

Executive Summary

The synthesis report (Part I of this volume) covers three topics, based on the findings in the main report on China’s innovation system (Parts II and III):

- From sustained to sustainable growth: China’s need for innovation as the engine for growth.
- The Chinese national innovation system: main features, performance and shortcomings.
- China’s current governance and policy for innovation and recommendations for improvement.

From sustained to sustainable growth: the need for innovation as the engine for growth

Underpinned by economic reforms and the “open door” policy, the Chinese economy has performed extraordinarily over nearly three decades. China’s re-emergence as a major power in the world economy is one of the most significant developments in modern history.

- The Chinese economy is now the fourth largest in the world and its macro-economic performance remains strong.
- China has become a major destination for foreign direct investment (FDI) and a trading nation of global rank, with an increasing share of high-technology products in its export structure.
- A significant and continuing increase in income per capita and an impressive reduction in poverty levels imply huge domestic demand for goods and services.
- However, despite China’s success to date, the current pattern of growth may not be sustainable. High rates of economic growth, industrialisation and urbanisation are putting increasing pressure on the sustainability of economic growth and social development owing to:
 - High consumption of energy and raw materials.
 - Environmental degradation which also leads to damage to human health.
 - Uneven distribution of the benefits of economic development across regions, and between urban and rural populations.
 - Large migration flows that contribute to rapid urbanisation and strain the social fabric and the environment.

Meanwhile, increasing openness and global competition continuously exert pressure on Chinese industry to:

- Improve its competitiveness, increasingly on the basis of technology ownership and innovative products.
- Upgrade the structure of Chinese exports from low-cost manufacturing to high-technology and high value-added products and services.
- Base Chinese exports on innovative Chinese firms rather than on the foreign-owned companies which today are responsible for nearly 90% of high-technology exports.
- In sum, China's economic growth and development have been very impressive over several decades. One continuing and major challenge is to achieve comprehensive sustainable development in the three major dimensions: economic, social and environmental. Fostering innovation is a prerequisite for, and can play a major role in, this transition.

The Chinese national innovation system: main features, performance and shortcomings

The Chinese national innovation system: strengths and weaknesses

Overview

Currently, China is already a major world player in science and technology (S&T) in terms of funding and human resources for research and development (R&D). However, output still falls short of the levels in OECD countries with similar levels of R&D expenditure. The inefficiency of key actors and of the NIS as a whole points to deficiencies in the current policy instruments and governance for promoting innovation as China continues to move from a planned economy to a market-based system.

If the government addresses these shortcomings by following international best practices, China has the potential to develop an NIS that will be a powerful engine for sustainable growth and facilitate the smooth integration of China's expanding economy into the global trading and knowledge system.

Main findings

- China has excelled at mobilising resources for S&T on an unprecedented scale and at exceptional speed: R&D spending has increased at a stunning annual rate of nearly 19% since 1995 and reached USD 30 billion (at current exchange rates) in 2005, the sixth largest worldwide. In terms of total number of researchers, it has ranked second in the world since 2000 after the United States and ahead of Japan.
- R&D output has also grown very rapidly. For example, China's share in the world scientific publications rose from 2% to 6.5% over the decade ending in 2004, and China already ranks second, behind the United States, in world publications on nanotechnology. Chinese patent applications account for 3% of applications filed under the Patent Cooperation Treaty (PCT) of the World Intellectual Property Organization (WIPO) and are doubling every two years.

- While the impressive investment in resources has contributed significantly to China's rapid socioeconomic progress in the last decade, it has yet to translate into a proportionate increase in innovation performance. One reason is that the capabilities for making productive use of accumulated investment in R&D, human resources for science and technology (HRST) and the related infrastructure have developed much more slowly, especially in the business sector, despite an increasing contribution from foreign investment.
- Foreign investment in R&D is expanding rapidly and its motivation and content are changing. Access to human resources has become a more important driver than market access, adaptation of products for the Chinese market, or support of export-oriented manufacturing operations.
- In parallel, and even more recently, a first wave of innovative Chinese firms have developed a global brand and expanded their operations abroad, in some cases with a view to tapping into foreign pools of knowledge through mergers and acquisitions and the establishment of overseas R&D.
- Some framework conditions for innovation are insufficiently conducive to market-led innovation, especially those relating to corporate governance, financing of R&D and technology-based entrepreneurship, and enforcement of intellectual property rights (IPR). Their improvement could create the necessary conditions for the operation of an open system of innovation in which indigenous innovation capabilities and R&D-intensive foreign investment could be mutually reinforcing.
- The public support system for R&D and some aspects of the institutional arrangements of the NIS do not yet sufficiently encourage increased R&D efforts and their translation into innovative outcomes. Except in some targeted areas, such as nanotechnology, there is still a wide gap between a relatively small basic research sector and massive technology development activities.
- China's NIS is not fully developed and is still imperfectly integrated, with many linkages between actors and sub-systems (*e.g.* regional *versus* national) remaining weak. To the outside observer it appears as an "archipelago", a very large number of "innovative islands", with synergies insufficiently developed between them, limiting spillovers beyond them. Spreading the culture and means of innovation beyond the fences of S&T parks and incubators by promoting more market-based innovative clusters and networks should now be an important objective.
- Regions have played and will continue to play a key role in the advancement of S&T in China. However, current regional patterns of R&D and innovation are not optimal from the perspective of the efficiency of the national innovation system. For example, they create too great a "physical" separation between knowledge producers and potential users. They are also not optimal from a social equity perspective as innovation systems in lagging regions risk remaining underdeveloped.
- Despite the rapid growth of all components of the HRST pipeline, from university enrolments in undergraduate studies to PhD programmes, and even taking into account the large potential for improving the productivity of HRST, the bottlenecks that will mainly constrain China's future development may come from shortages in the specialised human resources that are needed at various stages of

innovation processes. This also has important global implications given the current role of Chinese students in international flows of human resources.

International integration: opportunities and challenges

The rise of China as a significant player in S&T and innovation will have important implications for the global knowledge and innovation system, as China will inevitably and increasingly become integrated in the global system of knowledge creation, diffusion and use. China will be able to make a positive contribution to global knowledge production and use and thus to addressing global challenges. However, this will also create competitive pressures and give rise to concerns and issues that must be dealt with appropriately. It is important that China's emergence not be viewed as a threat and the outcome as a zero-sum game. China's successful integration into the global innovation system will require both China and OECD countries to maintain a spirit of dialogue and co-operation and an open attitude so as to avoid reverting to protectionist measures that impede trade and capital and knowledge flows.

Recommendations for improving governance and innovation policy

This report makes recommendations to the Chinese authorities in two key areas: improving framework conditions for innovation; and adjusting, differentiating and enhancing dedicated policies to promote science, technology and innovation activities.

Improving the framework conditions for innovation

- Promoting a modern and mature national innovation system in China entails, most importantly, framework conditions that are conducive to innovation by Chinese as well foreign entities. These include a modern system of corporate governance and finance, antitrust laws and, last but not least, effective intellectual property rights protection.
- Improving framework conditions is particularly important for China because it is still in a process of transition from the planned economy to a market system, and because policy efforts have so far mainly concentrated on S&T-specific policy measures. China should reap considerable benefits from developing appropriate framework conditions for innovation.

Dedicated S&T and innovation policies

General guidance and priorities

The Chinese government should work to:

- Enhance the innovation capability and performance of the Chinese business sector, which remains a weak link in the current NIS, with a view to fostering its absorptive capacities.
- Develop a modern set of institutions and related mechanisms for steering and funding public research institutes, whose role in knowledge production needs to be strengthened to support innovation in the NIS.

- Improve synergies between hotspots of innovation activities and spillovers beyond the fences of S&T parks; and strengthen the interaction between the various actors in the innovation system, notably between public research and industry.
- Derive an adequate mix of dedicated policies in the area of science, technology and innovation. These should be sufficiently differentiated while avoiding excessive proliferation and overlapping.

Specific recommendations

Adjust the role of the government, notably by:

- *Overcoming the legacy of the planned economy* by encouraging changes in the attitudes and methods of work of government officials so as to allow market forces, competition and the private sector to have a greater role.
- *Enhancing the role of government in the provision of public goods* in areas characterised by a prevalence of market and systemic failures, such as regional disparities, and in the delivery of public goods through science and innovation, including by addressing social and ecological issues.
- *Better balancing the role of government* between improving framework conditions conducive to innovation and providing dedicated policies aimed at supporting R&D and innovation.

Enhance framework conditions for innovation, especially with respect to:

- *Improving the enforcement of intellectual property rights protection*, as a condition both for attracting knowledge-intensive FDI and for increasing the propensity of domestic firms to innovate.
- *Fostering competition*, notably through the adoption of modern and effective antitrust legislation to encourage firms to put innovation more at the centre of their business strategy.
- *Continuing to improve corporate governance*, with a view to improving incentives for business to invest in R&D and innovation.
- *Fostering open and efficient capital markets* to support the founding of new and innovative ventures, entry into new markets and development of innovative products and services.
- *Implementing innovation-oriented public procurement policy with care* to avoid hampering China's prospects for joining the World Trade Organization's (WTO) Government Procurement Agreement (GPA), which will open public procurement markets abroad to Chinese firms, and those in China to foreign firms.
- *Using technology standards to foster innovation following international best practices*, in line with WTO regulations, avoiding distortions of national and international competition which may eventually stifle innovation.

Sustain growth of human resources for science and technology, particularly with regard to:

- *Sustaining growth of HRST* through measures to reverse trends such as the declining share of science and engineering degrees in the tertiary education system and the drop in the number of undergraduate degrees in science.
- *Increasing the quality and efficiency of researchers* by implementing reform measures aimed at raising the qualifications and efficiency of the workforce of public research institutes.
- *Providing incentives for investment in training* to help raise the currently insufficient level of business investment in this area and to address deficiencies in vocational training.

Improve governance of science and innovation policy by:

- *Creating a better framework for central and regional government relations and better co-ordination of regional innovation initiatives* with a view to ensuring the efficiency of the national innovation system as a whole.
- *Managing support programmes at arm's length* and making further efforts to ensure adequate separation of policy making from the operational management of funding programmes.
- *Strengthening evaluation* by developing necessary competencies, making evaluation a standard feature of the design and implementation of R&D programmes and funding for R&D institutions, and ensuring the independence of evaluation agencies.
- *Creating an interagency co-ordination mechanism* at the central government level to improve co-ordination across agencies and levels of government to ensure a better co-ordinated whole-of-government approach to the implementation of the National S&T Strategic Plan (2006-20).

Adjust the set of policy instruments towards:

- *Encouraging more in-depth R&D* with a view to addressing the wide gap between a relatively small basic research sector and massive technological development activities in many areas.
- *Avoiding high-technology myopia*, by paying more attention to other industries, such as traditional industries and the services sector.
- *Overcoming “programme activism”* by introducing new public programmes only when this is deemed the best way to address a specific market or systemic failure, and adjust existing R&D programmes to changing priorities, taking evolving needs of beneficiaries into account.

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- *Balancing spending on “hardware” and “software”* by giving more attention to “soft factors”, such as fostering public awareness of science, technology and innovation, the entrepreneurial spirit, and improving education and training in the non-S&T skills required for innovation, notably innovation management.

Ensure adequate support for public R&D, especially by:

- *Building on the strengths of public research*, in order to maintain the strong science base needed to support an enterprise-centred innovation system, while ensuring a better balance between mission-oriented research and research driven by market demand.
- *Striking a better balance between competitive funding and institutional funding of public research institutes*, by securing a sufficient level of stable core funding for public research, while using rigorous performance evaluations to ensure efficiency and adequate returns on the investment in public R&D.

Strengthen industry-science linkages, inter alia by:

- *Creating public-private partnerships for innovation*, aimed at fostering long-lasting co-operation in R&D and innovation between business firms and public research institutes or universities, drawing on OECD countries’ extensive experience in designing, establishing and operating competence centres for innovation over the past two decades.