP, 2007	2.7	5.15	4.64

Source: UNESCO (UIS, 2010).

However, as regards the amount of public resources devoted to public education relative to GDP, or the amount of public expenditures per secondary or tertiary student, Peru fares rather poorly compared with the more advanced large Latin American countries.[39] The low level of resources accounts in part for Peru's extremely poor record in terms of educational quality, as measured by student achievements in reading, maths and science. In the OECD's most recent PISA international comparative exercise of 2009, Peru participated along with 64 developed and developing countries and ranked systematically near the bottom (Table 2.9).[40]

Literacy, widely understood to encompass reading, maths and science, is necessary not only for successful tertiary education in science and engineering but also for mastering skills not acquired in education that are needed to participate actively in innovative activities. Sustained quantitative and qualitative efforts to improve Peru's primary and secondary education system must be made and maintained over the medium to long term in order to develop the human capital required by a more knowledge-based and innovative society and economy.

Table 2.9. PISA scores on educational achievements: Peru and selected countries, 2009[1]

	Reading scale	Mathematics scale	Science scale
OECD average	493	496	501
Korea	539	546	538
Finland	536	541	554
Spain	481	483	488
Chile	449	421	447
Mexico	425	419	416
Colombia	413	381	402
Brazil	412	386	405
Argentina	402	388	401
Peru	**370**	**360**	**369**
Last country	314	331	330
Peru ranking among 65 countries	**63**	**64**	**64**

1. The 2009 PISA exercise involved 65 countries including all OECD and eight Latin American countries.

Source: OECD, PISA 2009.

The structure and expansion of the Peruvian higher education system

In a context of sustained economic growth and increasing enrolment rates in secondary education over the last 25 years there has been strong social demand for higher education. It has been met by a significant increase in supply through the creation of a large number of public but mostly private higher education institutions, only some of which are part of the university system (Table 2.10). Whereas in 1985 Peru had 45 universities, of which 18 were private, it now has 99 of which 67 are private.[41] The more rapid growth of private universities was facilitated by a 1996 Legislative Decree that allowed the establishment of private universities and other higher education institutions as for-profit entities (GRADE, 2010). These institutions have responded to the growing demand for higher education that is not addressed by the public sector, particularly since the 1980s. In 2009, 949 000 students were enrolled in higher education, of whom 588 000 in universities and 361 000 in non-university higher education institutions. Enrolment in universities has grown consistently; it increased until 2005 in non-university institutions but has since declined.

Table 2.10. Enrolment in higher education institutions, 1985-2009

Thousands

Year	Population 17-24 years old	University	Non-university	Total
1985	3 102	355	98	452
1990	3 453	360	239	599
1995	3 785	391	299	690
2000	4 068	426	360	786
2005	4 249	559	385	944
2009	4 145	588	361	949

Source: GRADE (2010).

The rapid growth of private higher education institutions made possible by the Legislative Decree changed the balance between public and private ones.[42] It led to a heterogeneous HEI system and had a negative impact on the overall quality of higher education. Among the main reasons are: *i)* the failure to implement a reliable certification system for newly created private institutions and, more generally, delays in the certification procedures; and *ii)* a poor match between the requirements of the labour market and the future expected needs of the Peruvian economy and the curricula offered (GRADE, 2010). Moreover, the uncontrolled establishment of university branches and programmes has led to unhealthy competition among universities and a lack of balance between supply and demand in certain curricula.

The number of non-university higher education institutions has increased at a pace similar to that of universities: the number of technological high institutes grew from 300 in 1991 to 674 in 2005; enrolment was 141 000 in 2005 compared to 121 000 in 1993 (Díaz, 2008). This expansion generated problems similar to those of universities. The growth of supply, prompted by rapidly increasing demand and a lack of quality control, has led to a very diverse body of THIs.[43] However, some, such as TECSUP, have a very good record in terms of accreditation, interaction with industry for the development of curricula, quality of tuition, employability of students after graduation, and applied research activities.

The most recent available census data on university education enrolments differentiated by careers indicate that in 2008 about 315 000 students (53% of total university enrolments) were enrolled in programmes in the natural sciences, exact sciences and engineering. The largest group (23%) was in engineering, a rather high proportion by international standards, although the absence of certification of a number of programmes raises the question of their quality. Basic sciences, on the other hand, had a very limited share of total enrolments, with only 0.5%, 0.4% and 1.3% of students enrolled in mathematics, physics and chemistry, respectively.

Challenges and bottlenecks

Peruvian universities are fully autonomous; there is no oversight by the Ministry of Education regarding the quality of teaching, the development of curricula and research performance. Two institutions are involved in the governance of the university system as a whole. One is the National Assembly of Rectors (ANR); it has responsibility for regulatory matters and is supposed to oversee the operation of universities. The role played by this body in steering the university system towards higher achievements is weak at best and is questioned by a number of universities, generally among the best performing, in particular in terms of research.[44] The second is the National Commission for the Authorisation of Operation of Universities (CONAFU); its role is to examine and approve the establishment of universities. Because ANR and CONAFU do not co-operate on matters involving their common responsibilities, many universities operate informal branches or campuses without due authorisation.

Given the special regime governing Peru's university system, the rapid rise in enrolments has led to a number of problems related to the differences in the quality of higher education,[45] the relative lack of capacity of the overwhelming majority of universities to engage in research activities, beyond their teaching mission, not to mention the so-called third mission calling for the commercial valorisation of research results . Certain areas are in need of particular attention.

The *internal governance* of universities is not conducive to better teaching and research performance. In view of their composition and the role of vested interests, governing bodies tend to underestimate the importance of research. They have little accountability. Members of the scientific community are not adequately represented, with negative consequences for the share of resources devoted to research. Criteria of relevance and excellence seem far from systematically applied in most universities for the selection and assessment of research projects, resource allocation and promotion (Garfias Dávila, 2009). This poor governance system and lack of incentives have contributed to the brain drain of a significant number among the best qualified academic researchers

Persistent budget constraints in public universities have weakened the quality of education and research. Academic salaries are extremely low in absolute terms and in relation to private-sector salaries so that most universities have lost many of their best professors. Practically no funds are used for S&T infrastructure. The economic constraints faced by professors and students have led to a situation in which professors and students often work part-time: 27% of undergraduate students, nearly 50% of graduate students, and 65% of doctoral students can do academic work only on weekends (ANR/INEI, 2010). Moreover, for the best-qualified students only a very small number of scholarships are available for doctoral or post-doctoral studies in Peru or abroad.[46] Under such circumstances it is extremely difficult to ensure high-quality education and research.

Despite the creation in 2006 of the Council of Evaluation, Accreditation and Certification of University Higher Education (CONEAU) in the framework of the National System of Evaluation, Accreditation and Certification of the Educative Quality (SINEACE), there does not yet seem to be an accreditation system that is reliable by international standards either for universities or for curricula leading to accredited degrees. In the context of the 1996 decree authorising the creation of private for-profit universities this absence of a *reliable accreditation system* has certainly contributed to the disorganised growth of the university system, a decline in the overall quality of the training of human resources and very weak involvement in R&D.

A major shortcoming of Peru's higher education system is the *absence of bridges between universities and technological high institutes.* Although the engineering programmes offered in institutes such as TECSUP are accredited by international engineering associations, their academic credits and degrees are not recognised by Peruvian universities. This means that their graduates cannot get credit equivalents to continue their education at universities for academic degrees. Non-university tertiary education has therefore become less popular as Peruvians place higher value on academic degrees.[47] This has also contributed to the increasing mismatch between the demand for and supply of labour, since industries demand a well-trained technical workforce but young people prefer university degrees to technical certificates.

R&D activities

In Peru, the higher education sector performs a large share of R&D. In 2004, the last year for which statistics are available, its share was 38% or USD 91.3 million (see above Figure 1.8). Although information disaggregated by institution is not readily available, it is estimated that no more than 5% of all universities conduct some scientific research activities that satisfy internationally recognised quality standards and that over 90% of total higher education R&D is performed by a very small number of public and private universities. These universities account for the majority of contract funding from national and international sources, indexed scientific publications and number of PhDs. Table 2.11 shows the ranking of these universities according to standard indicators. Apart from the social sciences, research is concentrated in areas that are largely in line with Peru's social priorities: health, biodiversity, plant genetics, oceanography, meteorology and astro-physics, and climate change.

Table 2.11. Best research-performing Peruvian universities, 2003

Universities	Number of publications in indexed reviews	Amount of research contracts awarded by CONCYTEC (PEN millions)	Number of postgraduate theses supported by CONCYTEC	Number of postgraduate diplomas (2000-03)	Number of registered PhDs	Ranking[1]
Peruana Cayetano Heredia	45	356	42	197	195	1
Nacional Mayor de San Marcos	25	380	117	106	148	2
Nacional Agraria "La Molina"	3	188	124	203	51	3
Pontificia Universidad Católica del Perú	16	528	52	51	66	4
Nacional de Ingeniería	7	74	121	73	85	5
Nacional de Trujillo	2	69	89	111	62	6
Nacional San Agustín	3	140	7	156	64	7

1. This ranking is based on a weighted average of the points given to each indicator. There is a wide gap between these seven universities and those that follow.

Source: Piscoya (2006), based on Guerra García (2004).

In public universities most resources for research come from institutional funding in universities' budgets. The actual volume remains difficult to evaluate as such resources are not identified separately in general university funds (GUF) and there is no estimate of full-time equivalent spent on research by professors to distinguish the share of wages that can be attributed to research activities. However, there is little doubt that the amount is quite small, not only in absolute terms but also as a share of universities' resources.

Since the 2004 amendment of the Canon Law, 20% of the proceedings from the Canon proceedings are to be used to develop S&T capacity in regional public universities.[48] Between 2004 and 2008 these transfers amounted to USD 170 million, a significant amount in light of the low levels of budgetary resources allocated to public research in Peru. However, the Law and SNIP procedures impose strict restrictions on the use of these funds. They are to be used for S&T infrastructure and equipment and not for the financing of researchers or the purchase of research material. Because of these restrictions and the limited availability of human resources able to develop research projects in regional universities, only about a quarter of the resources were actually used between 2004 and 2008 (Garfías Dávila, 2009); the rest were frozen and some may have been used for other purposes.[49] To overcome these restrictions and limitations, some regional universities have developed research co-operation agreements with universities that cannot benefit from Canon funding but have a strong research capacity. However, this is far from common practice.[50]

Universities also receive funding for research projects through competitive grants awarded by FINCYT and FONDECYT. In the case of FINCYT they can apply to two components that are restricted to public research institutes and higher education institutions (with possible co-operation with enterprises): one is for basic, applied and pre-competitive "blank" research projects (PIBAP), and the other is the so-called national interest projects (PIN) in priority research areas. Programmed budgets for these two components are respectively USD 8.8 million and USD 2.0 million. At the end of 2009 these resources were entirely committed, a sign that there is significant unsatisfied demand and that these new resources constitute a welcome addition.[51] In the case of FONDECYT, the programme that best corresponds to the generation of knowledge is PROCYT, which funds competitive projects in priority areas.[52] The maximum amount that can be allocated to a project is about USD 10 000. This seems extremely low and is certainly below what is needed for a medium-term R&D project.

The lack of sufficient and stable resources to fund academic research, including S&T infrastructure, the low salary levels and a governance system that does not encourage the pursuit of research careers have weakened universities' research potential and contributed to the emigration of qualified scientists. This is a trend that is difficult to reverse. However, some recent initiatives aim at strengthening universities' human capital for research and their ability to retain or attract back highly qualified researchers. The most important is the "CONCYTEC Chair" initiative which finances the constitution of research teams of high-level scientists in public universities around an R&D project selected on a competitive basis in line with priorities defined by CONCYTEC.[53] Financial incentives are given to the director of research and two associate researchers and scholarships are given to doctoral and master's level students working on the project. The maximum amount of the grant is USD 50 000 plus additional monies for financial incentives and scholarships for research personnel. This programme is however relatively poorly endowed and lacks critical mass. At the beginning of 2010 there were approximately 14 endowed CONCYTEC Chairs in public universities.

Knowledge interactions between universities and the productive sector are limited and tend to focus on the provision of R&D services rather than on collaboration on R&D and innovation projects. Peruvian enterprises have shown a clear preference to solve their technological problems by hiring consultants from overseas. Generally, in the absence of specific incentives, they have been reluctant to engage in research and/or innovation-related projects in collaboration with Peruvian universities. Universities have also tended to shun collaborative activities with the private sector because of cultural barriers, differences in interests, motivations, research time horizons, but also regulatory barriers. Obstacles pertaining to institutional mobility of academic researchers and the Public Administration Career Law, which prohibits public university professors from receiving payments from more than one source, constitute important barriers to co-operation between universities and companies. Fees that professors could receive from participation in joint projects are rather low in comparison to other Latin American countries. Temporary secondments to other institutions or the private sector are also difficult. Alleviating these restrictions may call for special provisions concerning researchers in the Public Administration Career Law.

Thanks to FINCYT programmes there are indications that this situation is beginning to improve and that there is latent demand for more collaboration. FINCYT resources are however limited and measures should be taken to amend the Canon Law so that resources derived from it could also be used to foster public-private collaboration in innovation projects of regional interest. If regulatory barriers are revised and relaxed, at least in part, there is a potential for greater integration of the Peruvian innovation system.

In addition, the most advanced public and private universities[54] have joined forces to create the IDI Network,[55] a non-profit association for greater collaboration with the private sector inspired by the Spanish RedOTRI.[56] To narrow the knowledge and cultural gaps between the two sectors, the IDI network has developed diffusion activities to increase the private sector's awareness and knowledge of participating universities' portfolio of research activities with potential applications in the productive sector. Although IDI has so far generated few collaborative efforts it has had positive results from projects in the agro-industrial and manufacturing sectors. IDI has also facilitated the presentation of joint projects to FIDECOM and FINCYT.[57]

As noted, research co-operation among universities and with PRIs is rare, but it should increase with the growing importance of multidisciplinary research. Many OECD and emerging countries have found that research and technology programmes organised and funded by national funding agencies are the most effective way to promote collaboration, and this should probably be emphasised in the FINCYT and CONCYTEC support programmes.

Fostering the international openness of Peruvian universities and their linkages with the international scientific community is a further important challenge. The international mobility of human resources is an area which deserves more attention. Scientific activities have always had a strong international dimension but in recent years international activities have expanded in developed and developing countries alike and become more diversified. One of the weaknesses of the Peruvian science system is its very low level of internationalisation as illustrated by low levels of joint national and international authorship of scientific publications, Peruvian participation in international research projects, foreign grants awarded and numbers of foreign scientists. Expatriation of high-level Peruvian scientists has also helped to isolate the Peruvian scientific community. At present, international collaboration is more the purview of a few leading scientists[58] than a normal procedure of all members of research communities.

On the one hand, the attractiveness of Peruvian universities to expatriates and foreign scientists should be enhanced. Expatriates can be a significant resource for the development of their home country's research capacities. They can serve as "bridges" by providing access to international research and expertise. As returnees they can make a significant contribution to the further development of their fields of expertise and catalyse the constitution of research teams that meet standards of excellence. Beyond initiatives that can be taken by private universities, such as University Cayetano Heredia,[59] attractiveness programmes should be developed on a broader scale and benefit from public support as they do in other countries or regions facing similar challenges (Box 2.10). CONCYTEC should have the means to design funds and programmes to attract expatriates and foreign researchers more generally. CONCYTEC fellowships funded by FINCYT for the reinsertion of highly qualified Peruvian expatriate scientists in the country's research institutions and universities are a good move in that direction[60] but raise the more general question of the institutionalisation of such programmes. They should not suffer from the precariousness of one-off special projects.

Box 2.10. Ikerbasque: The Basque initiative to attract foreign scientists

Ikerbasque is a foundation created by the Basque government in 2007 following a proposal made in the context of the preparation of its Science, Technology and Innovation Plan. Its objective is to expand the scientific potential of the Basque country by attracting foreign scientists of international reputation to lead or participate in research projects developed in, or in collaboration with, Basque research or technological institutions for a period up to 12 months.

Ikerbasque provides financial and logistical support to interested scientists who are selected on the basis of excellence, on a joint basis with a Basque research institution (contrary to the Catalan scheme, ICREA, in which application is made through a local research institution).

Ikerbasque, a rather small and agile institution with a staff of less than 10, is chaired by the Minister of Education. Its resources come from the Basque government (70%), Spain and the European Community. Its budget currently amounts to EUR 6 million.

Foreign scientists who have come in the framework of the Ikerbasque programme have been instrumental in creating and/or promoting Basque Research Excellence Centres and in obtaining competitive research grants from the EU and Spain.

There are currently around 90 foreign scientists in the Ikerbasque programme, of whom close to 80% come from outside of Spain, mainly from the EU.

Source: OECD (2011).

On the other hand, more resources are needed to raise substantially the number of postgraduate scholarships and post-doctorate fellowships in foreign universities in the S&T area. Awards of these scholarships and fellowships should include some contractual conditions that lower the risk of lasting expatriation.

Governance and regulatory issues

The experience of a number of OECD countries has shown that reform of the steering and funding of higher education, by providing guidelines and incentives that focus on quality and relevance, can help strengthen the contribution of public investment to scientific progress and innovation (OECD, 2010d). Better governance of universities needs to be supported through the use of new mechanisms, such as greater use of project funding (typically contracts and grants awarded through competition) than institutional

block grants, selective increases of funding for research fields linked to social and economic needs, and promotion of national and international collaboration. It also often requires a greater commitment to evaluating researchers and research organisations, as well as changes in the way such evaluations are conducted. Universities should not have autonomy unless there is a social consensus on the scope of their mission, clarity as regards their financing patterns and agreed accountability procedures that allow regular assessment of their progress. Conversely, universities and teachers cannot be made accountable for results unless they have sufficient autonomy, resources and opportunities to develop their capacity.

Improving the performance of the Peruvian university system, in particular as regards its S&T activities, is predicated upon reforms of its governance. This may involve changes of a legislative or regulatory nature and changes in the procedures for allocating funding.

There is a broad acknowledgment, at least in the scientific community, that the 1983 University Law, which in principle still applies to public universities, suffers from major deficiencies which are amplified by internal rules or the perverse practices of university boards, largely because of their mode of selection or appointments influenced by vested interests:

- While the Law recognises generation of knowledge and teaching as the main missions of the university it make no mention of the increasingly important "third mission", the transfer of knowledge for the development of innovative activities by, or in co-operation with, the productive sector or in response to social concerns. In most countries with university laws this mission is now emphasised[61] and most universities have established technology transfers offices (TTO) and/or technology licensing offices (TLO).
- Contrary to current practice in other countries, the research mission of universities is not explicitly present in the governing bodies of Peruvian public universities: there is no vice-dean or vice-rector in charge of promoting research activities and ensuring their quality. This role should be filled in open competition and based on competence. It should also entail responsibility for the oversight of TTO/TLO and the management of intellectual property rights, notably as regards the sharing of royalties between the university, the research laboratory and the inventor.[62]
- There is too little internal evaluation of performance of research groups and individual researchers as a criterion for promotion and resource allocation, and in most cases no system of incentives that fosters quality, if not excellence.
- Temporary secondments to other institutions or the private sector are also difficult. Alleviating these restrictions may call for special provisions in the Public Administration Career law concerning researchers.

2.4. Intermediary institutions

Beyond the performance of various institutions in R&D and innovation activities, the intensity of market and non-market knowledge interactions among actors affects the dynamism of the innovation system as a whole. These interactions essentially concern collaborative arrangements for the generation and productive use of knowledge, provision of S&T services, technology diffusion and the articulation of the supply of and demand

for technology. Weak interactions are generally the results of a combination of market and systemic failures. The development of stronger ones is facilitated by:

- A regulatory environment and a system of incentives that encourages – or at least does not hinder – collaboration and institutional mobility of S&T personnel.
- An adequate balance between supply- and demand-driven activities on the part of research institutions and technological centres.
- Availability of, and access to, S&T information.
- The existence of support programmes that give a premium for collaboration with public or private intermediary institutions that foster the diffusion of technology as well as the development of absorptive capacities in the productive sector, in particular in the less innovative SME segment, and provide S&T infrastructure services, *e.g.* in the areas of standards, certification, metrology services, testing labs.

This last issue is partly addressed in the design of FINCYT and FONDECYT support programmes which give a premium to collaborative projects. Other initiatives to develop public and private intermediary institutions that promote the diffusion of technology and provide S&T training, information and other services that contribute to innovation capacity building have recently been initiated or consolidated.

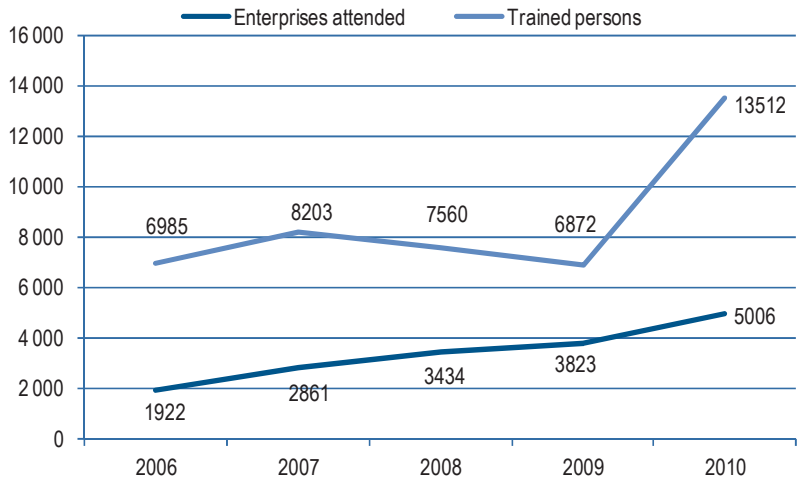
Technological innovation centres (CITEs)

The CITEs are probably the most representative intermediary institutions in the Peruvian innovation system. They were created in 2000 under the aegis of the Ministry of Production to enhance the innovation capabilities of SMEs, foster their productivity and improve their ability to comply with international standards. They are essentially institutions engaged in technology diffusion and the provision of technical, certification, testing and training services for producers' associations in the sectors of activity in which they operate. They can also act as "knowledge brokers" between firms and other sources of expertise and technologies (universities, research institutes, consultants, international technical co-operation).

CITES have either a public or a private status and are accredited by the Ministry of Production (PRODUCE). Public CITEs receive institutional funding from this ministry and other revenues from the sale of their services to enterprises or producer associations or from project-related grants from international co-operation agencies (public or non-governmental organisations). Private CITEs are not funded by the ministry. CITEs' activities are overseen and co-ordinated by OTCIT,[63] an office of PRODUCE, which provides assistance for the diffusion of technological information, project development and management. OTCIT is also involved in the certification of new CITEs.

At present, 14 active CITEs (3 public and 11 private) operate in industries with previously well-organised conglomerates of SMEs. They cover nearly 6 000 SMEs and have very broad coverage in terms of programmes or instruments in the field of innovation in Peru. [64] Over 2006-10 the number of enterprises assisted was quite stable until 2009 and more than doubled in 2010 (Figure 2.4), the number of trained persons rose substantially, and the average annual number of transactions involving technological services was over 17 000. The largest increase in CITEs' activities concerned the agro-industrial sector owing to the need to increase productivity and develop innovative products for fast-growing external markets.

Figure 2.4. CITEs' results: Enterprises attended, Persons trained, 2006-10



Source: Ministry of Production (2010).

Private-sector representatives and users, who pay for the services and thus contribute to the centres' revenues, positively evaluate CITEs' actions. They recognise their impact and important role in helping SMEs to increase their productivity, export potential and product quality, at least in the first or less sophisticated stages, by facilitating the adoption of better technologies and practices and helping to increase their collaborative capacity and improve their social capital (Box 2.11).[65] However, as firms grow and begin demanding more sophisticated technological services, the CITEs seem to be less effective and cannot always meet their needs, mainly owing to capability and budget constraints that prevent CITEs from engaging in R&D, upgrading services and hiring highly skilled personnel.

Box 2.11. CITE-Vid and the upgrading of the Peruvian pisco industry [1]

The development of the pisco industry during the 2000s, with exports increasing ten-fold to USD 1 million in 2007, illustrates the positive impact of CITE-Vid, an intermediary institution which, along with private investment, improved co-ordination among the different actors in the pisco production chain and contributed to a move towards a more export-driven and innovation centred strategy.

CITE-Vid, the technological innovation centre for the pisco and wine industry, was created in 2000, based on the Spanish technological institutes. Its objective is to improve quality, productivity, information and innovation in the pisco and wine-making production chain and to support the domestic and international promotion of pisco. CITE-Vid played an important role in improving the organisation of small producers of pisco. It promoted their first consortium and provides technical assistance and infrastructure for wine and pisco producers in order to improve and standardise the quality of pisco, while preserving the essence of the traditional production process.[2] In particular, it has facilitated closer links between the pisco industry and training and research Institutions and universities, to a level that is quite unusual for Peru. This has led to the provision of diverse services and facilities, such as: training services, standardisation, technical assistance and technology transfer (from Spain and Argentina), laboratory testing services and market information linked to Conapisco action in the exploration and development of foreign markets. Revenue from sales of services increased nearly tenfold (from 2001 to 2007) and users evaluated positively the services provided by CITE-Vid, whose main contribution has been in raising pisco quality and developing new markets.

1. Pisco, an alcoholic drink (*eau de vie*) made from grapes, is a national beverage in Peru.

2. A strict requirement of the strategy to position Peruvian pisco brand in world markets, based on appellation of origin.

Source: Kuramoto (2009) and interviews during OECD fact-finding mission.

Based on their successful experience, the network of CITEs has the potential to develop further in various directions:

- First, although CITEs have steadily increased the number of firms they serve, their coverage is still rather limited compared to the number of firms that could benefit. Scaling up the CITE model to increase the coverage of SMEs and industrial sectors would help to accelerate the catching-up process and increase productivity in a wider base of the SMEs pyramid ready to engage in innovation activities as they upgrade their technological capacity to meet the demand of more advanced enterprises or export consumer markets. Such an expansion may be accomplished through the development of a new sort of CITE that would be neither private nor public institution but a public/private one. Cost sharing may help to draw more producers' associations into the CITE scheme.
- Second, as the technological capacities of enterprises served by CITEs increase, they require more sophisticated services. To respond to this demand, CITEs would have to develop their own applied research and technological development capabilities. Here again, in order to ensure a good match between supply and demand the most effective model would probably be one that involves the private sector in the governance of CITES more intensive in applied research activities. Such centres could be public-private, with a share of their resources coming from performance-based institutional funding from budgetary allocations. Alternatively, they could be private, with applied research activities financed by revenues from research and technological services to producers (individuals or associations) and by competitive innovation funds such as FINCYT and FIDECOM. This model, with a gradual upgrading of applied research capacities and public support, has been successfully adopted in a number of countries or regions.[66]
- Third, by increasing their S&T capacity, private CITEs would be in a better position to engage in mutually beneficial S&T co-operation with PRIs and universities. As CITEs mainly operate at regional or local level, joint projects with regional universities might benefit from Canon resources for their investment in R&D and technological development activities including S&T equipment. This would apply to both public and private CITEs.

Finally, to boost overall productivity in the industries in which CITEs operate, it is necessary to complement their work with programmes to create links between SMEs and large firms, either through Productive Chain programmes (see below) or initiatives for cluster development in fields in which Peru has sound comparative advantages (mining, fishing, agribusiness, tourism, jewellery and apparel).

Value-chain-based programmes

Other initiatives that have begun to establish links among agents are the Productive Chain programmes, which seek to increase the competitiveness of "flagship products", an effort in which PRODUCE and MINCETUR, the Ministry of Foreign Trade and Tourism, have played significant roles as facilitators. This has involved the provision of services to producers (*e.g.* market studies, support with administrative procedures to request denominations of origin, etc.), as well as assistance in the elimination of bottlenecks in production and marketing chains (GRADE, 2010).

These programmes are perceived to provide much more effective co-ordination platforms than traditional sectoral business associations, since they involve the various participants along a value chain (producers, processors, exporters and traders, retail, providers of goods and services, storage and transport, etc.). This makes it easier to take a systemic approach to bottlenecks and opportunities to improve competitiveness (GRADE, 2010). These initiatives certainly constitute a very good base for improving multi-sector and public-private collaboration and for taking a strategic pro-market approach. They need to be strengthened financially and institutionally, systematised and scaled up, especially for the main natural resource-based industries, in order to deepen the respective clusters.

Business associations

Local private business associations tend to take the more traditional role of representation, negotiation and lobbying on the part of the sector's interests with the government and others political actors. They are more concerned with the short term than with the competitive and strategic issues of the industries they represent, critical failures of co-ordination and the provision of the public goods needed to improve their competitiveness. They are structured according to broad sector definitions instead of clusters or value chains and are poorly staffed in terms of analysts and technical experts and overstaffed with lawyers.

However, there are some exceptions. "New generation" associations, notably in non-traditional agriculture, have played an important role in the export boom of the present decade.[67] These associations were created with government support, through PROMPEX,[68] the Peruvian export promotion agency at that time (predecessor of PROMPERU), and are now funded entirely by the private sector, a clear indication of their success.

Initiatives of higher education institutions

Several higher education institutions have recently initiated or further developed formal schemes to extend their interaction with the productive sector through the provision of technological or innovation management services. The Cayetano Heredia University, the first to have created a technology transfer office, has developed a close relation with the pisco and wine industry and CITE-Vid (with a joint genetic mapping research programme on grape varieties). In 2006 the Pontificia Catholic University launched its Innovation and Development Centre (CIDE) which provides new start-up firms with incubator-type services such as technical ICT assistance, relationships with financial markets for access to seed capital, as well as business development and mentoring services. National universities such as San Marcos and the University of Engineering have also, or are in the process of, developing schemes to make their research and technological potential more attractive to the productive sector and activate latent demand for collaborative projects or technological services. As indicated above, some of the best-performing public and private universities have joined forced to create the IDI Network, a non-profit institution that promotes greater interaction with the private sector, but it is clear that public universities currently face more constraints than private ones for developing a wide portfolio of innovation-related collaborative or contractual efforts with the private sector.

Regulatory institutions that encourage innovation

Some regulatory institutions play an important role in innovation systems in that they nurture business environments and provide public goods or services that foster innovation. This is essentially the case of institutions responsible for the protection of intellectual property rights, the establishment and enforcement of competition regimes, certification, standards, quality control and metrology.

INDECOPI

In Peru, contrary to the situation prevailing in most countries, INDECOPI the institute in charge of the protection of intellectual property rights is also entrusted with the oversight of other important regulatory activities that affect innovation performance and S&T capacity building in particular areas such as enforcement of competition, certification, metrology, standards and norms. INDECOPI is an autonomous and financially independent institution operating under the aegis of the Presidency of the Council of ministers (PCM).

INDECOPI seems to be quite well governed and has been quite successful in developing a professional patent registration, examination and grant (or rejection) process. Like similar institutions in other developing countries, INDECOPI should address new challenges (Malkin, 2006; OECD, 2004) at the same time as it consolidates the progress made so far. It should be given the means to step its efforts to:

- Speed up examination procedures and train agents to examine patent applications in new technological areas, in particular those related to the protection and exploitation of biodiversity resources and indigenous knowledge.
- Strengthen its ability to enforce IPRs and curtail infringement.
- Be more proactive in diffusing an IPR culture in both the business sector and public research institutes and take a leading role in developing guidelines for IPR management in such institutions.
- Expand its activities on the diffusion of technological information and develop user-friendly platforms to access this information.

In its more technical regulatory activities related to certification, standards, norms and metrology INDECOPI seems to have a positive record. Decentralisation to accredited public and private institutions, supported by training, could disseminate the culture and use of norms and standards across sectors and regions more extensively.

Patent offices are depositories of technological knowledge which they can manage more or less actively as regards the diffusion of that knowledge to economic agents not only for patent filing decisions but also to raise their awareness of available technologies. This knowledge diffusion mission is particularly important in countries in which the great majority of enterprises lack the resources to access this information, individually or collectively. In many countries patent offices have developed information platforms which are organised to facilitate access and retrieval for further analysis and possible technological adaptation or transfer. INDECOPI does not seem to have emulated good practice in the development of such platforms.

The same is probably also true of the promotion of an intellectual property culture not only among enterprises but also among PRIs and universities. Given Peru's very low patenting performance in both the private and public sector, INDECOPI should probably strengthen its activities to enhance an IP culture and to provide assistance in the management of IP portfolios in PRIs' technology transfer and technology licensing offices.

While the legislative and regulatory framework governing competition in Peru seems in line with good practices (OECD/IDB, 2006), INDECOPI's enforcement capacity could probably be improved. It is likely that the scope of its missions hinders its enforcement capacity in this area.

In light of the available resources, the scope of INDECOPI's activities may be too broad to allow it to fulfil all of its missions efficiently (GRADE, 2010). A way to improve the situation would be to separate the functions of IPR protection and technical regulatory functions from those related to regulation and enforcement of competition as is done in most countries. A potential obstacles is the fact that the more lucrative patent registrations may cross-subsidise missions such as enforcement of competition, potentially at the expense of other missions that are equally important for innovation. It would therefore be useful to consider separating INDECOPI in two institutions: one devoted to competition issues and the other to intellectual property and S&T infrastructure and diffusion of technological information as is the case in most countries.

SENASA

The National Service for Agricultural Sanitation (SENASA) is a public institution with management and financial autonomy under the aegis of the Ministry of Agriculture from which it gets its institutional funding.[69] Its main mission in terms of promotion of innovation is to enhance the value of Peru's natural and agricultural and biodiversity resources through phyto- and zoo-sanitary certification, inspection and control, and the promotion of international standards for the processing and exportation of agricultural or agro-industrial products (GRADE, 2010). SENASA also offers training activities to producers' associations. To fulfil its mission it can engage in collaborative R&D projects or technical co-operation with PRIs, universities and the private sector.

In the present decade SENASA has significantly developed its activities, widening its outreach to individual producers and producers' associations in the agricultural and agro-industrial sectors and has thus contributed to the export surge in these sectors. It has benefited from important increases in resources to expand its activities (by 88% between 2003 and 2010).

Notes

1. This is true for each type of innovation, product, process, organisation and commercialisation.
2. See Oslo manual (OECD/Eurostat, 2005).
3. By the end of 2009 FINCYT had approved the financing of technological innovation projects by enterprises in the amount of USD 7.65 million (71% of the fund's budget for this type of projects).
4. In particular sectoral innovation studies (CIES, 2010), data from the census of manufacturing and interviews with business representatives during the OECD field missions.
5. In the sense of the Oslo or Bogota Manuals.
6. This is expected to be the case for the survey to be carried out by INEI at the request of MEF in the near future.
7. The proportion of the adult population involved in the creation of a new business or firm.
8. 68% are in retail and small commerce, hotels and restaurants, basic services, transport (GEM, 2009).
9. Although progress has been achieved in recent years Peru still ranks 114th and 88th in time required and number of procedures to start or close a business, respectively (WEF, 2010).
10. As Schumpeter argued, entrepreneurs and new entrant firms distort the market equilibrium by introducing new and better product market combinations or innovations. They push less productive firms out of the market and move the production frontier. Whether entrepreneurs succeed, or whether their innovations are copied by incumbents, the effect is the same: higher productivity and economic growth.
11. In the pisco, leather and footwear industries, among others.
12. This new agro-exports boom began with asparagus, which is still now the main export, followed by other rapid growth non-traditional crops, such as prepared/preserved artichokes, avocados, paprika, grapes and mangos.
13. Efforts towards quality that are illustrated by the relatively wide adoption of certification schemes as Global Gap, good manufacturing practices (GMP), ISO standards, certification of organic production and fair trade, among others.
14. For mango (APEM and ADEPROMANGO), asparagus and other vegetables associations (IPEH).
15. See Morón and Serra and Ormachea *et al.* in CIES (2010).
16. In particular since the implementation of the Andean Trade Promotion and Drug Eradication Act (ATPDEA) in 2002.
17. China is already a large importer of llama and alpaca wool from Peru and has adapted its cashmere textile machinery to the texture of camelidae yarn.
18. This section draws on GRADE (2010), Kuramoto (2006), Kuramoto and Torero (2004).
19. INGEMMET, nominally a public research institution in the mining and metallurgical sectors, conducts hardly any research as its main activities are of a regulatory nature.
20. *e.g.* sectoral associations in agribusiness and around CITE activities.

21. This section partly draws upon a diagnosis of PRIs commissioned by FINCYT (Lemola et al., 2011).

22. The National Institute of Health (INS) and the Peruvian Geophysical Institute (PGI) are exceptions. They were created earlier, in 1936 and 1947, respectively, essentially with a mission to develop knowledge as a public good.

23. Such as the Institute for Industrial Technology and Technical Norms (ITINTEC) dismantled in 1992 in the wave of liberalisation that did away with any form of institution that could be seen as an instrument of industrial policy. Since then, and apart from INICTEL, which is now affiliated with the University of Engineering, Peru does not have research and technology institutes that focus on applied research for industry such as those in a number of countries (*e.g.* VTT in Finland, TNO in the Netherlands and the Fraunhofer Institutes in Germany).

24. For instance CONCYTEC has been entrusted with the mission of steering Peru's innovation system and allocating resources to strengthen it, but, strictly speaking, it does not conduct research activities. Although they play an important regulatory role in the innovation system, INDECOPI and SENASA do not seem to qualify either.

25. So-called service administrative contracts (CAS) for the services sector.

26. INGEMMET gets 10% of mining concession rights, IMARPE gets a percentage of fishing permits and IIAP gets 3% of the oil Canon levy (GRADE, 2010).

27. Apart from the assessment by Mullin Consulting, which was limited in scope, PRIs are not subjected to performance-based evaluations and there are no official data on their achievements.

28. At IMARPE, the Peruvian Marine Institute, for instance, around 70% of the 600 research and administrative staff are temporary short-term (0.5 to 1 year) hires.

29. However the author does not indicate the coverage of PRIs used for this estimation.

30. The situation has not always been so bad. In fact, INIA has deteriorated over time, especially during the 1990s. In 1980 INIA had a total staff of around 6 000, 90%of whom were S&T personnel (researchers, engineers and technicians (Garfias Dávila, 2009). Part of the present INIA's administrative costs may also be attributable to the implementation of extension projects.

31. For instance, in INIA the share of professional staff at postgraduate level is presently less than 32% (of which 2.4% of PhDs) as compared to 96% (of which 64% of PhDs) in EMBRAPA in Brazil. IPEN, the Peruvian Nuclear Energy Institute, which boasts ambitious plans to construct and operate a synchrotron accelerator for medical purpose on its own technology, has only 10 doctoral and 24 master's level researchers out of a total research and administrative staff of about 300.

32. In the sense that R&D-performing entities can present projects to these programmes and projects are selected on the basis of competition.

33. In Mexico for instance there has been a gradual evolution towards an increase of external financing of the 27 CONACYT Research Centres. At present, for the whole set of research centres the external financing represent close to 40%, varying between 0% and 80% (OECD, 2009).

34. To undertake collaboration with the private sector PRIs are legally obligated to select their potential partners through an open call for tenders. Administrative red tape that can lead to long delays for launching projects discourages collaboration. According to officials from the

Research Institute on the Peruvian Amazon (IIAP), this is an important obstacle to the participation of the private sector in R&D projects for the sustainable commercial exploitation of Peru's biodiversity resources.

35. When these regions enjoy the fiscal autonomy to create PRIs on their own budgetary resources.

36. Most PRIs do not make publicly available information (annual reports, websites) on their budget, sources of funding, staff structure, portfolio of S&T collaboration with other institutions, or outcome of their activities in terms of scientific publications or patents.

37. Some of the limitations of this procedure in Peru are well analysed in a recent World Bank publication (World Bank, 2011). Too rigid an application of the procedure can be counterproductive when it ignores the structural conditions that affect performance and when commitments made by institutions do not reflect policy guidelines from ministerial bodies responsible for their oversight.

38. HTIs are divided in three categories: technological high institutes, pedagogic high institutes, and artistic training schools.

39. Peru devotes less than USD 1 000 per secondary or tertiary student whereas countries like Argentina, Brazil, Chile and Mexico spend between two and three times more.

40. Programme for International Student Assessment (PISA) (OECD, 2010c). Peru also came last in the 2000 OECD/PISA assessment covering 41 developed and developing countries, including Argentina, Brazil, Chile and Mexico (OECD, 2004).

41. Of which 26 (4 public and 22 private) are in the process of institutionalisation by the National Council for the Authorisation and Operation of Universities (CONAFU).

42. According to the National University Census, the share of enrolment in public HEIs in total enrolment declined from 60% to 40% between 1996 and 2010.

43. Enrolment in THIs is heavily concentrated in commercial and services curricula at the expense of manufacturing and extractive industries (Díaz, 2008).

44. According to interviews carried out by the OECD with representatives of several of the best-performing universities for the preparation of this report.

45. Public universities are much more selective than private ones, with a few exceptions such as the University Cayetano Heredia and the Pontificia University (GRADE, 2010; Díaz, 2008).

46. The contrast with Chile is telling: in Chile CONICYT awarded 1 744 such scholarships in 2009 whereas CONCYTEC awarded only 34.

47. Estimates of private and social rates of returns to investment in higher education that take into account the level of wages of graduates show that rates are much higher for university graduates than for high technology institutes, and higher for public than for private universities (Yamada, 2007).

48. A fraction of these resources can also benefit public universities in the Lima area. The National University of San Marcos is the main beneficiary in Lima.

49. Some estimates indicate that of all the Canon resources available in 2009 between 5% and 10% were used for R&D-related projects (Semanario Comexperu, November 2010).

50. For instance, in August 2008 the National University of San Cristóbal de Huamanga signed a research co-operation agreement with the University Cayetano Heredia focused on the sequencing of the potato genome.

51. University officials interviewed during the OECD field mission confirmed the high value they attach to FINCYT grants in terms both of additional resources and management (the selection and delivery processes).

52. The OECD mission could not find information on this programme's budget, beneficiaries or acceptance rates.

53. This initiative is one of the concrete recommendations of the "Programa de promoción y evaluación de los studios de postgrado en ciencia y tecnología (PECEP), a comprehensive assessment of the research capacities and quality of Peruvian universities' postgraduate studies in S&T launched in 2004 under the auspices of CONCYTEC (Guerra-García, 2004, 2006).

54. Three of these universities are public (U.N. de San Marcos, U.N. Agraria La Molina and U.N. de Ingeniería) and two are private (U. Cayetano Heredia, U. Pontificia Católica).

55. IDI stands for "Investigación, Desarrollo e Innovación" (Research, Development and Innovation).

56. Network of Spanish universities' Research Results Transfer Offices, *www.redotriuniversidades.net/*.

57 During the current year universities have shown a more active attitude towards co-operation with SMEs as shown by participation in joint projects submitted with SMEs for FIDECOM funding. PUCP is participating in 40 and UNI in 26 projects.

58. Or institutions such as INS and IGP.

59. In 2008 the University Cayetano Heredia instituted a return fellowship (beca de retorno) which provides attractive financial and logistical incentives to attract scientists with international credentials.

60. As of 2010, four Peruvian expatriate scientists have benefited from reinsertion fellowships.

61. See for instance Article 39 of Spain's Organic University Law, *www.ucm.es/cont/descargas/documento20216.pdf*

62. Issues raised by the management of IP in public research institutions and the variety of regimes used in OECD countries are reviewed in the publication Turning Science into Business (OECD, 2003b).

63. Oficina Técnica de Centros de Innovación Tecnológica.

64. Public CITEs operate in the following sectors: wine and pisco, leather and shoe, and wood and furniture. Private CITEs are in the following sectors: agro-industry, logistics, software, metal-mechanical, textile, apparel and design.

65. See Kuramoto (2009) for an evaluation of two CITEs: CITE-Vid for the wine and pisco industry and CITE-Ccal for the leather and shoe industry.

66. Such as Colombia's technology research institutes (World Bank, 2008) or the Basque technology centres (OECD, 2011).

67. Such as IPEH which promotes exports and competitiveness in asparagus and other non-traditional vegetables, and APEM and ADEPROMANGO, two of the most important organisations of the mango production chain.

68. Predecessor of PROMPERU.

69. There were no interviews with SENASA during the OECD field missions.

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Chapter 3

The role of government

Governments have important roles to play in shaping the performance of their national innovation systems. The specific roles and actions taken by governments depend, among others, on the innovation system's level of development. They shape the basic framework conditions that affect innovation and typically apply a mix of dedicated STI policies involving a range of instruments. Adequate institutional set-ups for this mix and overall governance arrangements are critical for the coherence and effectiveness of STI policy. This chapter first provides a brief account of the evolution of Peru's STI policy from its early beginnings – about half a century ago – to the present. After the introduction of relevant concepts and experiences, the institutions in charge of designing policies as well as implementation instruments are presented. This is followed by an exploration of issues concerning the policy mix and related "blind spots". Next, the chapter turns to the way forward by discussing political commitment and guiding principles, then focusing on moving towards a more efficient S&T policy and ways to improve the STI governance structure and institutional reform. As Peru today is at a crossroads in moving towards a more efficient innovation policy, different options concerning the country's future STI governance architecture are discussed.

3.1. Peru's STI system: Evolution of the institutional setting and policy orientations

Since the 1960s the institutional setting for Peru's S&T policy has evolved through various stages, influenced by changes in the overall political environment that shaped the evolution of macroeconomic and structural policies and by different visions of the role of science and technology in the development process. At the same time, some aspects of the design and implementation of S&T policy have changed little:

- **Low levels of political commitment and public resources** for the development of S&T capacity and the promotion of innovation activities even during periods in which political discourse emphasised the role of technology in fostering productivity and diversifying industry structure. This lack of commitment to STI may be partly explained by the greater urgency of other socio-economic issues in successive governments' policy agenda as well as budgetary constraints.
- **Lack of efficient governance structures and mechanisms** to define policy priorities, allocate budgetary resources, and organise policy implementation. In a context of scarce resources, a weak governance structure coupled with little involvement in the policy-making process of the main stakeholders – the business and research communities – is likely to result in conflicts among the public institutions in charge of policy implementation and/or involved in the development of S&T activities.
- **Institutional inertia** and undue reliance on a formal – and often unrealistic – legalistic approach to the consolidation of the innovation system have resulted in uncoordinated policy initiatives, overlapping responsibilities, lack of articulation between poorly endowed institutions and difficulties in adapting institutional settings and support policies to evolving conditions that determine innovation performance.
- **Poor systems of monitoring public and private investment** in R&D and innovation activities and lack of evaluation of policy outcomes and the wider socio-economic impact.

The initial stages

At the beginning of the 1960s, on the recommendation of international organisations such as UNESCO (Finnemore, 1993) and with funding support of multilateral financial institutions, among which the Inter-American Development Bank (IDB) played a leading role, public agencies were established in a number of Latin American countries to formulate S&T policies and support the development of research capacities in human capital and infrastructure. This support was first directed to the academic sector, owing to its autonomy as regards the choice of fields of science and research projects. At a later stage, and in keeping with the so-called supply push or linear model of innovation, a growing share of resources went to public research institutions or technological institutes established to develop R&D or technologies in S&T priority areas. This, in principle, would contribute the knowledge required to meet social needs or improve competitiveness and foster the innovation capabilities of domestic industries with low technological capabilities. Following this model, several initiatives that in principle would have promoted an articulation between supply and demand were taken in Peru:

- New public research institutes (PRIs) were created in areas in which technological development was considered essential for socio-economic development.[1] They were essentially funded by sectoral ministries and conceived as driven by demand. Their main mission was to carry out applied research and transfer technology to the business enterprise sector. Owing to the scarcity of qualified human resources, bureaucratic management and poor articulation of weak industry demand and the PRIs' research orientations, the institutes' performance was generally weak, with some notable exceptions. The PRIs nevertheless helped strengthen S&T capacity in terms of human resources and physical infrastructure. The only institute that seemed to have been able to foster demand and technology transfer was the Institute for Industrial Technology and Technical Norms (ITINTEC).
- As regards the supply side, a National Research Council (CONI)[2] was established as early as the end of the 1960s. Its mission was to design a science and technology policy and channel resources to institutions that would implement it through a National Research Fund as its operative arm.[3] However the Research Fund was never created and the Research Council was left without most of the budgetary resources required to implement the policy it was supposed to design, notably as regards the development of basic and applied research capacities and S&T infrastructure. As it turned out, and contrary to other Latin American countries this supply side axis of the STI policy was short-changed.

This institutional and policy inconsistency resulted in an incapacity to develop interactions between supply and demand. The PRIs that were supposed to leverage demand did not have real research capacity and could not be helped by institutions starved of resources. In other words, the technological bias of S&T and innovation policy, while it had some positive results, had lasting detrimental systemic effects. The example of ITINTEC's performance over time is illuminating in this regard. Despite its initial achievements, performance declined when the difficulty of working with weak partners on the supply side was compounded by management problems (Box 3.1).[4]

Several reasons can be advanced for the failure to build a well-integrated innovation system:

- First, a lack of resources for STI policy. Faced with budgetary constraints the government showed a clear preference for multilateral financing for social programmes with higher priority on the policy agenda. The government was reluctant to use its budgetary resources to complement loans from multilateral financial institutions to support S&T capacity building in autonomous academic institutions. Indeed throughout the 1970s and 1980s the resources allocated to the public university system declined in real terms (GRADE, 2010).
- Second, tight resource constraints made it more difficult to pursue an integrated approach to STI policy. Because of critical mass effects, supply-demand complementary routes may not be efficiently followed. Moreover, returns to supply policies take longer to materialise than demand policies that encourage demand for incremental innovation from diversified sources of knowledge.
- Third, there is the endemic weakness of the Peruvian academic sector which has limited capacity to train qualified S&T personnel and to develop scientific programmes. Indeed, despite the fact that some of the first Latin American universities were established in Peru in the 16th century, the country does not have a long tradition of scientific research, unlike several other Latin American countries such as Argentina, Chile, Mexico or Uruguay.

Box 3.1. The Institute for Industrial Technology and Technical Norms – ITINTEC

The evolution and performance of ITINTEC from its creation in 1970 to its dismantlement in 1992 provides an illuminating illustration of the conceptual and institutional shifts that shaped Peru's STI policy throughout a period marked by important political changes. ITINTEC's evolution highlights the difficulty of enhancing the performance of incipient innovation systems through institutional initiatives that mainly address one component of the system without paying due attention to its interactions with others. It also highlights the fact that efficient support is strongly predicated upon its design, management and delivery. Lessons from ITINTECs experience can usefully be drawn for the future development of Peru's STI policy.

Policy rationale, mission and financing instrument

The rationale behind the creation of ITINTEC in 1970 was the development of endogenous industrial technology capacities through demand-pull policy instruments and the build-up of technological infrastructure.

ITINTEC was not developed as a technological institute but as a multi-function institution in charge of policy orientations for industrial technology development, metrology, standards and industrial property management, and provision of support to enterprises' technological development and innovation projects.

Its resources came from a 2% levy on industrial enterprises' before-tax profits and were used to:

- Cover administrative and technical costs related to its technological infrastructure development missions.
- Select and fund projects presented individually or jointly by enterprises. The funds could be used for internal investment in innovation or for contracting out technological services to public and/or private national institutions (including ITINTEC).

If firms did not present projects or their projects were not selected, the proceeds of their levy were appropriated by ITINTEC, presumably to finance other missions or develop its own research capacity.

Policy design and implementation issues

The development of ITINTEC raises important policy issues:

- ***Lack of balance between demand and supply***. ITINTEC was launched on the basis of a demand-pull policy when Peru's research capacity – human resources and infrastructure in universities and public research institutions – was still extremely weak and CONI was practically without resources. ITINTEC's record in fostering interactions between public research and industry could only be poor.
- ***Mission overlap***. ITINTEC was developed to perform several functions. This impedes efficient management and may generate conflicts over resources. It has been argued that proposed projects were sometimes rejected to divert levy contributions to the general ITINTEC budget (and even to raise salaries for administrative staff).
- ***Instrument of support***. The mandatory 2% levy which had be to allocated to the firm that contributed it is totally unrealistic and is bound to generate perverse effects. When such levies are considered, as in the region of Sao Paulo in Brazil, they are mutualised to cover S&T infrastructure or precompetitive research at sectoral level.
- ***Evaluation***. ITINTEC probably helped to strengthen the technological capacities of Peru's industrial sector. In all, it funded 614 projects (out of 1 520) for USD 30 million (out of USD 66.5 million of enterprises' contributions). However no evaluation of the impact on firms' performance has been conducted.

Conclusion

In the absence of an integrated STI policy, ITINTEC may have held some promises to address the weak technological capacity of Peruvian industry. However, its implementation under a "dirigiste" government led to inefficient broadening of its missions, rigid forms of support, inadequate performance and ultimately its dismantlement.

Source: Authors, based on Flit (1994) and interviews with Peruvian stakeholders during the OECD missions.

Deprived of the expected budgetary resources to strengthen the country's S&T potential the National Research Council nevertheless remained in existence. As a formal body created by presidential decree – and therefore difficult to abolish – it received a mission to co-ordinate four new sectoral technological institutes financed by levies on the enterprise sector and by sectoral ministries.[5] These institutes were to develop applied research and technological development activities in line with industry requirements and to provide technological services such as audits, testing laboratories and metrology. Apart from ITINTEC the record of such institutes in promoting innovative activities in the business sector seems to have been mixed at best. Their managerial staff included a very small proportion of scientists and engineers (Mullin, 2002) and their agenda was driven more by internal R&D priorities and vested interests than by demand from, or interaction with, the productive sector.

A failed attempt at strengthening the STI system under the control economy

In the late 1970s and early 1980s and in the context of a largely administered economy, there were some attempts to revamp the institutional setting of S&T policy and to increase the budgetary resources to S&T activities, mainly based on a sectoral approach,[6] but these initiatives proved either short-lived or ill-managed.

New PRIs were created under the auspices of sectoral ministries (*e.g.* ITP, IIAP and IPEN); their funding came from levies and/or ministries' budgets. The National Council of Science and Technology (CONCYTEC), created in 1981 to replace the National Research Council, was given a more prominent role and endowed with much larger resources to fulfil its planning, co-ordination and funding support missions. Between 1981 and 1985 it has been estimated that its budget grew by 800%, but a large, if not the largest, part was spent on planning and administrative functions rather than on the funding and implementation of programmes to enhance the S&T capacity of PRIs and to expand technology transfer to, and promote innovation in, the productive sector.[7]

In fact, despite a moderate increase of public resources to S&T activities, the share devoted to the actual performance of R&D and innovation activities by PRIs and the private sector remained very limited. Indeed the resources allocated to research in the academic sector[8] decreased and technological stagnation characterised most of the productive sector owing to the negative investment climate created by the control economy and a macroeconomic environment characterised by high inflation and interest rates. In this context, the support to PRIs could not counterbalance the negative impact on technological development of low levels of private investment and weakening demand.

In brief, it can be argued that during this period the efforts engaged to consolidate the Peruvian STI system through moderate institutional changes and limited increases in resources was unable to jump-start a dynamic interaction between supply, diffusion and application of knowledge. Apart from the negative effects of macroeconomic mismanagement on investment, there are many reasons, in retrospect, for the limited chances of success. These include overconfidence in top-down approaches to planning in a control economy; an imbalance between resources devoted to policy programming, administration and management and those devoted to implementation; a dramatic absence of critical mass in supported projects; a misconceived attention to the requirements of the private sector and a failure to involve it in policy formulation and in the management of most technological institutes. Overall, this situation was bound to lead to failure and, ultimately, to a further weakening of the country's S&T and innovation system in terms of institutions, resources and performance.

From failure to dismantlement during economic stabilisation and recovery

This traumatic episode had lasting consequences throughout the 1990s. In accordance with the framework of the so-called "Washington consensus", growth recovery was induced by macroeconomic stabilisation policies that brought down inflation and interest rates and structural reforms that reduced market distortions, raised the efficiency of resource allocation and liberalised foreign trade and investment. At the same time, most proactive government policies that could appear to interfere with market-led resource allocation were discarded. Allocation of public resources to overcome market or systemic failures through the provision of public goods in S&T infrastructure or incentives to the private sector to increase their investment in R&D and innovation were considered to distort markets and raise the risk of government failures, misappropriations and corruption. It may therefore be argued that the very policy stance that facilitated the recovery hindered the emergence of a dynamic process of structural transformation towards a more innovation-driven economy through the building of S&T capacity and fostering of technology diffusion and technological change (Tello and Tavara, 2010).[9]

The level of R&D expenditures in the 1990s was consequently extremely low. In 1997 it was not even 0.1% of GDP as compared to more than 0.5% for Latin America as a whole. The lag is similar in other S&T indicators. For instance, in the same year Peru had 175 scientific publications registered in the SCI index, compared to 545 in Colombia and 1 170 in Chile (RICYT).

Support institutions created prior to 1990 such as CONCYTEC and most of the sectoral research and technology institutes were not dismantled but saw their already meagre resources diminish.[10] They survived as bureaucracies largely deprived of means and mission.[11] Programmes in support of R&D and innovation in the business sector all but disappeared. FEDU, which had been created at the end of the 1980s to support academic research, was severely curtailed and could not fund research projects of critical mass. Universities increasingly used fund resources to finance wage increases and other operational costs, thereby defeating the fund's original purpose (Garfias Dávila, 2009).

Renewed attempts at strengthening a fragmented STI system

Since the beginning of the 2000s, with an improved budgetary situation and in view of the dramatic degradation of the supply and demand components of the Peruvian STI system and the adverse effects on the prospects of productivity gains, industrial diversification and international competitiveness, the Peruvian government took institutional, policy and funding initiatives to strengthen this system and foster interactions among stakeholders. Among the most important ones are the following:

Creation of technological innovation centres

The system of technological innovation centres (CITEs) was developed in 2000 by the Ministry of Production. They can be either public or private (but not public-private bodies). The centres were designed to provide technological and training services to SMEs or producers' associations and fill an important gap in technology transfer to sectors not covered by national research institutes. Development of these services has contributed significantly and efficiently to the expansion of demand.

The 2004 S&T and Technological Innovation Framework Law

This law entrusted CONCYTEC with the comprehensive and ambitious mission to "lead, promote, coordinate, articulate, supervise, and assess all the State actions in the area of science, technology and technological innovation", notably through the following (Marticorena, 2007):

- Responsibility to co-ordinate the so-called "National System of S&T and Technological Innovation" (SINACYT) which covers the set of institutions and socio-economic agents involved in R&D and innovation activities and their promotion.[12]
- The development of the National STI Plan (PNCTI) with the participation of SINACYT stakeholders, mainly from the academic sector and PRIs. The plan was supposed to define priority areas with detailed lines of action and implementation programmes; it generally stopped short of linking prioritisation and budgetary appropriations or indicating the sources of funding for programme implementation.
- The management of the National Fund for S&T Development and Technological Innovation (FONDECYT), as CONCYTEC's operational arm for financing and managing programmes in support of a wide array of S&T policy areas: basic and applied knowledge, technology transfer and diffusion, and the development of highly skilled human resources in S&T.

CONCYTEC was established under the aegis of the Presidency of the Council of Ministers (PCM) which plays a major role in inter-ministerial co-ordination for the definition of policy orientations and budgetary allocation. However, CONCYTEC lost this powerful institutional status when its oversight was transferred from the PCM to the Ministry of Education in 2005.

The creation of three well-endowed STI competitive funds

Two funds are co-financed by the Peruvian government and loans from multilateral financing organisations.

- INCAGRO launched in 2001 with an initial endowment of USD 20 million raised to USD 45 million in a second phase[13] to promote innovation, technological transfer and public-private collaboration in the agricultural sector.
- FINCYT launched in 2007 with an endowment of USD 36 million[14] to fund a wider range of programmes mainly aimed at providing support to innovation projects, strengthening the research and innovation capacity of enterprises, universities and public research centres and fostering collaboration among them, and promoting the development of highly skilled human resources.

A third fund, FIDECOM, was created in 2006 by the Ministry of Production with an endowment of about USD 65 million.[15] It supports innovation projects in the enterprise sector with a premium given to collaborative projects and SMEs. A first tranche of USD 5.5 million started to be committed in 2010 of which USD 1.9 million was disbursed.

Canon Law transfers

The Canon Law, which transfers part of corporate tax revenues to regional governments[16] was amended in 2004 to use 20% of these revenues for the development of the research capacity in public regional universities in order to contribute to the regions' economic development. These transfers amounted to around USD 170 million between 2004 and 2008. However, owing to the stringent conditions imposed on the use of the proceeds, only a fraction of this amount is effectively used for R&D projects.

A system in transition

These initiatives demonstrate an incipient political commitment to increase the overall volume of public resources for STI activities and infrastructure by ensuring that at least the part of the increase channelled through the newly created innovation funds would be allocated so as to foster better integration of the innovation system and improve the leverage of public resources on private investment in innovation. However these initiatives have left open the question of an institutional and policy framework able to enhance the integration and performance of Peru's innovation system to ensure the overall efficiency of these public resources. As regards the increase of resources the record is still mixed. Peru's budgetary classification system does not allow having data on budget appropriations dedicated to STI related activities[17] and there is no systematic survey on government expenditures on R&D or S&T.[18] It is therefore difficult to provide precise figures of the evolution of public resources devoted to such activities during this period of expansion through institutions providing public support. However, some partial estimation based on budgetary resources allocated to STI institutions and innovation funds are possible and give orders of magnitude of the evolution of public funding (Table 3.1).

Table 3.1. Executed budget allocations to STI related institutions and innovation funds, 2003-09[1]

Million current USD

	2003	2009
CONCYTEC[2]	3.60	4.59
as % of total budget	0.03%	0.03%
Public research and technological institutes (PTRI)	190.83	236.55
as % of total budget	1.60%	1.45%
Innovation funds[3]	3.07	16.73
as % of total budget	0.03%	0.10%
CITEs	.052	1.21
as % of total budget	0.005%	0.007%
TOTAL	240.70	257.87
as % of total budget	1.72%	1.59%

1. Institutions do not include public universities as it was not possible to separate out their research activities funded by budget resources.

2. CONCYTEC budget includes FONCECYT resources (around USD 3 million per year).

3. Innovation funds only include INCAGRO for both years and FINCYT for 2009. FIDECOM is not included as disbursements only started in 2010.

Source: Adapted from GRADE (2010).

Overall, this public funding increased very little between 2003 and 2009 and the fact that its share in the total budget declined casts a shadow on the political commitment. Apart from the significant additional resources to academic research provided by the Canon Law (which, strictly speaking, do not come from the budget and should count as foregone fiscal revenue), the only significant increases in budgetary resources for STI activities were channelled through the innovation funds, but the amounts remain extremely low in comparison to those to public research and technological institutes.[19] However, as will be seen, this imbalance has to be strongly qualified owing to measurement biases in the accounting of S&T-related expenditures in PRIs. In many, if not most, of these, a large share of resources is not spent on S&T activities but on administration and management.

Nonetheless, the importance of the qualitative shift in policy implementation, which gives more prominence to better-managed competitive innovation funds than to traditional means of support, should not be underestimated. This highlights the fact that the policy initiatives developed during the phase of transition have left open an important questions related to the governance of the Peruvian innovation system or for that matter for any such system: that of the institutional arrangements for policy implementation that should limit overlaps of responsibilities among implementing agencies and ensure clear distinctions between policy design and policy implementation functions.

In conclusion, the changes brought about by the recent initiatives have not resulted in a significant increase of public resources to STI activities or a more efficient institutional and policy framework, they have had a demonstration effect. In the absence of efficient governance structures, well-managed innovation funds can provide temporary second-best pragmatic solutions for strengthening the various components of the Peruvian STI system and fostering their interactions.

Current regulatory obstacles to innovation funds

In Peru the efficient management and delivery of support through innovation funds is hindered by the system that controls public investment and by stringent restrictions on the transfer of public funds to private sector institutions. This system seems to depart from current international practices.

Control of public investment

Publicly funded S&T projects have to be approved by the National System of Public Investment (SNIP), which is managed by the Ministry of Economy and Finance. This system was created in 2000 to ensure that all public investment proposals correspond to national priorities and to prevent misappropriations in the use of public funds (Box 3.2). This raises two problems for S&T project proposals:

- First, such projects generally include a large share of operating costs. SNIP management has had difficulties considering them as public investment and has approved (or rejected) projects on a case-by-case basis. This has caused delays in the implementation of approved projects.[20]
- Second, by their very nature most S&T projects involve risk and uncertainty. This makes it difficult to estimate social rates of return on investment using the standard methodologies that apply to traditional investment in physical infrastructure. The concept of social return to investment is a valid one but should be applied with a portfolio approach to programmes rather than to individual projects. Moreover,

there are no standard methods for evaluating *ex ante* the social returns to support programmes. This is essentially a matter of policy learning, best practices in design, management and delivery and *ex post* assessments.

Box 3.2. National System of Public Investment (SNIP): Approval and financing of innovation fund projects

The SNIP is a control system managed by the General Directorate for Investment Policy (DGPI) of the Ministry of Economy and Finance. It was created in June 2000 in order to ensure that all public investment projects:

- Correspond to priorities established in the framework of national, regional and sectoral strategic plans, and are financially sustainable over time.
- Have adequate social rates of return and are financially sustainable over time.

The basic rationale behind the creation of the SNIP was an emphasis on more stringent mechanisms for project formulation and evaluation, and control of disbursement in order to avoid waste or misappropriation of public resources.

The effective appropriation of public resources for an investment project is submitted to a "viability" approval by the DGPI.

This system is basically a good practice to improve the quality and efficiency of public spending, especially in a country such as Peru that has suffered in the past from misuse of public resources.

However, the SNIP seems ill-adapted to S&T activities as such investment falls in a grey area surrounding the definition of "public investment project". In effect, investment in S&T programmes or projects generally includes operating expenditures that fall outside the definition, such as additional wages or fees of S&T personnel, hiring of scientific services, costs of licences, purchase of research materials, etc. This explains why regional public universities have been able to use only a fraction of the research resources allocated to them by the Canon Law.

Moreover, S&T programmes and, even more, individual projects are, by their very nature, characterised by a high degree of uncertainty as regards results and outcomes. Their *ex ante* evaluation should be based on criteria other than those applied to physical infrastructure projects.

This has posed particular problems for SNIP validation of S&T project proposals that involve public transfers to the private sector, in particular by innovation funds such as INCAGRO and FINCYT. In effect SNIP procedures may invalidate such transfers or, in the case of funds, lead to unnecessary red tape, additional costs and delays, when these funds finance projects that imply a transfer from public resources to the private agents responsible for the implementation of the project.

Innovative management solutions have been found to address some of these problems. In the case of INCAGRO S&T projects are considered "consultant contracts" passed by the Peruvian state and are subject to adapted SNIP validation procedures designed in collaboration between DGPM and INCAGRO management. In the case of FINCYT projects which involve public transfers to the private sector, these are also considered as consultant contracts but the approval procedures are more efficient. In view of the ill-adapted SNIP procedures for S&T projects, the IDB, in negotiating the FINCYT loan, succeeded in ensuring that the delegation of validation and approval of projects would be granted to the Fund Executive Board under the Presidency of the Council of Ministers. Moreover, in both cases the Treasury Accounting Office (*Contaduría Pública de la Nación*) has agreed that the disbursements be made during the course of the projects on the presentation of technical/financial execution reports.

It is expected that FIDECOM, the innovation fund chaired by the Ministry of Production and managed by the FINCYT Executive Board, will follow the same procedures.

Source: Adapted from notes from the Presidency of the Council of Ministers and the Ministry of Economy and Finance.

Restrictions on the transfer of public funds to private-sector institutions

In all OECD countries legal and regulatory provisions define the rationale and conditions under which such transfer can occur. This is notably the case for public support to R&D activities. In Peru the general rule forbids public transfers to the private sector. The provision of financing for R&D and innovation activities is hindered by legal and administrative obstacles and is very difficult to introduce. Rules to facilitate the enactment and implementation of support instruments may involve long delays and complex administrative procedures.[21]

3.2. Policy rationales, policy mix and governance: Concepts and experiences

Concepts and experiences

In all OECD countries – as well as in the more advanced developing ones – governments play an important and legitimate role in the development of S&T capacity. Their aim is to foster innovation in order to sustain growth through increased productivity and competitiveness and respond to social challenges.

Policy rationales

The rationales for government intervention in STI policy have been well analysed. Prominent among these are (OECD, 1998, 2010a):

- Market failures resulting *e.g.* from non-appropriability of the results of R&D by private actors that would lead them to underinvestment in this activity.[22]
- Systemic failures that hinder knowledge and technology interactions among economic agents or institutions.[23]

Another rationale is often invoked: The provision of S&T inputs to better respond to social needs either for safety reasons where the government has control and regulatory powers or to promote innovations in areas such as health, environment and energy in which high R&D costs and relatively low or uncertain returns could hinder the (initial) involvement of the private sector. In keeping with these rationales government should always be cautious about possibilities of government failures in policy design and implementation.

Beyond government interventions that reflect these rationales through dedicated STI policies the promotion of innovation also requires fulfilling certain framework conditions. As discussed Chapter 1, these framework conditions concern macroeconomic stability, education and skills development, infrastructure, product, labour and financial markets, entrepreneurship, tax regimes, and the management and protection of intellectual property rights.

Finally, and this seems particularly important in the case of Peru, one should also mention the adaptation of regulatory frameworks concerning the conditions of approval of public investment to the specificities of such investment in science and technology either in support of S&T activities developed by innovation actors, or in the operating rules governing funding agencies and innovation funds, or in the provision of S&T infrastructure.

Policy mix

The scope, nature and focus of government interventions can be very country-specific. They depend on various factors: that have to do with the level of development, the institutional context, the structure and openness of the economy, the endowment in natural resources, the initial conditions regarding the strength and organisation of S&T capacities and the framework conditions that impinge upon innovation performance (OECD, 2005a).

Box 3.3. Policy mix issues

The notion of policy mix has become increasingly popular in recent years. It is adopted by international organisations, such as the OECD and the European Commission, when advising governments on their innovation policies, and increasingly by countries themselves in policy design and implementation.

Ideally the task of STI policy makers is to design an optimal mix of policies that takes into account possible positive and negative interactions among support programmes and instruments to address current weaknesses and prospective challenges in the innovation system in order to improve its performance. A policy mix is therefore an explicit or implicit portfolio of policies and the corresponding implementation programmes, instruments and resources.

In assessing policy mixes, the key issues revolve around whether the mix is appropriate, efficient and effective. For example, does the policy mix address the country's main innovation challenges or are there obvious gaps? Is the balance of the main policy areas (and the resources allocated to them) consistent with the relative magnitude of the current and prospective innovation challenges? At the level of instruments, are there too many or too few, and is the scale appropriate? Are individual instruments well-designed and effective (*i.e.* is the right type of instrument used to address the particular problem to be solved and does it build on good practice)? How should policy goals and instruments be sequenced to best effect? Are there synergies between and among individual instruments?

Policy mixes have to evolve in line with the strengthening of the innovation system, the dynamism of its actors and the breadth of their interactions, as well as framework conditions. Questions surrounding the policy mix are therefore not confined to existing policy and institutional arrangements. They also extend to the disappearance of some and the design of new ones. In all countries that have successfully managed to move from an STI system in which the public and university sectors have the predominant role as R&D performers to one in which the private sector assumes the major role, this transition has been accompanied, and in many cases jump-started by, changes in policy mixes.

Examples that are relevant for Peru include:

- The balance between resources allocated to support business innovation on the one hand and to S&T infrastructure and capacity building on the other.
- The balance of funding of public research between sectoral research institutes and universities.
- The balance of institutional and competitive funding.
- The balance between direct and indirect (*e.g.* tax incentives) support to business R&D and innovation investment.
- The impact of the adaptation of capital markets to the financing of innovation on the design of innovation funds support instruments.

Source: Adapted from OECD (2010a).

Beyond differences among countries, these interventions should relate to the rationales mentioned above and give rise to explicit or implicit "policy mixes" that address the challenges faced by the innovation system. They should involve a combination of: *i)* measures to enhance S&T capacity (infrastructure, generation of knowledge and human resources development); *ii)* support measures and incentives to increase private-sector investment in R&D and innovation activities and to foster diffusion of knowledge and interaction among institutions and agents; and *iii)* institutional and regulatory reforms to reduce obstacles to innovative activities, including those related to framework conditions (Box 3.3).

The efficiency of policy mixes is predicated upon the coherence and complementarity of policy instruments so that they ensure balanced support for the challenges faced by the innovation system. One indicator of success of a policy mix is the leverage that public investment in S&T has on private innovation expenditures to enhance productivity and competitiveness. Another pertains to the strengthening of the articulation between generation, diffusion and commercialisation of knowledge that generate positive feedbacks between supply and demand and encourages structural change (Teubal, 2008).

Policy mixes should evolve with the consolidation of innovation systems and changes in the nature of the challenges they face. Such changes can result, for example, from the positive effects of past policies and improvements in framework conditions, the growing role of the private sector in the performance and financing of S&T activities, or evolving patterns of innovation processes.[24]

Policy governance

There is ample evidence that, for a given volume of resources for STI, countries' innovation performance depends on the quality of the governance of STI systems, *i.e.* the set of largely publicly determined institutional arrangements that shape policy design, implementation (agencies and instruments), delivery and evaluation and determine how the various public and private actors interact in allocating and managing resources. Governance of STI systems has changed profoundly over the last three decades in most OECD countries.[25] The main factors behind these changes have been:

- The increased importance of a "whole of government" approach to policy design, and hence the need for efficient co-ordination mechanisms among concerned ministries as regards STI policy orientations and their translation into the definition of a policy mix and budgetary allocations to ministerial agencies' in charge of the implementation of programmes in support of STI.
- Broader involvement of stakeholders from the research community and the business sector in the definition of strategic orientations. This has often led to the creation of S&T policy councils. In some countries, these have an advisory role; in others they make policy recommendations that affect the (re)definition of the policy mix, policy initiatives and budgetary allocations (Box 3.4).[26]

- The development of new public management (NPM) approaches that distinguish the functions of policy design from those of policy implementation. It has led to the creation or transformation of government implementing agencies with greater management autonomy balanced with greater accountability (Box 3.5).

- The increased importance of public-private partnerships to increase the leverage of public investment in S&T on private spending, improve innovation performance of the private sector and better respond to social and collective needs.

Box 3.4. STI policy councils

A number of OECD countries have established science, technology and innovation policy councils to advise government on the strategic orientations of STI policy. In most countries these councils have been established by law. They almost always involve both industry and academia representatives and, to a lesser extent, representatives from public research institutes. Councils engage with a sufficiently wide set of stakeholders and provide a neutral forum for discussion, so that attempts by special interests to pursue their own objectives quickly become visible. In several countries these councils have an effective role in policy co-ordination and in the evolution of policy mixes:

- The Finnish Science and Technology Policy Council, headed by the prime minister, has been a reference for many similar institutions around the world.
- Canada's Science, Technology and Innovation Council brings the public and private sectors together to advise the government on priority setting. It produces a biennial State of the Nation report to track the impact of policies.
- Korea has made persistent efforts to better co-ordinate its STI policies. It established a National Science and Technology Council under the prime minister, which has been progressively strengthened to play a pivotal role in policy co-ordination. Among other functions, it is responsible for improving coherence between rival ministries' programmes.
- In Germany, the Expert Commission for Research and Innovation (EFI) presents the federal government annual proposals for national research and innovation policy making based on a comprehensive analysis of the strengths and weaknesses of the German innovation system.
- Mexico established a council in its 2002 S&T law. This council, chaired by the president of the Republic, includes ministers in charge of departments whose policies impinge on the development of S&T activities and the performance of the innovation system. It also includes representatives from the research and business communities. The Council sets policy orientations, approves the S&T development plan and defines criteria for budget allocation to STI-related programmes; it approves the consolidated S&T budget and prepares an annual report on the execution of the budget.
- Chile has set up an advisory National Innovation Council for Competitiveness which has succeeded in developing a national strategy and deploying a cluster initiative. The council has triggered changes in the governance system, including the creation of an Inter-ministerial Committee for Innovation, the council's counterpart in the executive branch. There has been some initial uncertainty concerning its composition and its role in allocating resources from the Innovation for Competitiveness Fund (which was established along with a levy on mining revenues).
- The People's Republic of China's State Council Steering Group for Science, Technology and Education, headed by the prime minister, is a top-level co-ordinating mechanism on strategic matters. There is a lack of co-ordination on the design and implementation of STI policy, and co-ordination between the central and provincial levels, and among regions, remains weak.

Source: OECD (2010), *The OECD Innovation Strategy. Getting a Head Start on Tomorrow*, OECD Publishing, Paris.

Box 3.5. Governance and New Public Management

The New Public Management school of thought (NPM) has had significant influence in most OECD countries' systems of governance over the last couple of decades. NPM challenges the once dominant view that tightly integrated and controlled organisations are more efficient than fragmented, self-operated units. The argument against integrated organisations can be summarised as follows: hierarchical, centrally controlled organisations lack initiative, are slow to adapt to changing conditions and are not sufficiently responsive to the interests of those they serve. Giving agencies operating autonomy spurs them to innovate and improve performance. Because they are free from departmental fetters, agencies are inherently more adaptive and responsive (Schick, 2002).

Organisationally, agencies have usually been created by isolating structures within ministerial departments and providing them with a quasi-contractual relationship with the top hierarchy of the ministry; or separating them institutionally from traditional, vertically integrated ministries; and/or providing them with a complete or partial legal identity separate from that of the state (OECD, 2002a).

A majority of OECD governments[1] have adopted the tenets of New Public Management (NPM) in STI governance, distinguishing policy making from policy implementation and bodies. They have established agencies for a mix of service delivery tasks, including research funding, innovation support, and even research performance. Ministerial departments in charge of policy design generally retain oversight responsibility of implementation agencies whose greater management autonomy is counterbalanced by stronger accountability requirements.

1. Most notably Nordic countries, Australia, New Zealand, the United Kingdom, Chile.

Source: OECD (2009a).

A greater reliance on policy learning and experimentation based on broader use of monitoring and evaluation of agencies, support programmes and funding schemes in order to provide feedback to policy makers.In many countries governance structures inspired by NPM approaches that clearly separate the functions of priority setting, policy orientation and budgetary allocation from those of policy design, management and implementation have been generally found to constitute a better practice for policy efficiency.

In countries like Peru that are working to integrate a disarticulated innovation system, the case for such an approach is strengthened by the presence of conflicts of interest and responsibilities among agencies or funds that combine policy design and policy implementation. This can lead to duplication of support programmes and inefficient use of public resources for projects of less than critical mass. However, the clarification of functions among implementing agencies requires a strong inter-ministerial co-ordination mechanism that facilitates the building of a consensus on a coherent policy mix and its translation into budgetary appropriations to ministerial departments and institutions in charge of policy design and implementation. Inter-ministerial co-ordination is important to avoid waste and overcome inertia in budgetary appropriations and to facilitate the evolution of appropriations to reflect changes in the policy mix in line with policy priorities and the progressive consolidation of the innovation system.

Beyond the low level of resources for STI policy, Peru has not performed well in terms of good governance practices and coherent and efficient policy mixes. This was true not only of its disparate S&T policy during the three decades from 1970 but also since, in spite of a slight increase in resources and new institutional and funding initiatives.

Peru's STI governance: Weak and inefficient

As of 2002, after the dismantling of S&T policy in the 1990s, Peru's government took some legislative and institutional initiatives to set up new governance structures for its S&T and innovation system. Among the main initiatives were the following:

The National Competitiveness Council (CNC) was established by presidential decree in 2002, initially under the aegis of the Presidency of the Council of Ministers (PCM) and under the Ministry of Economy and Finance as of 2009. It is composed of ministers from various departments[27] and representatives from the business sector. It has a broad mandate covering all policy areas impinging on competitiveness, including those related to the promotion of innovation and the improvement of the education system. Currently, neither the PCM nor the Ministry of Economy and Finance is directly involved in the governance of the STI system.

The 2004 Framework Law on Science, Technology and Technological Innovation (Law 28303) gives a legal definition of the Peruvian National System of Innovation (SINACYT) as a broad set of public and private institutions involved in the development and/or promotion of S&T and innovation activities[28]

Under that law, CONCYTEC was entrusted with formal authority to "steer" SINACYT and in particular "to orient, promote, co-ordinate, supervise and assess the actions of the state in S&T and innovation matters". It was institutionally placed under the Presidency of the Council of Minister to reflect its role in interdepartmental co-ordination.[29] This position was meant to serve as an institutional guarantee of CONCYTEC's role in steering, co-ordinating and funding Peru's STI policy. It also gave CONCYTEC greater ability to propose new funding schemes in support of STI policy objectives.[30]

However, no standing co-ordination mechanisms – at government level and/or involving SINACYT stakeholders – were put in place to define priorities and link them with budgetary allocation across ministries and institutions. CONCYTEC was also entrusted with the formulation of the National STI Plan (CONCYTEC, 2009) but this remained largely a rhetorical exercise. It set an utterly unrealistic objective of a ratio of R&D expenditures to GDP of 1.5% by 2013 and ignored the links between R&D expenditures and the capacity to spend funds efficiently. It established a list of general objectives and priorities and an unmanageable number of "priority lines of action", without any hierarchy or indication of the resources required for the plan's implementation as a whole or by type of programme.[31] The unrealism of the planning exercise puts in evidence wide gap between the mission entrusted to CONCYTEC by Law and its ability to fulfil it.

At the same time CONCYTEC's responsibility as a funding agency, to be exercised through FONDECYT, its operative arm, was confirmed. This fund was supposed to finance with a meagre budget a wide array of programmes in the areas of basic or applied research, technological development and innovation, and the development of human resources in S&T.

In 2008 the National Institute for Agricultural Research (INIA), formally under the aegis of the Ministry of Agriculture, was entrusted by law with steering the so-called Agricultural System of Innovation, despite the role entrusted to CONCYTEC in steering the innovation system as a whole.

To sum up, CONCYTEC was unable to fulfil the leading role envisioned for in the 2004 STI Law in the governance of the Peruvian STI system for a combination of reasons:

- Confusion of its recognised role in funding its own portfolio of support programmes and a new role for channelling resources to other institutions.
- Uncertainties about its managerial capacity to carry out the missions entrusted to it by the new law and its mixed record in fostering lasting and dynamic interactions with the productive sector.
- Last but not least, lack of the political backing needed to play a major role in the preparation of decisions concerning budgetary allocations to research institutions and support programmes in the STI area. This lack of political backing was reflected in the transfer of responsibility over CONCYTEC from the PCM to the Ministry of Education.

This situation still prevails and highlights fundamental weaknesses in Peru's governance system.

Peru's government culture is characterised by a legalistic rather than a functional approach under the implicit assumption that a legal framework will resolve latent conflicts or differences of interests among government departments or institutions. However, a legal framework does not replace strong backing at the highest political level. CONCYTEC did not have – and still does not have – the requisite political authority. Effective governance would imply ensuring inter-ministerial co-ordination of strategic orientations and priority setting, an influence on budgetary appropriations for the STI policy area and the budgetary allocation process among ministries and institutions in line with horizontal or sectoral priorities, as well as a consultative voice in other policy areas that impinge upon innovation performance (*e.g.* regulatory regimes).

By Law CONCYTEC is entrusted both with governance and implementation responsibilities. It proved ineffective in overcoming the institutional inertia to better adapt the structure of policy implementation agencies to strategic orientations and policy priorities, or at least ensure a working coordination among them, with the counter-productive effect of maintaining overlapping design and implementation responsibilities – and lack of articulation – between poorly endowed institutions. In addition it has proved unable to foster a culture of accountability either in policy implementation agencies or public research institutions.

In a related area, CONCYTEC did not ensure the development of the information systems necessary for policy monitoring and evaluation[32] and the establishment of a budgetary classification that gives a more transparent record of budgetary allocations to ministerial departments for the implementation of STI-related programmes.[33] In this matter Peru dramatically lags far behind OECD and all other major Latin American countries.

These weaknesses in governance are compounded by other factors that have helped to reduce the effectiveness and efficiency of public programmes in support of S&T and innovation and largely continue to do so. First, the overall volume of public resources devoted to these programmes remains very limited even after a substantial increase in 2009 (Table 3.2). The variety and dispersion of these programmes raise problems of critical mass and hence of the efficiency of government support.

Table 3.2. Estimates of total expenditures on STI activities by source of funds, 2008-09[1]

USD millions

	2008	Share 2008	2009	Share 2009	Growth rate 2009/08
Direct budgetary resources					
To CONCYTEC	3.5	4.2%	4.6	3.5%	
To public research institutes	30.0	35.6%	40.0	30.6%	
To public universities	19.0	22.6%	30.0	23.0%	
To FIDECOM[2]	-		-		
To FINCYT	1.34	1.6%	2.94	2.3%	
To INCAGRO	1.21	1.4%	1.59	1.2%	
To CITEs[3]	n.a.		n.a.		
Sub-total direct budgetary resources	**55.05**	**65.4%**	**79.13**	**60.6%**	**46.4%**
Multilateral financing institutions' loans					
FINCYT (IDB)	3.34	4.00%	6.27	4.8%	
INCAGRO (IBRD)	4.65	5.5%	6.10	4.7%	
Sub-total multilateral financing institutions	**7.0**	**8.3%**	**12.37**	**9.5%**	**76.7%**
Private universities					
Own funds	10.0	11.9%	12.0	9.2%	
Matching funds for FINCYT projects	-		2.1	1.6%	
Sub-total private universities	**10.0**	**11.9%**	**14.1**	**10.8%**	**41.0%**
Private enterprises					
Own funds	2.0	2.4%	5.0	3.8%	
FINCYT matching funds	-	-	4.1	3.2%	
Matching Funds for INCAGRO projects	2.14	2.5%	2.80	2.2%	
Sub-total private enterprises	**4.14**	**4.9%**	**11.90**	**9.2%**	**187.4%**
Other sources					
Bilateral and multilateral co-operation	8.0	9.5%	10.0	7.6%	
Foundations	-		3.0	2.3%	
Sub-total other sources	**8.0**	9.5%	**13.0**	10.0%	**62.5%**
TOTAL	**84.15**	**100%**	**130.5**	**100.00%**	**56.8%**

1. These estimates are based on different sources which are not always consistent. The expenditures allocated to FINCYT and INCAGRO programmes include multilateral loans, national contributions from the Treasury and private-sector matching funds. They have been distributed among sources of funds according to their estimated respective share in total funding. Owing to problems of consistency among sources and availability of data it has not been possible to update this table to 2010.

2. FIDECOM is not included as disbursements only started in 2010.

3. No available information for CITEs.

Sources: GRADE (2010), Presidency of Council of Ministers (2010), Sagasti (2009).

Second, there is a duplication of management responsibilities, as different institutions or funds implement and manage projects with similar objectives. For instance FONDECYT's PROCYT and PROCOM programmes have objectives similar to FINCYT's components that deal with the generation of basic and applied knowledge (component 2) in PRIs and with the promotion of technological innovation in the enterprise sector (component 1). Not only is the maximum grant amount per project rather small by international standards but the duplication of sources of funding increases overall management costs. FIDECOM, a trust fund operating under the Ministry of Production, which became operational in the second half of 2010, is also supposed to finance primarily technological innovation projects in the enterprise sector on the basis of competitive projects, with matching funds covering basically the same areas as FINCYT component 1.[34]

More generally, this governance structure has not led to policy management and implementation in line with the strategic orientations of STI policy (generation, diffusion and productive use of knowledge). It has not minimised overlaps among agencies or fostered complementarity and co-ordination. This situation typically reflects a governance failure to solve conflicts between different rationales. One the one hand a legalistic rationale would entrust CONCYTEC with the management of FINCYT; on the other an efficiency rationale would maintain FINCYT under the aegis of the Presidency of the Council of Ministers because of its superior management and operating rules. To these two conflicting rationales can be added a bureaucratic one. While it may seem legitimate for the Ministry of Production to develop its own support programmes to foster innovation in the business sector, as is the case in a number of OECD countries, it is hard to understand why FIDECOM's programmes duplicate those of FINCYT.[35]

3.3. Policy design institutions and implementation instruments

In the area of policy design and implementation, there is a lack of clarity in the hierarchy and reporting and accountability relationships among various types of institutions. It could even be argued that Peru has, not an STI policy, but a set of largely uncoordinated policy actions designed and implemented by various ministries and public institutions.[36] In this regard, it is symptomatic that, contrary to the practice in OECD and many developing countries, Peru does not make information on its S&T and innovation policy available in a consolidated way and identifies and connects policy orientations, support programmes and resource allocations.[37]

In many, if not most, instances the effectiveness of disconnected policy actions has been curtailed by programmes' level of resources, the lack of projects of critical mass, bureaucratic problems in project assessment and delivery, and limited accountability and capacity to assess outcomes. There are of course exceptions to this bleak panorama, but their relative success generally derives largely from the fact that they were conceived and developed at the margin of the institutional framework and in two cases (INCAGRO and FINCYT) with the financial and organisational assistance of multilateral financing institutions.

Ministerial bodies

Some ministries are involved in STI policy design, as well as in funding and implementation either directly or through research institutions or agencies formally operating under their aegis. The main ones are:

The Presidency Council of Ministers (PCM)

The PCM is the main inter-ministerial co-ordinating body and, along with MEF, plays an important role in the budgetary arbitration process. Although it does not presently play a formal role in STI policy design, it oversaw CONCYTEC until 2005. It is now the formal executing agency of FINCYT whose resources come from an IDB loan and the National Treasury. It was involved in the design of the fund and nominates the Board that reviews, assesses and approves or rejects proposed projects.

Ministry of Economy and Finance (MEF)

Beyond its preeminent role in budgetary allocation and the approval of loans from multilateral financing institutions, MEF is an important player in the STI policy arena. In recent years it has started to overcome a rather rigid view of the economic rationale for public support to STI activities and of the potential benefits for productivity, growth and competitiveness. This greater openness, which reflects an acknowledgement of successes in both developed and developing countries, is, with good reason, tempered by a cautious approach to public spending and close attention to sound macroeconomic policy. A more proactive STI policy should safeguard against waste of resources due to failures in policy design, funding and implementation, and lack of synergies.

At the same time, the ministry tightly controls public investment and the transfer of public resources to the private sector:

- *Restrictions on the transfer of public funds to private-sector institutions.* In all OECD countries legal and regulatory provisions define the conditions under which transfers can occur. This is notably the case for public support of R&D. In Peru the general rule forbids public transfers to the private sector. The financing of R&D and innovation activities is hindered by legal and administrative obstacles and is very difficult to introduce. The establishment and implementation of support instruments may involve long delays and complex administrative procedures.
- *The SNIP procedures* regulate and validate public expenditures for investment purposes by public institutions. As Box 3.2 points out, these procedures were conceived for physical investment and it has proven difficult to apply the criteria to R&D and innovation-related intangible investment. SNIP regulations have limited the use of resources derived from Canon Law for S&T projects in regional universities. For projects proposed by the private sector for funding by FINCYT and INCAGRO, these regulations exacerbate the restrictions mentioned above. To deal with this problem, such projects have been defined as services contracted to the government.[38] Contrary to the situation in Peru, in practically all countries once a fund is established its operational rules entrust the managing agency with full responsibility for selecting and approving individual projects and disbursing grants according to general accounting rules.

According to a recent World Bank report (2011, p. 64): "It is not efficient in Peru to keep on managing public investment under rigid rules that were useful in previous times of scarcity and weak development of the private sector ….It would be worthwhile to develop clearer rules that distinguish investment in public goods from those that involve public-private partnerships [when there are elements of risk sharing]." This statement is particularly valid for public investment in support of S&T which involves either public transfers managed in the framework of innovation funds or public-private partnerships.

While controls and regulations remain important for sound management of public expenditures, the proactive efforts of MEF in support of public investment in S&T call for adapting these controls to curtail regulatory obstacles that hinder the management and delivery of public support to S&T and innovation activities. MEF should also clarify some of the grey areas of the Tax Code related to business investment in R&D (see above Boxes 2.1 and 3.2).

Finally, MEF plays an important role in assessing the use of budgetary resources by government agencies or programmes, in particular to determine future appropriations.[39] Current practices to avoid waste and redirect budgetary appropriations may need to be revisited. As highlighted in the same World Bank report (2011, p.58): "[While implementation agencies should understand that they have a commitment to fulfil the objectives they have announced] it is also necessary to understand that a results-based budget implies a prior discussion about policy priorities so as to reduce the risk that, in practice, each agency engages in a parallel budgetary process". This has to be seen in the context of the New Public Management approach that gives more autonomy to implementing agencies under the condition of increased accountability. In Peru this would mean that MEF and/or sectoral ministries with oversight responsibilities for implementing agencies should frame their assessment on the basis of performance agreements that reflect policy orientations, the fulfilment of which agreements would be an essential element of budgetary appropriations.[40]

Ministry of Production (PRODUCE)

Until the beginning of the 2000s PRODUCE had the main role – albeit with limited resources – in promoting innovation activities in the private sector, originally through ITINTEC, the Industrial Technology and Technical Norms Institute established in the 1970s and abolished in the 1990s. From the beginning of the 2000s, this role has been played by the 14 technological innovation centres (CITEs). CITEs respond to a real demand and their technological services are delivered efficiently. An open question is their possible evolution into private, public or public-private centres able to develop their own R&D capacities in order to provide higher-value technological services. This is the case in many OECD countries and in Brazil and Colombia (World Bank, 2008). PRODUCE has not been active in knowledge and technology diffusion programmes to firms that already have a certain level of innovative capacities. Apparently, such an evolution is not presently in order. It could however be considered in the wider context of an eventual reform and rationalisation of the present PRI system to ensure greater accountability procedures. FIDECOM, which supports innovation projects in the productive sector, does not presently have components focused on the provision of technological services

Ministry of Agriculture (MINAG)

This Ministry deserves special mention in view of the sector's importance in Peru's economy and society and the role that technological development and innovation can play in upgrading its productivity, deepening and broadening its export capacity, and its impact on poverty reduction. The definition of S&T and innovation policy priorities and their implementation was largely devolved to INIA, the National Institute of Agricultural Research, which was also entrusted in 2008 with the steering of the so-called "Agricultural Innovation System". INIA's rather satisfactory record in the years following its creation in 1992 began to deteriorate towards the end of the 1990s owing to governance problems and

management constraints that had an adverse effect on the overall quantity and quality of its S&T staff and led to an inflation of administrative staff.[41] INIA, as the leading public S&T institution in the agricultural sector, was involved, together with the Ministry of Agriculture in the establishment of the INCAGRO fund financed through a World Bank loan with participation by the Peruvian Treasury. Despite its weak management record and possible conflicts of interest INIA was made executing agency for INCAGRO. As of the end of 2010, INCAGRO was administratively absorbed by INIA.

Ministry of Education (MINEDU)

Although it has formal responsibility for the formation of the qualified human capital necessary to the development of S&T and innovative capacity, the Ministry of Education's role appears limited in this respect. This is partly because of the much higher priority given to meet the increasing demand for basic and secondary education and partly because of the broad autonomy of universities under a governance system which largely excludes the ministry (GRADE, 2010). The pressure of the demand for education at all levels and a certain benign neglect on the part of the ministry has contributed to anarchic growth of education institutions, wide differences in the quality of academic education and, until recently, the emigration of researchers. The ministry has been unable to participate in the steering of academic research through financing (institutional and competitive), to link funding to criteria of excellence and to provide higher education institutions with incentives to make productive use of research results. The ministry has also been unable to push for and enforce an evaluation-based system of accreditation for universities, an issue that is still pending in Peru despite the creation in 2006 of the Council of Evaluation, Accreditation and Certification of University Higher Education (CONEAU).[42] Peru's situation is very unusual among developed and developing countries alike. The higher education sector should not remain a *de facto* "orphan" in Peru's government structure. The autonomy guaranteed to this sector should not shield it from sound governance practices that entail evaluation and determination of funding and act as safeguards against the primacy of vested interests.

Other ministries

The Ministry of Health, the Ministry of the Environment and the Ministry of Energy and Mines are also indirectly involved in S&T and innovation policy making and implementation through their responsibility for, and funding of, their public research institutes (Table 2.6). However, in many cases the relationship between the ministries and institutes is an arm's-length one as regards the definition of research priorities;[43] in some cases the institutes' budget appropriations are directly negotiated with MEF.

Other ministries are also relevant insofar as they are responsible for the oversight of laws and regulations that impinge upon the performance of the innovation system. Labour is a typical case:

- *Labour laws applied to civil servants* negatively affect the possibility for public university researchers to engage in collaborative projects with other institutions because of restrictions on inter-institutional mobility or the difficulty – if not impossibility – of receiving payment for services rendered to another institution while on the university payroll,
- *Service administrative contracts (CAS) applied to the public sector*. This type of contract has perverse effects for public research institutes as rigidities in the labour

laws make personnel turnover difficult so that better qualified personnel must be recruited as temporary workers.

Regional governments

The Regional Governments Organic Law stipulates that these governments are entrusted with responsibility for formulating regional S&T and innovation policies. However most if not all regional governments lack the resources or policy instruments needed to develop significant programmes in support of innovation (GRADE, 2010).[44]

Since 2008 CONCYTEC has also supported the formation of regional councils of science, technology and innovation (CORCYTECs) in the 25 Peruvian administrative regions. In principle, through these councils, each region's socio-economic development plan should include programmes to S&T and innovation with matching budgetary resources. In practice this system has not worked as anticipated. First in many regions suffer from a scarce capacity in the formulation of S&T and innovation programmes. Second, regional councils are often no more than formal or marginal institutions within regional governments. Third, there is a lack of co-ordination between CONCYTEC and the various regional councils. One can argue that even if co-ordination were better it would be very difficult to reconcile regional STI plans and national priorities, including in terms of budgetary allocations, within the present governance structure of Peru's S&T and innovation system.

S&T and innovation funds

Apart from the funding processes that channel institutional resources (block grants) to public research institutes and higher education, the major instrument of Peru's S&T and innovation policy is the four S&T and innovation funds. Two, FONDECYT and FIDECOM, are entirely financed by the budget, while the other two, INCAGRO and FINCYT, are financed partly by loans from multilateral financing institutions and partly by the Peruvian Treasury, with contributions from the private sector for the implementation of projects benefiting enterprises or associations of enterprises. The co-existence of these funds raises a number of questions: How do they fit into the overall framework of S&T policy implementation and what policy areas do they address? What are the main issues raised by their management? Particularly in the case of INCAGRO and FINCYT, how is their management integrated into the Peruvian institutional setting? And what issues are raised by their possible extension and, in the longer term, an eventual transition towards full funding by the Peruvian budget after the World Bank and IDB loan programmes are phased out?

FONDECYT

FONDECYT is CONCYTEC's operational arm for the funding of S&T and innovation-related programmes and projects as well as international scientific co-operation. Its resources are extremely limited (less than USD 4 million disbursed annually), especially if CONCYTEC's high management and administrative costs are taken into account.[45] FONDECYT support covers a very broad range of policy areas, ranging from basic and applied research mainly in PRIs and universities to business innovation projects and scholarships for the development of advanced human resources in S&T (Table 3.3).

Table 3.3. CONCYTEC/FONDECYT programmes and budget, 2000-10

	2000	2002	2006	2010	Observations
TOTAL CONCYTEC budget (USD million)	3.27	3.38	4.69	4.80	-
Share of management expenditures	n.a.	30%[3]	20%	28%	
TOTAL FONDECYT budget	n.a.	n.a.	1.98	2.10	-
Share of management expenditures	n.a.	n.a.	15%	15%	
FONDECYT grants to STI competitive support programmes					
Basic and applied research (PROCYT)	n.a.	n.a.	0.38	0.20	USD 17 800 max. per project 20 projects in 2010
Technological Innovation (PROCOM)	n.a.	n.a.	0.40	0.30	USD 50 000 max. per project Six projects in 2010
Technological transfer and extension (PROTEC)	n.a.	n.a	0.0	0.032	USD 18 000 max. per project Four projects in 2010
Sub-total			*0.78*	*0.532*	
Support to human resources					
CONCYTEC Chairs (competitive)	-	-	0.026[1]	0.402	In 2010 the programme financed eight Chairs, six doctoral and 23 master's scholarships USD 50 000 max. per research project USD 17 800 per scholarship (doctorate level)
Postgraduate scholarships					
Peruvian universities	n.a.	n.a.	0.42.	0.193	In 2010 the programme financed: Nine doctoral scholarships a year (USD 17 800) 20 master scholarships a year (USD 11 550)
Foreign universities	n.a.	n.a	0.15	0.045	
Sub-total	***n.a.***	***n.a.***	***0.57***	***0.64***	
Other FONDECYT programmes[2]	n.a.	n.a.	n.a.	n.a.	

1. In 2007, year of creation of CONCYTEC Chairs.

2. Includes support to scientific publications, Peru's contribution to bilateral S&T co-operation, S&T prizes.

3. Estimate (Mullin, 2002).

Source: CONCYTEC and GRADE (2010).

There is a clear lack of focus in FONDECYT programmes which is due to the contrast between the small overall budget and the breadth of activities supported. This probably reflects the fact that CONCYTEC is eager to retain its formal role in "steering the STI system" entrusted to it by law. As this role has *de facto* largely become a virtual one, CONCYTEC intervenes in all policy areas and funds most of its projects with resources that, for the most part, are below critical mass. A possible exception is the CONCYTEC Chairs which provide monetary incentives to leading researchers to allow them to constitute and finance a research team.[46]

Unfortunately, CONCYTEC does not produce any systematic, publicly available information that would allow for assessing the quality of projects proposed for FONDECYT funding, such as approval rates or sectoral distribution. Neither does it conduct or commission any assessment regarding the match between supply and demand for funding or the output and outcomes of funded research, innovation and technology transfer projects.

INCAGRO

INCAGRO has its origin in a programme developed in 2001 by INIA and the Ministry of Agriculture, with the support of the World Bank, to improve the innovative capacity and competitiveness of the Peruvian agricultural sector, essentially through projects related to S&T capacity building and the provision of technological services. From the start, there was a commitment from the private sector through so-called strategic alliances in project development and implementation. The first phase of the programme (2001-04), endowed with USD 14 million, was experimental. Given the positive results a second "expansion" phase was initiated to cover 2005-10 with an endowment of USD 45 million of which USD 25 million from the World Bank, USD 6 million from the Peruvian Treasury, and USD 12 million from the private sector, mainly producers' associations. INCAGRO has two distinct funds (Ramirez Gaston, 2010).

- **The Strategic Services Development Fund (FDSE)** which finances public-good type projects, S&T capacity building in the areas of basic and applied research, and the development of human capital (researchers and support technicians for field work).
- **The Agrarian Technology Fund (FTA)** which co-finances the development of innovative business-oriented projects through the provision of technological services and adaptive research.

In addition INCAGRO funds and manages a monitoring and evaluation unit (USPE) whose main lines of action are the management of information networks, *ex ante* project evaluation and *ex post* programme and project assessment, and prospective studies on S&T in the agricultural sector.

While formally integrated in INIA INCAGRO was granted management autonomy for the selection, funding and implementation of projects. This allowed INCAGRO to develop its activities with more efficiency than would likely have been possible if INIA had retained the role of executing agent.[47] However, its management efficiency was impaired in the second phase of the programme when the SNIP procedures that vet public investment programmes were introduced and led to red tape and delays in project approval.[48]

There seems to be a general agreement that, given the conditions under which it operates, the INCAGRO programme is successful.[49] The balance between supply-led S&T capacity building and demand-driven provision of services seems adequate and generates leverage effects. The private sector's financial participation in FDSE and FTA projects, in the framework of "strategic alliances" with the public sector, has been good, with more than 50% of the whole budget and over 61% if management and financial costs are included (Table 3.4). Participation has even been higher than initially committed (USD 15.48 million instead of USD 12 million). The USPE monitoring and evaluation system could usefully be emulated across Peru's PRIs. Finally, overall management and financial costs have been kept within a reasonable margin of less than 10%.

Table 3.4. INCAGRO expenditures second phase, October 2005-November 2009

USD millions

Programme	Public contribution		Strategic alliances contribution		Total
	Loan	Treasury	Amount	%	
Agrarian Technology Fund (FTA)	11.96	0.51	5.69	45.63%	18.16
Strategic Services Development Fund (FDSE)	7.83	0.30	9.78	120.30%	17.91
Capacity building in project development management and evaluation (UPSE)	1.84	2.79	-	-	4.63
Sub-total	21.63	3.61	15.48	61.26%	40.71
Management and financial costs	1.50	3.0	-	-	4.51
Total	23.13	6.61	15.48	51.02%	45.21

Source: INCAGRO.

The second phase of INCAGRO concluded at the end of 2010. Despite its acknowledged success, due to rigorous and efficient management, broad outreach in the agricultural sector[50] and strong leverage on private involvement and financial participation, INCAGRO was abolished as a *de facto* autonomous agency and incorporated within INIA. INIA will be in charge of the implementation of the so-called third "consolidation phase"; its endowment, initially set at USD 130 million, is under discussion with the World Bank and the Ministry of Agriculture.

Although this decision may have seemed appropriate from a governance point of view it was probably not the best option for several reasons. First, in terms of efficiency, INIA's management record suggests that INCAGRO's good practices will be lost. Second, there are clear conflicts of interests owing to INIA's roles as both an implementing agency whose principal resources are institutional and competitive and its new role in channelling the funds for what would have been INCAGRO's third phase.

FINCYT

FINCYT is the fund derived from the loan agreement signed in 2006 by Peru with the American Development Bank to finance a science and technology programme. The programme effectively started in 2007 for a first phase of three years with the possibility of extension. The fund amounts to USD 36 million of which USD 25 million for the IDB loan and USD 11 million from the Peruvian Treasury.

The scope of the programme is very broad. Projects can be presented under four main components that cover a wide range of S&T and innovation policy areas (FINCYT, 2010 and 2011). They are funded on a competitive basis and on the basis of matching funds from enterprises for the first two components:

- Promotion of technological innovation in enterprises, at individual (PITEI) or collaborative, precompetitive level (PITEA).
- Strengthening of the research and/or technological development capacity through projects presented by public research and higher education institutions, or consortia involving these institutions and enterprises. Research projects can aim to increase the knowledge generation capacity in general (PIBAP) or address questions of national interest (PIN). A premium is in principle given to projects that foster the creation and/or development of knowledge networks.
- Development of highly skilled human resources in S&T, including S&T and innovation project management, mainly through the granting of scholarships.
- Strengthening of the national innovation system and its articulation through activities that help to improve policy design and implementation and increase the efficiency of support programmes.

FINCYT operates under the aegis of the Presidency of the Council of Ministers which reflects an acknowledgment of the comprehensiveness of its programme portfolio and a recognition of the transversality of its action that cuts across ministerial competencies. This institutional situation at a high government level has helped to alleviate some of the regulatory constraints imposed on public investment projects by the SNIP procedure and on public procurement by the General Comptroller's Office. In effect, in the case of FINCYT the SNIP procedure is not applied on a project by project basis and disbursements are made upon presentation of technical and financial reports.

The more flexible regulatory environment in which FINCYT operates has facilitated the emergence of operational management more aligned with the international best practices of S&T and innovation funds. On the demand side institutions applying for grants have sometimes complained about the bureaucratic burden involved in the presentation of project proposals (Rivas Perlwitz, 2010; GRADE, 2010) and the lack of clarity in the criteria used in the selection process, but there is a learning curve on both sides. FINCYT management has been improving its selection procedures by introducing a first stage of simpler project profiles, and on the demand side the ability to present projects on the basis of clearer requirements should improve in time. The differences in focus of the fund's components could probably also benefit from more customised proposal requirements and selection procedures.

A more general problem for the selection process is the quality and professionalism of the assessment panels asked to pass judgment on proposals. In a cultural environment in which the practice of competitive calls is quite recent, endogamic behaviour in evaluation is a risk, competencies take time to develop and panels would benefit from occasional participation of foreign evaluators.

However, on the whole and in line with external evaluations commissioned by the IDB (Abeledo, 2010; Rivas Perlwitz , 2010), FINCYT management has quite rapidly developed operational practices that have become more efficient through experience and constructive interactions with enterprises and research institutions.

Since it began operations in the autumn of 2007 FINCYT has had a very good record in terms of budget commitments. According to the latest available figures, 94% of the operational budget was committed and over 75% executed by the end of 2010 (Table 3.5).

Table 3.5. FINCYT committed budget on 31 December 2010

USD millions

Programmes	FINCYT budget[3]	Committed budget		Executed budget[4]	
		Amount	Percentage	Amount	Percentage
Technological innovation	**12 300**	**12 000**	**98%**	**8 700**	**71%**
Individual enterprise projects (PITEI)	7 200	6 900	96%	4 600	64%
Collaborative enterprises projects (PITEA)	5 100	5 100	100%	4 100	80%
Research and development	**10 800**	**10 800**	**100%**	**10 576**	**98%**
R&D projects in universities and public research institutes (PIBAP)	8 800	8 800	100%	8 576	97%
R&D projects of national interest (PIN)	2 000	2 000	100%	2 000	100%
Creation & strengthening of S&T capacity	**5 760**	**4 319**	**75%**	**2 875**	**67%**
Doctorate and post-doctoral scholarships (domestic and abroad)	2 160	2 160	100%	1 090	50%
Master's scholarships and enterprise fellowships for graduate studies	1 600	309	19%	235	15%
Strengthening of S&T capacities	2 000	1 850	93%	1 550	64%
Institutional strengthening of national system of innovation[2]	**1 640**	**1 550**	**95%**	**1 051**	**64%**
Subtotal	**30 500**	**28 669**	**94%**	**23 202**	**76%**
Other[1]	**7 108**	**2 900**		**2 756**	
TOTAL	**37 608**	**31 569**		**25 958**	

1. Includes auditing, administrative and loan interest costs.
2. Includes consulting, training and information diffusion activities.
3. Includes increase of local contribution by USD 1 608 million from FIDECOM in November 2009.
4. The projects have an execution period of 2 to 3 years.

Source: FINCYT (2010).

Some conclusions can be drawn from this overall good record:

- FINCYT has undoubtedly met latent demand for funding S&T and innovation projects in the enterprise sector as well as in public research and higher education institutions.
- Response is related not only to the fund's existence but also to its management practices, and possibly to the institutional setting in which it operates.
- The fact that the ratio between approved and evaluated projects is around 25% shows, on the one hand, that actual demand is much higher and, on the other, that the rapid execution of the fund is probably not due to a lack of selectivity.
- There are differences in supply/demand according to types of programmes. Apparently funds for R&D grants to public research and higher education institutions are used up more rapidly and projects presented in collaboration have a better chance of being accepted. This means that FINCYT has or induces an interest in collaboration. In either case the outcome is positive.
- Given the very low level of resources available in Peru for postgraduate scholarships, one would have expected this component to be rapidly exhausted. That this is not the case may be due to the scheduling of the competitive calls. It is hoped that this component, which complements in part the scholarships associated with the CONCYTEC Chairs, will gather momentum.

The fact that FINCYT successfully addresses unfulfilled latent demand, as measured by the number of proposals and the high rate of budgetary commitments, raises important design and policy issues.

First given the scope of the eligible costs that can be covered in programmes focusing on technological innovation (PITEI and PITEA) and a subsidy rate that range from 50% to 80% (Table 3.6), one can wonder if the technological innovation programmes do not give rise to windfall profits for certain enterprises that take advantage of subsidised capital equipment costs to present modernisation projects as innovation ones.

This leads to a second question related to evaluation. Evaluations are important to assess the efficiency and impact of support programmes in terms of their input and output additionality[51] and opportunity cost, but also because they should shed light on their impact in terms of "behavioural additionality",[52] *i.e.* changes in firms' innovative behaviour over time, notably as regards their reaction to incentives and their propensity to engage in collaborative activities. For FINCYT it is probably too early to undertake such evaluations. They appear to be envisaged and would be financed under FINCYT's fourth component. It would be useful for such evaluations to address the questions of possible windfall profits, sensitivity to subsidy rates and various types of additionality.

The third issue is the impact of FINCYT on the institutional setting of STI policy formulation and implementation and an eventual transition to an improved governance structure. As indicated above, the scope of FINCYT programmes or components is very broad and covers almost all the areas of government support of S&T and innovation activities. At the outset, this was certainly justified, not only because of the additional resources for S&T policy, but also because it could complement or replace less efficiently managed programmes or institutions in addressing the weaknesses of Peru's innovation system. To a large extent it represented a kind of institutional "leapfrogging". But, beyond FINCYT's commendable performance, its objectives and activities overlap those of institutions that may contend that they have more formal legitimacy.

Table 3.6. FINCYT programmes: eligible costs and subsidy rates

Programmes	Eligible costs	Amount of non-reimbursable financing
Technological innovation		
Individual enterprise projects (PITEI)	Equipment Material input Consulting fees Technical services Other	Up to 50% Up to 70% In case of collaboration with a university or research institution Maximum of USD 95 000
Collaborative enterprises projects (PITEA)	Equipment Material input Consulting fees Technical services Other	Up to 70% Up to 80% In case of collaboration with a university or research institution Maximum of USD 140 000
Research and development		
R&D projects in universities and public research institutes (PIBAP)	Personnel and equipment, material input, services, temporary posting abroad	Up to 90% of research project cost Maximum of USD 140 000
R&D projects of national interest (PIN)	Personnel and equipment, material input, services, temporary posting abroad	Up to 90% of research project cost Maximum of USD 300 000
Creation & strengthening of S&T capacity		
Doctorate scholarships abroad		Maximum of USD 80 000
Doctorate scholarships (domestic)		Maximum of USD 17 860
Master's scholarships and enterprise fellowships for graduate studies		Up to 50% of total cost Maximum of USD 6 430
Strengthening of S&T capacities	S&T equipment	Up to 80% of total cost Maximum of USD 96 500
Technological services to enterprises	Fees	Up to 50% of total cost Maximum of USD 30 000

Notes: n.a.: information not available; n.ap. : not applicable; values in USD are approximate.

Source: FINCYT, *www.fincyt.gob.pe/web/*.

One should not preclude the possibility of an eventual overhaul of the STI policy governance structures that would centralise the management of most STI funding programmes, apart from those funded by research institutions under the aegis of sectoral ministries. However it can be argued that the current arrangement is a temporary second-best solution that should be maintained until new and more efficient governance structures are put in place that could draw on FINCYT's experience but with an eventual separation of the various functions that FINCYT is currently performing. Until this happens, as it should, the envisaged extension of FINCYT should maintain its present scope, while benefiting in its operations from continuing evaluation exercises.

FIDECOM

As already mentioned FIDECOM (R&D Fund for Competitiveness) was allocated under the aegis of the Vice-Ministry of Industry and SMEs of the Ministry of Production with an endowment of about USD 65 million. It can provide grants to enterprises on a competitive basis for: *i)* innovation projects (in products, process and services), and *ii)* capacity-building projects based on technology acquisition and development, including training. A premium is given to collaborative projects.

FIDECOM became operational only in 2010 after the successful designation of FINCYT as the technical secretariat in charge of operational management. This "delegation of power" to FINCYT effectively allows FIDECOM projects to benefit from the same alleviation of regulatory constraints as FINCYT projects and allowed for a rather quick start of commitments once this issue was resolved (Table 3.7).

There is apparently no difference between the first type of FIDECOM projects and the FINCYT technological innovation component. This suggests possible duplication and overlap. At the end of 2010 another component was added to support technological innovation in micro-enterprises. To date very few projects have been funded under this component.

At this stage, there has been no evaluation of outcomes of FIDECOM support programmes.

Table 3.7. FIDECOM committed and executed budget on 31 December 2010

USD millions[1]

Programmes	FIDECOM budget	Committed budget		Executed budget[2]	
		Amount	Percentage	Amount	Percentage
Productive innovation	**56.1**	**5.1**	**9.0%**	**1.9**	**3.3%**
Individual enterprise projects (PIPEI)	17.6	1.4	7.9%	0.33	1.8%
Collaborative enterprises projects (PIPEA)	32.1	3.6	11.3%	1.5	4.7%
Micro-enterprises (PIMEN)	6.1	0.5	0.8%	0.006	0.0%
Creation & strengthening of S&T capacity	**17.9**	**-**	**-**	**-**	**-**
Strengthening of S&T capacities	17.9	-	-	-	-
Other[1]	**8.2**	**0.5**	**5.5%**	**0.27**	**3.3%**
TOTAL	**82.1**	**5.6**	**6.8%**	**2.2**	**2.7%**

1. Exchange rate: PNL 2.8 per USD.

2. The projects have an execution period of two to three years.

3. Includes auditing and administrative costs.

Source: FIDECOM (2011), Informe de Gestión, Fondo de Investigación y Desarrollo para la Competitvidad, Ministerio de la Producción, Lima.

Indirect support for enterprise R&D

In contrast to most OECD countries, Peru only provides direct support to enterprises' investment in R&D through innovation funds. There is no indirect R&D support scheme through fiscal incentives irrespective of the nature of the industry or the R&D project.[53]

Beyond the evidence that, when properly designed, they do have a positive effect on private R&D investment, fiscal incentives have the advantage of being a horizontal measure that does not discriminate between sectors or technologies and, in principle, is more cost-effective in terms of management when it is automatic (not subject to administrative vetting procedures). Moreover, foregone fiscal revenues are expected to be compensated by future increases in such revenues from expected higher profits by innovative firms that benefit from the incentive.

Nonetheless, some countries do not use this instrument. The main reasons relate to the possible distortions and windfall profits that such fiscal incentives can create. Several reasons can be advanced. First, some countries are of the view that the fiscal system should be essentially neutral as regards the nature of investment. Second, exceptions can open the way to dubious and uncontrolled demands coming from vested interests. Third, in the case of R&D, fiscal incentives can create distortions between profitable innovative enterprises that benefit from the incentives and not (yet) profitable innovative start-ups that may not. Another important reason is that *ex ante* or *ex post* control systems are necessary to ensure that the investment that gives rise to the fiscal benefit really involves R&D.

In Peru, the decision against such incentives is probably related to the importance attached to the neutrality of the tax system *vis-à-vis* private investment, to the risks associated with pressures from vested interests and to the enforcement of control procedures. Other reasons may also justify such a decision. They are linked to the respective advantages of direct and indirect support measures in promoting private R&D and technological development given the country's industrial structure and the gap between a small minority of firms with innovative capacity that could benefit from the incentive and an overwhelming majority for which direct support instruments are better adapted.

Typically, R&D tax incentives benefit enterprises with experience in research activities and are mainly used by these firms to complement their own resources for incremental innovation projects. It is therefore not an instrument that is likely to induce enterprises that innovate little or not at all to engage on a path requiring investment in R&D.

Compared to tax incentives, direct funding support programmes, such as broad-based innovation funds or sectoral funds, allow for more targeted support not only to R&D but also to other innovation and technology-upgrading activities. They provide implementing agencies with the opportunity to direct resources to areas believed to yield the greatest social returns in line with policy priorities. Direct support programmes can also customise subsidy rates according, for example, to the size of enterprises and the existence of collaborative arrangements. Funding can be more effectively directed towards S&T capacity building in priority industries or technologies that can increase productivity and and/or create spillovers.

For all these reasons, the development of a tax incentive system may not be currently in order in Peru. This issue could be revisited when the range of enterprises able to benefit has expanded and spillovers are more likely. At present the most important question concerning the influence of the tax regime on R&D investment is whether such investment should be considered as expenditures to be written off against profit, as argued above.

The Canon Law provisions to fund research infrastructure

Since the 2004 amendment of the Canon Law, 20% of the proceedings accruing from the Canon levy on the mining sector are to be devoted to the development of S&T capacity in regional public universities. Between 2004 and 2008 these transfers amounted to approximately USD 170 million. However the Canon Law provisions and the MEF's control over the conditions under which public investment is authorised (*i.e.* the resources cannot be used for expenditures other than physical infrastructure) have led to a "freeze" on a large share of the resources. (Another cause has been the limited absorptive capacities of regional universities.) In particular, strict compliance with the Canon provisions does not allow the resources to be used to strengthen the human resources component of S&T activities. This situation has led to a waste (and sometimes a diversion) of these resources and a paradoxical situation in a country that suffers from an overall deficiency in S&T investment.

In recent years the stringent rules and procedures that limited the efficient use of Canon resources have been somewhat loosened by the MEF (Garfías Dávila, 2009). Part of the Canon resources can be now used to develop infrastructure for teaching activities. The provisions of the Canon Law and the conditions for the use of the resources should be amended further to strengthen the S&T capacity of the regions and give universities greater discretion in managing these resources. Changes in the following directions could be considered:

- Funding of chairs and postgraduate research scholarships and fellowships in S&T fields.
- Funding of collaborative research projects between universities and other institutions (*e.g.* PRIs, CITEs, private enterprises), including honoraria received by academic researchers.
- Performance wage incentives to academic researchers submitted to external evaluations.
- Development of non-physical S&T infrastructure such as information systems and technology transfer offices (TTOs).

3.4. Policy mix issues and blind spots

A policy mix can be defined as the relative balance of programmes and instruments dedicated to specific S&T policy areas and implemented to achieve the overall objectives of S&T and innovation policy. There are no norms in this matter as policy mixes depend on diagnosed weaknesses of the innovation system and evolve with the dynamics and consolidation of that system in a changing domestic and international environment.

The emphasis placed on various policy areas is also shaped by other factors: the institutional settings in which S&T and innovation policy priorities are defined and funded through the budgetary process, the balance of power among stakeholders with an influence on the policy-making process, the architecture of institutions in charge of policy implementation that compete for resources, and by framework and regulatory conditions that impinge upon the performance of the innovation system.

As argued above, Peru does not have an explicit STI policy with agreed strategic orientations, but a multilayered body of largely uncoordinated policy actions which accommodate vested interests and are more or less independently designed and carried out by various ministries and public institutions. This situation is aggravated by the low level of overall resources devoted to STI and a lack of integration of the innovation system which leads institutions to pursue individual rather than collaborative strategies. While some policy initiatives, when efficiently managed, have had positive results, it seems that the main developments that have brought some coherence to the system are those that "bypassed" the national legal, institutional and regulatory frameworks because their design and implementation modalities were largely defined in the framework of loans with multilateral financial institutions.[54] However, while such developments can initiate a virtuous process and provide useful lessons, they cannot replace a revamping of the policy making framework.

Fragmentation and co-ordination failures

In Peru, the process that should lead to an effective policy mix is hindered by certain factors that limit its ability to address the main weaknesses of the innovation system in an integrated manner and kick-start a virtuous dynamics with good leverage of public investment on private innovation performance:

- Governance. Most components of the innovation system are weak and poorly articulated and there is no functioning governance system with a comprehensive vision than can effectively engage in priority setting and co-ordinate policy orientations across ministerial departments and follow up on budgetary appropriations and policy implementation by dedicated agencies or institutions. This results in a fragmentation of programmes that lack critical mass, synergies and complementarities.
- Institutional functionality. The functions of policy design and programme funding and management (*e.g.* CONCYTEC), and sometimes programme implementation (in some public research institutions) are often confused. These distinct functions call for different types of responsibilities and competencies. Moreover such confusion can create conflicts of interest, with the result that resources are appropriated for internal management purposes rather for funding of projects.
- Operational functionality. Some funds and institutions have excessively broad missions that encompass the range of S&T policy areas (generation of knowledge and human capital development, private-sector R&D and innovation, technological development, diffusion and transfer). These functions may require different types of responsibilities and competencies. It should however be recognised that in the case of FINCYT the decision to give it a broad scope was the most appropriate one and a second-best solution.

- Overlap of responsibilities and duplication of support programmes between institutions or funds that operate in similar policy areas with little co-ordination and few synergies. This aggravates the chronic critical mass problem and reduces the efficiency of support programmes.
- Institutional rigidities and a legalistic culture that hinders the development or the effectiveness of new policy instruments within the existing institutional architecture (*e.g.* Canon Law for regional universities, SNIP procedures, governance system of universities).

Some blind spots

Fragmentation and failures to co-ordinate are partly responsible for some of the blind spots or weaknesses and the inefficiency of certain programmes in Peru's S&T policy portfolio. Some of these blind spots or weaknesses are in the following areas:

- Mission-oriented programmes to be developed in collaboration between research centres and the private sector require co-ordination by ministries and/or public institutions for their design and funding. In the many countries with such programmes these have benefited from multiannual funding and been implemented through public-private partnerships (see Box 2.7) and/or through dedicated research funding allocated through competitive calls.
- Intermediary institutions active in knowledge transfer and the provision of technology upgrading services to SMEs already have a certain level of absorptive capacity. However, CITEs' capacities for applied research and technological development could be enhanced. Support to transfer activities through sectoral research institutions and CITES is mainly supply-oriented and limited resources are available to SMEs to undertake technological assessments of production processes or of potential innovative projects.
- Effective cluster policies go much further than the provision of technological services by CITES to participants in producers' associations or PROMPERU's support to business associations. Evidence from OECD countries or regions indicates that efficient cluster policies should have both a supply and a demand component. They should focus on the provision of common S&T infrastructure and intangible services to firms to enable them to increase their knowledge absorption and exchange capacities and put innovation at the core of their development strategies (OECD, 2001, 2007a).
- Procurement policies. Many OECD countries or regions pursue active public procurement policies to encourage enterprises' innovative capacity and better respond to pressing social needs in areas such as health, environment, energy, education and transport (OECD, 2011a). In Peru such policies are largely inexistent. As the experience of other countries illustrates, an active public procurement policy at both national and regional levels, when compatible with international trade rules, can be a potent driver of innovation and strengthen public-private collaboration in submissions to public tenders for social infrastructure and for goods and services with a high technological content.
- Intermediary institutions dedicated to the provision of financial services better adapted than the traditional banking system to the needs of new technology-based firms. The lack of such services impairs the development of such firms in areas in

which Peru has significant competitive advantages owing to its natural resources endowment (*e.g.* biodiversity).

Transparency of the policy mix

The policy mix approach casts a fresh look at the relationships between the portfolio of support programmes, the corresponding budgetary appropriations and regulatory reforms. As such it helps overcome budgetary inertia, even if care must be taken to strike an appropriate balance between policy changes and policy stability. This approach requires appropriate budgetary information, organised so that it is possible to account for public expenditures by broad policy areas.

Presently, this is hardly the case in Peru as its policy mix is more implicit than explicit and has been constructed *a posteriori* on the basis of resources allocated to different policy areas. Unfortunately, this promises to be a difficult exercise in Peru. The current budget classification does not allow it; management costs in some public research institutes introduce biases in the amount of resources allocated to S&T activities; the institutional funding of research activities in the higher education sector is often opaque; the overlap of programmes among institutions complicates accounting. However, this issue is important and addressing it is essential for monitoring and assessment purposes.[55]

3.5. Moving towards a more efficient STI policy

Political commitment

Reaping the economic and social benefits of investment in science and technology takes time and continuity. Sustained political commitment, involving consensus building among stakeholders in determining national priorities and the social visibility of the benefits to the economy and society as a whole, is essential to a successful S&T and innovation policy. Oversight processes are needed to ensure that priorities are effectively addressed in the design of innovation policies and reflected both in budgetary appropriations and institutional arrangements for implementation. The scientific, economic and social outcomes of increased public investment should be highlighted in due course in the public debate over STI policy.[56] This underlines the importance of accountability.

Political commitment should reflect a social consensus that transcends political boundaries. It needs to be maintained over time by the executive and legislative branches of government and should not be captured by vested interests.[57] There are no examples of developed or emerging countries that have succeeded in putting knowledge and innovation at the core of their development strategy without such a long-term commitment.

Guiding principles

Sound macroeconomic and framework conditions

A sound and stable macroeconomic framework contributes to improved business confidence in the private sector. When it underlies growth, as it has in Peru, it reduces uncertainty and helps create a climate conducive to investment in innovation with expected longer-term returns. However the benefits from a good macroeconomic

environment can be limited by institutional and regulatory conditions that hinder innovation-related investment, transfers of public resources to the private sector and public-private collaboration. Institutional and regulatory frameworks must be revisited in the light of innovation policies.

Effective governance

Effective governance is predicated upon the fulfilment of the following conditions:

- *Political commitment* at the highest executive levels of government regarding adequate budgetary appropriations in support of STI activities and their allocation to ministerial departments and/or autonomous public agencies.
- *Efficient consensus building* processes involving relevant ministerial departments and major stakeholder institutions in the setting of S&T and broad innovation orientations and priorities.
- *Institutional functionality*. As highlighted in Box 3.5, a clear distinction should be made between policy formulation and policy implementation to ensure more efficient management and better accountability. Two other arguments underpin this good practice: on the one hand these functions require different types of competencies and are subject to different accountability requirements and, on the other, their confusion may generate conflicts of interest.
- *Accountability and evaluation*. Regular evaluation of support programmes and institutions receiving public support should be the norm, with practical consequences for further rounds of support. However, a balance must be struck between the need for periodic adjustments based on evaluation and the stability of support programmes to ensure their long-term impact on the behaviour of beneficiaries. Regular audits should also check that budgetary appropriations earmarked for S&T are effectively spent in that area.
- *Monitoring the performance of the innovation system*. At a broader level, good governance also implies a system of information that produces, on a regular basis, a set of internationally comparable statistics and indicators that makes it possible to monitor the performance of the innovation system and benchmark it against quantitative policy objectives and other countries' performance. In this area Peru lags well behind OECD countries but also most other Latin American countries, such as Chile and Mexico.

Policy implementation

- *Operational functionality* and consolidation of the support system. This involves the reduction of unwarranted overlaps among implementing agencies to ensure that they concentrate on their core competencies, to reduce management and transaction costs, and to avoid the duplication of programmes of less than critical mass which may be a pervasive problem in Peru. As in many countries, different institutions or implementing agencies can usefully join forces to fund collaborative programmes, such as those between public research institutions and the private sector. In this case management rules should be defined at the outset.[58]
- *Implementation and funding of projects*. Programmes and projects can be supported through diverse financing instruments. For funds to private-sector projects matching funds should be the preferred mechanism. They could be

complemented by means such as guarantees in order to leverage contributions from financial institutions. The eligibility criteria for the types of innovation-related expenditures should be clear and restrictive. Sound, professional and timely evaluation procedures need to be established for the selection of projects. This requires lean delivery processes that avoid unnecessary red tape, as well as panels that include experts able to assess the scientific or technological relevance of projects and their business viability. Assessment panels should include foreign experts should be included.

- *Funding of public research institutions*. Best practices in most OECD countries and in many others involve three different sources of funding for public research institutes, including in higher education: *i)* institutional funding of programmes chosen and developed by these institutions (block grants), with the funding mainly based on performance criteria; *ii)* project-based competitive funding; and *iii)* revenue from the provision of S&T services or participation in collaborative projects with the productive sector.
- *Co-ordination and co-operation*. The operating rules governing the financing of programmes or projects should allow for a premium (priority or higher rate of subsidy) to collaborative ventures.

3.6. Improving the governance structure and institutional reforms

At present Peru lacks a structure that fulfils the conditions for effective governance as described above. In fact the dilution of governance responsibilities and the gap between the formal responsibilities entrusted to CONCYTEC by the 2004 S&T Law and its ability to exercise them make it necessary to establish a new institutional framework. This may require new legislation. It should not of course jeopardise efficiently managed support programmes.

Governance architectures in OECD countries: differences and commonalities

In most policy areas governance structures involving specific ministerial competences are well established and largely similar, but this is not the case for STI. The OECD area has a wide variety of STI governance architectures. Less than half of member countries have a science and technology (or science, technology and innovation) ministry. In the others this competence is shared among various ministerial departments[59] which usually include those responsible for higher education, for the promotion of competitiveness[60] and/or for sectoral matters.

Because of the broad scope of issues that impinge upon innovation performance and cut across ministerial competencies, a "whole-of-government" approach is increasingly used to shape innovation policy. This means that whether or not an STI ministry exists sound governance practices involve an inter-ministerial co-ordination process. It may be headed either by the minister in charge of STI, when there is one, or by another ministry or at a higher level (*e.g.* president or prime minister). As highlighted above (Box 3.4), governance practices also include the involvement of S&T councils with the participation of stakeholders from the business and the research communities. The role of such councils varies from an advisory capacity to responsibilities for defining strategic orientations and making recommendations on the policy mix and on regulatory reforms.

It should be stressed that governance structures have to evolve with the consolidation of innovation systems and increasing complex interactions among STI players. This may lead to a reshaping of ministerial responsibilities and co-ordination mechanisms. Korea offers a particularly illuminating example (Box 3.6).

Box 3.6. Evolution of STI governance in Korea

The growth of S&T expenditures in Korea has been accompanied by two distinctive changes in the S&T and innovation (STI) system. One was the rapid increase in and diversification of players and stakeholders, which resulted from the expanded role of S&T in socio-economic development. The other was the increasing complexity of institutional linkages between STI players and stakeholders. These trends underlie the evolution of the governance of the system over the last four decades, a period during which the important role of public expenditures on S&T in catalysing the performance of the innovation system and the government's commitment have never been questioned.

A central role of the Ministry of Science and Technology (MOST) in the 1960s and 1970s

During this period STI policy primarily focused on promoting technological learning in industry and S&T capacity building. STI governance was essentially a matter of channelling resources to a rather small number of players: *i)* support to (mainly large) private companies to acquire, assimilate and improve imported technologies, and *ii)* funding of government research institutes (GRIs) and a limited number of universities. Given the political commitment to S&T, increasing resources and budget co-ordination were not an issue, and the centralised system organised around MOST was generally effective.

Increased involvement of other ministries in the 1980s and 1990s

In the 1980s, Korean STI entered a period of growth and expansion. STI policy shifted towards technology catch-up through indigenous R&D. A number of other ministries started developing programmes to foster private R&D and innovation. This led to a rapid increase in R&D investments in the government and private sectors. This development was very positive in the sense that the STI policy domain expanded, but it also created several problems:

- *Inefficiencies due to absence of critical mass*: increased R&D investments in too many small projects.
- *Lack of coherence*: excessive reliance on bottom-up approaches to formulating R&D programmes.
- *Redundancy and duplication*: increased inter-ministerial competition over turf and resources.
- *Weak industry-science interactions*: mismatch between demand for technology and supply of R&D.

The creation of the National Science and Technology Council

In 1999, the government undertook a major restructuring of the STI system to eradicate the sources of inefficiency in the STI system through the creation of the National Science and Technology Council (NSTC). This body is chaired by the president of Korea and composed of ministers dealing with STI issues and the minister responsible for the budget. It is responsible for STI policy directions and priorities for resource allocation, and co-ordinates STI policies and the activities of sectoral ministries.[1] Even though the NSTC was composed of and chaired directly by the president, it was unable to overcome inter-ministerial rivalries. In 2004, action was taken to address this issue:

- MOST was given responsibility for basic research and responsibility for applied research was transferred to sectoral ministries.
- An Office of S&T Innovation (OSTI) was created within MOST as a co-ordinating agency with officials from the same ministries as NSTC as well as experts from the science and technology community. OSTI was entrusted with the role of secretariat to NSTC.

…/…

Box 3.6. Evolution of STI governance in Korea *(cont'd)*

Government reorganisation, dissolution of the Ministry of Science and Technology and new governance setting

As the pre-eminence of MOST in co-ordination matters was increasingly challenged, the government dissolved it in 2008 as part of a government restructuring which also affected other ministries:

- A new Ministry of Education, Science and Technology was created. Its responsibilities encompass non-industry-related basic research programmes and institutions.
- The responsibility of industry-related basic research programmes was transferred to the newly created Ministry of Knowledge Economy (MKE). It takes over functions previously under the Ministry of Industry and Energy and the Ministry of Information and Communication, dissolved in 2008.
- In 2011, the NSTC was transformed from a high-profile but rather symbolic body to a high-level administrative authority with powers of decision for policy and budget. This put an end to more than 40 years of MOST's pre-eminence in policy formulation and governance.

Lessons for latecomers

- In the early phase, a simple centralised governance system may be more effective in promoting growth of resources rather than their efficiency; resource allocation should generate positive feedbacks between supply and demand. A strong and stable political commitment to allocate resources to increase S&T investment in line with absorptive capacities is crucial.
- A centralised system of governance involving the ministry responsible for the budget and other ministries with a role in S&T support programmes is more efficient than a system led by a single ministry.
- Co-ordination requires more than organisational systems and processes. Far more important is information and data on STI activities and resources that allow for evidence-based decisions. Without such information, co-ordination may facilitate conflicts and distortions.

Source: Based on Park *et al.* (1996); OECD (2009a).

Possible options for Peru

Given the negative effects of the absence of an effective governance structure on the S&T policy-making process and on the performance and integration of Peru's innovation system, it is absolutely essential to undertake institutional reforms in order to improve governance arrangements. While taking due account of Peru's characteristics, these new arrangements should comply with the principles outlined above. Several options inspired by practices implemented in various countries are discussed below, but none will achieve the desired improvement if some prerequisite are not fulfilled:

- *Compliance with the good governance principles* outlined above, and in particular political commitment, formal interdepartmental co-ordination processes and institutional functionality.
- *Safeguarding of efficient support programmes* in the framework of new institutional arrangements.[61]

Three options are presented and discussed on the next pages.

A new Ministry of Science, Technology and Innovation

Under various denominations such ministries exist in a number of countries.[62] In Peru the creation of such a ministry has been advocated by CONCYTEC as well as by a large fraction of the academic community. The experience of countries in which this option was adopted indicates that it has been effective when the ministry is able to provide effective inter-departmental co-ordination of policies that affect innovation performance. This co-ordination allows for reaching consensus on budgetary appropriations among ministries and implementing agencies. In Peru, however, only the Presidency of the Council of Ministers and the Ministry of Economy and Finance possess the required governance authority. Moreover, the strong political commitment to science, technology and innovation that would ensure resource increases can only come from this political level. Given ministerial rivalries, it is doubtful that a new STI ministry would be able to steer an inter-ministerial co-ordination process effectively.[63]

A variant of this model involves a high-level ministerial council on S&T policy, typically attached to the prime minister's office. Included are the ministers in charge of S&T policy, of finance and of other ministries that oversee policy areas that affect S&T and innovation performance and make competing claims on the system's resources, especially human resources. This variant has usually been implemented in two situations:

- When an inter-ministerial co-ordination structure for STI policy and a sub-ministerial government body in charge of S&T were already in place and its status was raised to cabinet level. This was the case in Argentina where a co-ordination structure (GACTEC)[64] was created in 1996, and the Ministry of Science, Technology and Productive Innovation was established in 2007.
- When a ministry in charge of S&T policy predates the creation of the high-level ministerial council to promote a holistic view of policies that influence the performance of the innovation system and to ensure interdepartmental co-ordination of a system in which new players have an increasingly important role. This is what happened in Korea (Box 3.6). This variant represents a phase in the evolving role of an existing ministry.

In neither case do the conditions that underpin the creation of an S&T ministry or efficient co-ordination across other ministries exist in Peru. Moreover, given existing rivalries, it is far from certain that the creation of a dedicated ministry would resolve the issue of budgetary allocations to S&T. The more likely outcome would be a reallocation of resources through their "capture" by specific constituencies that would leave other sectoral ministries "out of the game". Therefore, this option carries risks. In this context the following two alternative governance options deserve a particular attention.

Horizontal policy design with a principal implementation agency

This option is exemplified by Mexico, where an inter-ministerial co-ordination structure (General Council for Scientific Research, Technological Development and Innovation) was established by the 2002 S&T law (DOF, 2011). This council, which includes non-governmental stakeholders, entrusts its executive secretariat to CONACYT (National Council for S&T) (Box 3.7). In practice the council largely remained a formal institution, with the result that CONACYT, a decentralised agency under the Presidency of the Republic, with administrative autonomy and a board chaired by the Minister of Economy, remained the unchallenged government body in charge of designing S&T

policy and implementing it in co-ordination with the sectoral ministries that fund R&D programmes and the Ministry of Finance for budgetary appropriations.[65]

This situation could give rise to potential conflicts as the body theoretically in charge of overseeing the co-ordination process, the General Council of Scientific Research and Technology Development, has not fully played its role. In practice, however, the co-ordination process works adequately because CONACYT has resources and support programmes that facilitate collaboration with sectoral ministries in the implementation of programmes it co-finances or complements. CONACYT's leading role in the governance process is therefore acknowledged and remains unchallenged. One of the main weaknesses of this governance option is the range of CONACYT's responsibilities from policy design to policy implementation and programme funding (OECD, 2009b). CONACYT is also in charge of monitoring the performance of the Mexican innovation system and the evaluation of policies and support programmes.[66]

Box 3.7. Mexico's General Council for Scientific Research, Technological Development and Innovation

Mexico's General Council, established by the 2002 S&T Law, is chaired by the President of the Republic. It is supposed to meet twice a year and includes:

- Ministers in charge of departments deemed important for STI development and/or in charge of S&T programmes (*e.g.* Finance, Economy, Education, Health, Energy, Agriculture and Rural Development, Environment, Transport and Communication).
- CONACYT's Director-General (Executive Secretary of the Council).
- General Co-ordinator of the Advisory Forum for S&T (FCCyT).
- President of the Mexican Academy of Sciences.
- Three representatives of the business community.
- One representative from the public research institutions system.
- General Secretary of the National Association of Universities and Higher Education Institutions.

The Council's main functions are to:

- Set the main orientations for the promotion of STI activities and their contribution to the country's socio-economic development, and approve the programme [developed by CONACYT] on the basis of these orientations.
- Define policy priorities and criteria for budget allocation to STI related programmes; approve the consolidated S&T budget; prepare an annual report on the execution of this budget.
- Approve new policy initiatives and support programmes proposed by ministerial departments.
- Define organisational frameworks to facilitate the co-ordination of and interactions between public and private actors involved in S&T activities and to foster the decentralisation of such activities.
- Establish an independent system for the monitoring and assessment of the outcomes and efficiency of STI policies and the performance of the STI system.

The Council can create intersectoral committees to facilitate policy articulation among ministries and the development of joint programmes. These committees, co-ordinated by CONACYT, can include representatives of the research and business communities.

In practice the Council has remained largely a formal body and did not function effectively in the definition of policy priorities or budgetary allocations. Good governance was impaired by CONACYT's dual role in policy design and policy implementation.

Source: OECD (2009a), Mexico's 2002 S&T Law, updated in 2011 (DOF, 2011).

The adaptation of this governance structure to the Peruvian situation would mean the creation of an inter-ministerial co-ordination body steered by PCM or MEF. Like CONACYT in Mexico, an agency – which could be a revamped CONCYTEC – would be the executive arm of the inter-ministerial body with responsibility for policy design and evaluation. It would also take over responsibility for the design of support programmes, implementation and funding in areas currently covered by FINCYT. Such a scenario can only be considered under the following conditions:

- Effective leadership by PCM or MEF in steering the inter-ministerial co-ordination body, notably for the definition of policy priorities and their translation into budgetary appropriations.
- Effective involvement in the co-ordination of sectoral ministries such PRODUCE and those in charge of agriculture, health, education, environment, energy and mines, transport and communications. These ministries would maintain responsibility for support programmes and/or sectoral institutions in charge of policy implementation, including their funding and assessment.
- Workable co-operation between CONCYTEC and sectoral ministries in the design and funding of sectoral programmes.
- The "new" CONCYTEC's proven capacity to manage support programmes with the same efficiency as FINCYT and termination of CONCYTEC programmes that currently duplicate FINCYT's.

Co-ordinated policy design with distinct implementation agencies

Chile is the archetype of this option (OECD, 2007b). It does not have a single ministry responsible for devising and carrying out S&T and innovation policy. This responsibility was entrusted to the Ministerial Committee for Innovation, chaired by the Minister of Economy.[67] The committee develops policy orientations on the basis of recommendations made by the National Council on Innovation for Competitiveness (CNIC), which is composed of non-government stakeholders, administers the Innovation for Competitiveness Fund (FIC) and is responsible for co-ordinating the different public agencies in the National System of Innovation for Competitiveness (SNIC) which are responsible for the funding and management of S&T support programmes (Box 3.8). The main public agencies included in the SNIC are:

- The National Commission for Scientific and Technological Research (CONICYT) which reports to the Education Ministry. It is the main institution responsible for the implementation of public support programmes for scientific and technological research and the development of human resources in S&T.
- CORFO-INNOVA, a specialised department of the Ministry of Economy's Development Agency, is responsible for promoting business innovation, technology transfer and entrepreneurship.
- The Foundation for Agricultural Innovation (FIA), which reports to the Ministry of Agriculture, is mainly responsible for promoting innovation and disseminating technological information in the agricultural sector.

Box 3.8. Toward a more cohesive and better governed national innovation system: Chile

Until the mid-2000s, Chile did not have formal structures to guide the formulation, implementation and evaluation of a national innovation strategy. The result was a fragmented system with duplicative initiatives and investments often thinly spread across knowledge areas. In this vacuum, funding agencies defined policies implicitly in a weakly co-ordinated manner.

Inspired by Finland's experience,[1] Chile established in 2005 the National Council on Innovation for Competitiveness (CNIC), an independent advisory body reporting to the president, and subsequently the Inter-ministerial Committee on Innovation, led by the Ministry of Economy. These have been two critical steps in moving towards a more cohesive and better governed national innovation system.

The CNIC, composed by non-governmental stakeholders,[2] has played a critical role by developing and continuing to review an innovation strategy based on consensus, monitoring progress towards the goals of the innovation strategy, and recommending priority investments or programmes (*www.cnic.cl*). Generating awareness and consensus within society about the importance of innovation for Chile's competitiveness has been one of the CNIC's main priorities. Progressively building a national consensus creates the foundation for continuity and diminishes the risks of short-term innovation policies and "dynamic inconsistencies" due to political changes. The government and the CNIC complement each other on innovation awareness and consensus building. Moreover, because it is independent the CNIC has the opportunity to shape a lasting consensus in support of innovation in Chile.

The responsibility for definition and execution of innovation policy is entrusted to the Inter-Ministerial Committee for Innovation chaired by the Minister of Economy.[3] This Committee *i)* develops policy orientations and monitors execution; *ii)* in line with previously defined policy, approves priorities for allocation of the Innovation for Competitiveness Fund (FIC), a sort of second-floor fund (USD 250 million in 2011[4]) administered by the Ministry of the Economy; and *iii)* is responsible for co-ordinating the different public executive agencies in the National System of Innovation for Competitiveness (SNIC) that are responsible for the funding and management of S&T support programmes, mainly CORFO and CONICYT, which receive a fraction of their budget from the FIC.

The National Commission for Scientific and Technological Research (CONICYT) which reports to the Education Ministry, is the institution mainly responsible for the implementation of public support for scientific and technological research and the development of human resources in S&T.

The Chilean Economic Development Agency, CORFO, which reports to the Ministry of Economy is responsible for promoting business innovation, technology transfer and entrepreneurship, through its department InnovaChile.

Examples of policy recommendations made by the CNIC which have been adopted and implemented by the Inter-ministerial Committee on Innovation include:

- The creation of an R&D tax credit of 35% to support research by firms tied to accredited universities and technological centres and the scaling-up of the scholarship programme (Becas Chile).
- The implementation of cluster programmes in natural resource-based industries with competitive advantages, based on international competitive studies carried out under supervision of CNIC.
- The Basales Centres programme aimed at reaching critical mass in high-level research capabilities and promoting collaborative R&D.

1. The Science and Technology Policy Council of Finland.

2. The Council, established by presidential decree and not by law, is composed of 17 representatives of scientific and business communities. Its chair is appointed by the President of the Republic. It operates with a small secretariat (under 20 people) and has access to ample resources (a budget of nearly USD 3 million in 2011) to conduct evaluation, benchmarking and prospective studies.

3. The Committee also includes the Ministers for Education, Finance, Agriculture, Public Works and Transport and Telecommunications.

4. About a third of total public expenditures devoted to R&D and innovation.

Source: Teubal *et al*. (2010), OECD (2009c).

This governance system is very robust. It ensures an efficient inter-ministerial system for co-ordinating policy orientations, priority setting and budgetary allocations recommended by a public-private advisory council which includes the main S&T players and is responsible for policy monitoring and assessment. This system follows the new public management practices which separate policy design and implementation functions and emphasise a balance between management autonomy and accountability.

Recommended option and transition issues

On balance, given the importance of ensuring a high level of inter-ministerial co-ordination in policy making and budgetary appropriations and to keep in line with best practices for institutional and operational functionalities, the best governance option for Peru seems to be an adapted version of Chile's, adjusted to take due account of the legacies of the past and Peru's legislative and institutional characteristics. This option involves:

- The establishment by law of an Inter-ministerial Committee for Science, Technology and Innovation. It could include PCM, MEF, PRODUCE, and the ministries responsible for education, agriculture, health, energy and mines, transport and communications. With their inter-ministerial responsibilities either PCM or MEF could chair or steer the committee. Given MEF's role in budgetary allocation, oversight of public investment and regulatory frameworks, it is possibly better placed to chair the committee.
- CONCYTEC, with increased means and improved managerial efficiency, would have functions similar to Chile's CONICYT in supporting scientific and technological research (including infrastructure) through institutional and competitive funding, human resource development and assessment of public research institutions.
- MEF and PRODUCE would share responsibility for innovation funds focused on private-sector innovation and technology diffusion and transfer.
- Public research institutes would continue to operate under their respective ministries with a representative of CONCYTEC on their boards. Boards would be entrusted with the design and monitoring of their respective institutes' performance agreement.

As in Chile, the committee would have to be supported by a small S&T advisory council with a limited number of representatives from public research institutes, public and private universities, and the productive sector. This body would propose strategic policy orientations, the introduction of new policy instruments, the consolidation of support programmes, and reforms of regulations that impinge upon innovation performance. It could also be responsible for developing an information system to monitor Peru's S&T and innovation performance (based on international standards) and for preparing accountability documents. This important task needs to be carried out irrespective of the governance structure, but should be overseen by that structure. The design of the information system and the questions related to its development, implementation and maintenance could be the object of a study financed by the fourth component of FINCYT.

If this recommended option is adopted, it is suggested that an in-depth study could be launched within one or two years following its implementation to examine its merits in detail and develop more precise operational recommendations.[68] A study launched under the responsibility of PCM or MEF could also be financed by the fourth component of FINCYT.

This option as well as any new form of governance, including the creation of a new S&T ministry, raises important transition issues concerning innovation funds:

- The management of innovation funds or programmes partially funded by loans from multilateral financing institutions so as to facilitate their transition to the framework of the recommended governance arrangements.
- Their eventual incorporation in the system of support exclusively funded by the Treasury.

The importance of these funds in promoting Peru's S&T capacities and innovation performance is discussed in previous sections of this report. There are many reasons for their success but the main ones are:

- They catalysed latent demand for research and technological development and helped to increase S&T capacity across the economy in both the public and private sector better than earlier types of programmes.
- Their design and focus matched the recognised weaknesses of Peru's innovation system they were or are addressing.
- Their efficiency in management and delivery, notwithstanding the many regulatory (and at times institutional) obstacles they have encountered.

The case of INCAGRO has already been dealt with through its incorporation into INIA. Provided management quality is maintained at previous standards, which is far from being ensured, this move is in line with the proposed governance arrangements.

For FINCYT, this report recommends extending the fund for additional phases under the aegis of the MEF with the same management and monitoring procedures as those presently in place, or even better ones if some regulatory obstacles are removed or alleviated.

In a more distant future, these funds and programmes or their successors that would no longer be funded by multilateral financing institutions will eventually have to be financed by the Peruvian Treasury. In this case their design, focus and management may have to change in accordance with type of governance chosen and its evolution.

Monitoring, evaluation and accountability

Whatever the option is chosen, good governance implies regular monitoring of the performance of the innovation system as well as evaluation at different levels (such as the system, programmes and institutions) with feedback on policy design and implementation. Peru is currently very weak in these areas. As this review has pointed out, Peru has no established statistical information system for monitoring the country's performance in the STI area and benchmarking it against standard internationally comparable indicators such as those developed by the OECD. The development of a system which provides reliable and timely indicators is not easy and may require substantial resources. It implies:

- The decentralised provision of basic statistics on S&T-performing institutions according to centrally defined guidelines which comply with international standards; INEI could play a central role in this.[69]
- A budgetary classification that makes it possible to identify clearly government expenditures devoted to S&T activities by programmes, institutions and S&T areas.
- A distinction between resources devoted to S&T activities by sector of performance and sector of financing.

In the STI policy area Peru lacks a culture of evaluation: assessments of institutions, policies and support programmes are either non-existent or limited to simple auditing exercises that describe the resources allocated and/or number of projects funded, as well as checks that delivery procedures have been respected. Various steps should be taken to improve this situation:

- Policy-implementing institutions should be encouraged, or even required, to launch or, preferably, commission periodically independent evaluations of the socio-economic outcome and impact of their programmes.
- Innovation surveys should be organised periodically according to best practices to better monitor the determinants of and obstacles to enterprises' innovative investment, as well as the impact of government support programmes on this investment.
- Regular audits should also check that budgetary appropriations earmarked for S&T are effectively spent in that area.

3.7. Concluding remarks

This report acknowledges Peru's remarkable economic achievements of the last two decades. Wise macroeconomic policies together with structural reforms have improved the allocation of resources at the microeconomic level. Greater international openness regarding trade and foreign investment has underpinned growth that is among the best in Latin America and has helped to reduce poverty.

However, the report warns that sustaining good performance over the medium to long term requires tapping into new sources of growth, considering the limitations of past and current drivers of growth, and notably the comparatively low level of productivity, which is among the lowest in Latin America. The main avenue is diversification of the economy towards higher value-added activities in order to extract more value from existing comparative advantages while creating new ones in areas in which strengthened national capabilities can match novel opportunities on domestic and world markets.

This requires above all ensuring throughout the Peruvian economy and society better use of existing knowledge and technologies while encouraging more contribution to the advancement of knowledge. This means more innovation-oriented strategies for all actors – individuals, firms, central and local governments, universities, public research organisations, and non-profit organisations – whose actions and interactions determine the direction and pace of Peru's socio-economic development.

Therefore, this report argues that accelerating the maturation of the still nascent and poorly articulated Peruvian innovation system should be a key policy priority. It claims that in addition to maintaining the good economic fundamentals that are necessary to encourage and reward risky innovation-related investment, a new round of structural reforms should be considered with a view to strengthening the institutional framework and incentive structures that determine the overall level and socio-economic impact of the country's innovation activities. With a focus on the role of central government, it proposes the following prioritisation of government initiatives.

The government should act on six fronts:

- Improve overall governance structures to ensure greater participation of the business sector and more effective leadership and coherence in the formulation, implementation and evaluation of policies in support of research and innovation.
- Enhance the contribution of the education system by implementing long overdue institutional reforms. In the academic sector there is an urgent need to raise the quality and social relevance of curricula and research, as well as to increase capabilities to engage in national and international innovation networks. This will involve better accreditation processes, accountability and other relevant regulations and infrastructures.
- Assign a clearer role to public research institutes, based on the results of a rigorous evaluation of their current operations and taking a prospective view of desirable interactions with other actors in the evolving innovation system.
- Continue to strengthen other elements of the innovation infrastructure that play a crucial role in the commercialisation and diffusion of knowledge and technologies, such as the CITEs and organisations involved in IPR, metrology, certification and standards.
- Pursue regulatory reform based on an assessment of the impact on innovation of current legislation regarding the tax treatment of business R&D, the mobility of public institutions' researchers, and public investment in R&D and innovation, including through public-private partnerships.
- Increase budgetary support to effective incentive programmes for business or public-private R&D and innovation-related activities where proven market or co-ordination failures inhibit optimal investment, using delivery channels (programmes or funds) with a proven track record.

Some of these initiatives will take time to bear fruit and transitory imbalances in the innovation system will have to be, when possible, counterbalanced by transitory measures. It is important to ensure that these do not discourage longer-term solutions. The issue arises especially for budgetary support to business R&D and innovation as weak demand combines with regulatory and other obstacles on the supply side to maintain private and public-private R&D investment at a very low level. So far multilateral financing institutions have played a crucial role in helping to break this vicious circle and, according to this report, the funds and programmes they have supported should remain in place for some time, as they address enduring market failures efficiently. However, they will eventually have to be financed by the Peruvian Treasury as an integral part of the national innovation system. The government should therefore be prepared to adapt their design, focus and management to the evolving governance of this system.

Notes

1. For instance the Peruvian Marine Institute (IMARPE) established in 1964.
2. *Consejo Nacional de Investigaciones* in Spanish.
3. The model resulted from recommendations emanating from discussions between the Peruvian and the US Academies of Science. Also considered were the possibility of support from the US Academy of Science to Peru's institutional build-up in S&T policy and collaborative research activities between the two countries.
4. It has been argued that ITINTEC could have attempted to play a more integrative role if it had developed a more ambitious strategy (Marticorena, 2007). As long as CONI continued to have an institutional existence, even with little means, such a strategy would have been difficult.
5. The Mining S&T Institute of Peru (INCITEMI, later transformed into INGEMMET), the Fishing Technological Institute (ITP), the National Telecommunications Research and Training Institute (INICTEL) and the Industrial Technology and Technical Standards Institute (ITINTEC) (GRADE, 2010).
6. See for instance Kuramoto and Torero (2004) on the mining industry as an example of the sectoral innovation system in the 1970s and 1980s.
7. Throughout this period FONDECYT, the CONCYTEC fund meant to channel resources to S&T and innovation-related projects, was hardly operational owing to insufficient funding.
8. To counteract the dramatic consequences on the academic research potential and on the emigration of researchers, the government created at the end of the 1980s, the government created the Special Fund for University Development (FEDU), essentially financed by parafiscal taxes, to finance academic research projects, which it did for a while until universities started to increasingly used this fund to cover wages and other regular operative operating costs. This led to a drastic curtailment of FEDU at the beginning of the 1990s.
9. As suggested by the experience of Korea when it was still a developing country in the 1970s or more recently that of Chile, proactive development policies that foster an innovation-led structural change are in fact compatible with sound macroeconomic policy and not detrimental to the efficiency of the resource allocation process.
10. ITINTEC was in fact dismantled in 1992.
11. However, during this period two important innovation-related institutions in the agricultural sector were created in 1992: the National Institute for Agricultural Research (INIA) and the National Service for Agricultural Sanitation (SENASA) which has mainly a regulatory and phytosanitary mission.
12. The definition is an institutional one and not the conceptual tool widely used by many countries for assessment and policy-making purposes. The list of institutions or agents belonging to SINACYT is not limitative. In practice, its main purpose seems to be to assert CONCYTEC's steering role in policy making, a role that CONCYTEC was not able or was not given the means to fulfil.
13. USD 25 million is from a World Bank loan, USD 6.5 million from the Peruvian government and USD 11.5 million from the private sector.
14. USD 25 million is from an IDB loan and USD 11 million from the Peruvian government.

15. Raised to more than USD 82 million by the end of 2010.

16. These are comprised of a share of the Corporate Tax and royalties collected from mining, gas, oil, hydroelectric, forestry and fishing firms.

17. Most OECD countries have budget lines for approved and executed budgets in the field of R&D and/or support to innovation by ministries that fund these activities, either directly or through institutional budgets of decentralised agencies.

18. All OECD member countries and an increasing number of non-members collect data on R&D expenditures and government budgetary appropriations and outlays for R&D (GBOARD) on the basis of definitions and methodologies provided by the OECD Frascati Manual. Peru's last R&D/S&T survey was carried out in 2004. It was issued with a warning regarding the reliability of its results given the sampling biases and did not provide data on R&D expenditures by sources of funding.

19. Budgetary resources allocated to innovation funds increased in 2010, mainly through the launch of FIDECOM operations and the conclusion of the second phases of FINCYT and INCAGRO but not to a point that changed the balance in Table 3.1.

20. This has notably been the case for INCAGRO. FINCYT has a more flexible mechanism place and control is carried out *a posteriori*.

21. For instance more than a year elapsed between the decision to create FIDECOM and the establishment of the modalities for its management and disbursements.

22. Similar market failures may also lead to enterprises to underinvest in training their personnel.

23. Such systemic failures can be the consequence of factors such as information asymmetries, regulatory barriers and institutional rigidities.

24. The globalisation of innovative activities, the increasing importance of services and demand-driven innovation, the development of knowledge outsourcing and R&D and collaborative ventures, the development of multidisciplinary approaches to R&D activities, etc. (OECD, 2010b)

25. For an overview of these changes and the factors that influenced them see OECD (2005b).

26. For a comprehensive overview of S&T councils in OECD countries see OECD (2009c).

27. Including the Ministries of Economy and Finance (MEF), of Production (PRODUCE), and of Foreign Trade and Tourism (MINCETUR).

28. Such a definition departs from the most commonly accepted notion of National Systems of Innovation (NIS) as conceptual tools to better understand the determinants of innovation performance emphasising the knowledge integrations among institutions and to frame policies on the basis of that understanding (OECD, 1997). Moreover, even in the context of that institutional definition, apparently no actual role is given to the SINACYT as a set of stakeholders in any kind of consensus building mechanism over strategic priorities. By Law SINACYT members are supposed to provide information on an annual basis on "the elaboration of indicators and standards necessary to assess the performance of STI activities at national and regional levels". No guidance is provided to define what this task entails without any guidance of what this task entails. Given the extremely poor state of STI statistics and indicators in Peru it is clear that this task has never and could not have been accomplished.

29. However, in October 2005 institutional responsibility for CONCYTEC was transferred from the PCM to the Ministry of Education. This considerably weakened CONCYTEC's horizontal role in policy design and co-ordination (Marticorena, 2007).

30. This was notably the case for a law proposing the establishment of an R&D and innovation fiscal incentive scheme (Marticorena, 2007).

31. In interviews conducted during the OECD field missions practically no reference was made to the plan.

32. However, in 2005 CONCYTEC took the initiative to launch ENCYT 2004, Peru's first survey on science, technology and innovation. Unfortunately this survey suffered from many limitations related to coverage, sampling and scope of collected information and no new survey has since been launched.

33. In Mexico the 2002 S&T Law introduced a new budget classification that in principle allows the tracking of all federal funds allocated to S&T under a same budgetary line (OECD, 2009b).

34. There are no real differences between FINCYT's PITEI and PITEA programmes and FIDECOM's PIPEI and PIPEA as regards eligibility, types of costs eligible for support or project selection processes.

35. In this case the problem is less important and may be due to the fact that the management of FIDECOM has been entrusted to FINCYT and that adding resources from the Treasury to FINCYT proved difficult in the framework of the IDB loan agreement.

36. Or a "multi-layer collage accommodating vested entrenched interests", as described by a high-level policy official during the OECD field mission.

37. The comparison with Chile is particularly striking. Chiles makes all information regarding policy orientations, resources allocated to implementing agencies and to programmes available online on the website of the National Council on Innovation for Competitiveness (CNIC). No such information is available on the CONCYTEC website.

38. A scheme which proved to be more complicated to implement in the case of INCAGRO than in that of FINCYT.

39. *Presupuesto por Resultados* or Results-based Budget.

40. Links between the fulfilment of performance agreements and budget appropriations should however be flexible since implementing agencies, notably in the S&T area, face risks and uncertainties or are subject to regulatory obstacles that may affect performance.

41. This partly explains why INIA never managed to approach the performance of other agriculture research institutions in Latin America such as EMBRAPA in Brazil.

42. The evaluation-based accreditation system developed in the European Union in the context of the "Bologna Process" aim at achieving the equivalency of curricula and diplomas among universities is described in "Accreditation and Evaluation in the European Higher Education Area" (Schwarz and Westerheijden, 2007).

43. An example quoted in GRADE (2010) is that of INGEMMET, the Geological, Mining and Metallurgy Institute, overseen by the Ministry of Energy and Mines, which does not conduct research on clean and/or remediation technologies in the mining sector. There are of course exceptions, one being the Research Institute for the Peruvian Amazon (IIAP) under the aegis of the Ministry of the Environment. This institute has introduced a governance system that includes the participation of government and non-government stakeholders, including representatives from the five Amazon regions, in the definition of its research priorities. It has developed a research portfolio that is well-balanced between the protection and the

exploitation of Peru's biodiversity resources. Other cases of good practice are those of the National Institute of Health and the Peruvian Geophysical Institute.

44. This assessment was substantiated during interviews conducted by the OECD mission with the Arequipa government and the Regional Innovation and Technological Centre (CIDET) an institution created by the regional government.

45. No information on FONDECYT's total resources or distribution of resources per programme was made available to the OECD during or after its field mission. However, as CONCYTEC's budget in 2009 was around USD 4.69 million this sets an upper limit, especially if the conservative figure of 25% is retained for management and administrative costs, which were estimated at 30% in 2002 by Mullin (2002).

46. Evidence of this low level of funding is given by comparison with Chile in the area of doctoral scholarships. While FONDECYT devoted no more than USD 500 000 to postgraduate scholarships in national universities, Chile's CONICYT devoted around USD 64 million for such scholarships in Chilean universities and around USD 30 million for scholarships abroad.

47. This would also have raised potential conflicts of interest as INIA was also in a position to present projects and apply for funding.

48. In the first two phases more than 500 projects were implemented.

49. It is not in the scope of this review to conduct individual assessments of sectoral support programmes but various internal or external evaluations led to that conclusion, in particular Trigo (2011) and Ramirez-Gastón (2010).

50. A possible criticism of the programme is its weak articulation with institutions such as CITEs or funds that also promote innovation in the agricultural sector. This reflects the policy dispersion and duplication highlighted above.

51. This means that public support has a positive multiplier effect in terms of private R&D expenditure (input) and positive outcomes in terms of productivity, patents or market shares (output).

52. This means that public support enhances a learning process through which firms improve and diversify their modes of knowledge acquisition and broaden their modes of innovation, notably through increased co-operation (OECD, 2006).

53. Currently 22 countries have such incentives (OECD, 2010c). In some the fiscal incentive also covers non-R&D innovation activities. They may also exist at the regional level, as in the Basque country (OECD, 2011b). Some countries have different tax incentive rates depending on the size of the enterprise. Some give a premium to collaborative projects (OECD, 2003a).

54. Thus INCAGRO played a positive role in the steering of the "agricultural innovation system" through the variety of its programmes, and FINCYT did the same for the overall innovation system. Nonetheless, these programmes lacked the institutional legitimacy to engage in a participatory steering process.

55. In this regard Peru could usefully emulate the S&T budget transparency efforts undertaken by Chile's National Council on Innovation for Competitiveness (CNIC, 2008 and 2009).

56. Such a debate is taking place in Peru, albeit on a modest scale and mainly involving academic stakeholders. See for instance the recent publication, *Emergencia de la Ciencia, Tecnología e Innovación en el Perú*, (Villaran and Golup, 2010) and "En busca del tiempo perdido; Ciencia, Tecnología e innovación en el Perú" (Sagasti, 2011a).

57. In Latin American terminology this long term commitment is often called a "State Policy" *(Política de Estado)*. Of course, there is no "silver bullet" to achieve such a broad based consensus across political lines. S&T Councils play a useful role in forging such consensus. In all OECD countries, beyond possible differences of emphasis on the scope and magnitude of government interventions to foster innovation the legitimacy of public support to S&T is not an object of debate. In some countries or regions (*e.g.* Catalonia) exercises have been carried out to develop a consensus across party lines and involving unions (OECD, 2010d).

58. For instance the sectoral funds in Mexico which are jointly financed by CONACYT and sectoral ministries.

59. The situation is further complicated in federal countries where regions or states have constitutional competence over areas related to STI such as education (*e.g.* Germany, Spain, Canada).

60. Under various denominations such as the Ministry of Economy in Mexico and Chile, the Ministry of Industry in France or the Department of Business, Innovation and Skills in the United Kingdom.

61. As highlighted in a recent analysis of STI in Peru (Villaran and Golup, 2010), one of Peru's worst political practices is "borrrón y cuenta nueva" (erasing and starting anew). This is confirmed by the overview of the various phases of Peru's S&T policy presented in Chapter 2.

62. Argentina, Brazil, China, Korea, South Africa and Spain. In some countries the responsibilities of such ministries also encompass higher education as in Japan. In France, Germany, Norway and the Russian Federation there is a ministry in charge of research and education (or parts of the education system) and innovation policy is mainly the responsibility of another ministerial department.

63. In this regard, it is conspicuous that CONCYTEC's proposal to create an STI ministry states in Article 5 that "the STI Ministry would exert an exclusive competence [specifically excluding all other departments] in all areas of policy formulation and management of support programmes". Hence what is advocated is not co-ordination but extreme concentration and exclusion.

64. Gabinete Científico Tecnológico (S&T cabinet). This cabinet includes ministers with policy and/or funding responsibilities in the STI area.

65. CONACYT's share in total federal budgetary appropriations to support STI-related activities is about 30%

66. See CONACYT organic law, *www.conacyt.mx/Paginas/default.aspx*.

67. This Committee also includes the Ministers for Education, Finance, Agriculture, Public Works and Transport and Telecommunications.

68. Such a study was launched in Chile following the OECD review of its innovation policy (OECD, 2009c).

69. The OECD area has a variety of institutional setups for the implementation of S&T statistical systems, notably as regards the diffusion of guidelines for the compilation of basic statistics and indicators according to international standards.

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