

Innovation Policy

A Guide for Developing Countries

Conference Edition Overview



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Overview

Innovation Policy: A Guide for Developing Countries

The presentation of innovation policy in this volume offers a detailed conceptual framework for understanding and learning about technology innovation policies and programs and their implementation in different countries. Inspired by the experience of both developed and developing countries, the book focuses on the latter's needs and issues.

The publication's main audience is the policy-making community. It includes not only those who are directly involved with technology, industry, science, and education but also those in charge of finance and economics, and indeed the top government leadership, which plays a crucial role in successful innovation policies.

This overview follows the organization of the volume, which is divided into parts and chapters. Before a summary of the individual chapters, however, the main messages that emerge from the volume as a whole are briefly presented.¹ The approach to innovation policy proposed in this volume revolves around the basic questions: Why? What? How?

Why? The Innovation Imperative

Technological innovation has always been at the heart of economic and social development. And as such, it is therefore essential to the further evolution of the developing world. Today, additional reasons make renewed attention to technology even more compelling. First, the world is in the midst of a serious economic crisis, and technology can be a means of

relaunching or recreating economic activities worldwide. Second, major environmental challenges require wide-ranging changes in patterns of production and consumption. And third, the global technical system is undergoing a profound transformation based on information technologies and new technologies such as biotechnology and nanotechnology that are changing our world and our societies.

Innovation should be understood as the dissemination of something new in a given context, not as something new in absolute terms. While economically advanced countries naturally work at the technology frontier, developing countries have considerable opportunities for tapping into global knowledge and technology for dissemination in their domestic context. This ability will be decisive for initiating new activities, notably in service industries, for improving agriculture and industrial productivity, and for increasing overall welfare in areas like health and nutrition.

Innovation depends significantly on overall conditions in the economy, governance, education, and infrastructure. Such framework conditions are particularly problematic in developing countries, but experience shows not only that proactive innovation policies are possible and effective but also that they help create an environment for broader reforms.

What? The Government as a Gardener

Innovation can be approached from an organic and evolutionary perspective. An efficient innovation policy addresses the overall innovation climate, which goes far beyond traditional science and technology policy, and involves many government departments.

At the same time, government action can usefully focus on a few generic functions comparable to nurturing plants to help them grow. It can facilitate the articulation and implementation of innovative initiatives, since innovators need basic technical, financial, and other support (watering the plant). The government can reduce obstacles to innovation in competition and in regulatory and legal frameworks (removing the weeds and pests). Government-sponsored research and development (R&D) structures can respond to the needs and demands of surrounding communities (fertilizing the soil). And finally the educational system can help form a receptive and creative population (preparing the ground). For each of these functions, economically advanced as well as less advanced countries offer good practices that can be adapted to local contexts.

The firm backing of top leadership, such as the head of state or prime minister, is essential to the success of an innovation policy. It gives credibility to a national vision and facilitates the adoption of key measures for removing bureaucratic hurdles. It is also important to have efficient mechanisms that facilitate cross-departmental cooperation. By its very nature, innovation policy

concerns parts of government that usually work independently. Agile and flexible agencies for implementing innovation policy measures may be necessary especially for supporting specific industries, technologies, or communities.

The institutional challenges to innovation policy should not be underestimated, as it intervenes in institutional settings that are already “crowded” with organizations that are supposed to fulfill—or claim to fulfill—its objectives and functions. Careful policy reviews and assessments, conducted with the help of the international community, can facilitate needed adaptations.

How? A Pragmatic Agenda

Since in most countries, particularly in the difficult institutional context of developing countries, implementing innovation policy is a challenging task, a long-term strategy should be inspired by a philosophy of “radical gradualism.” That term refers to a sequence of finely tuned small, specific reforms and successful outcomes that paves the way for broader, institutional changes.

Depending on countries’ technological competence and the quality of the business environment, governments will need to choose their goals. After focusing on prime movers and creating innovation endowments (well-defined technology centers, science parks, or export zones), they need to build critical masses of innovative and entrepreneurial initiatives by promoting industrial clusters, actively attracting foreign direct investment (FDI), and possibly even creating new cities. The multiplication of entry points in the economic system will facilitate broader reforms. In all cases, local communities and governments must be mobilized. This effort requires adequate incentives such as matching funds and administrative frameworks that include the delegation of power.

To materialize and advance this strategic process of change, policy initiatives targeted to specific industries, sites, or communities are best conceived through a collective vision and implemented in a holistic manner. They can thus fulfill the different “gardening” functions evoked above. Industries benefit from the necessary technological infrastructures, skill provision schemes, export networks, trade and intermediary professional structures, funding mechanisms, and the like. Technology sites, such as export zones or science parks, should combine the needed services and be well integrated in urban settings and well connected to the transportation infrastructure, including international airports. Local communities, even the poorest, have unique knowledge and entrepreneurial potential that can be exploited with appropriate support from surrounding actors such as research and education establishments, the business sector, and nongovernmental organizations. Acting in concert, with efficient local and global networks, is essential.

Innovation is fundamentally the task of the private sector and entrepreneurs. But history has shown that in moments of major transformations and crises, the role of governments has always been crucial. They alone can assume

the launching of large-scale programs that help renew infrastructure while facilitating nationwide learning processes for innovative initiatives. Only they can legitimately impose and fund the adaptation of the educational, research, and other knowledge sources that are required to cope with deep and rapid technical change. This publication provides governments with ideas and tools to facilitate their tasks. A host of examples of policy actions from throughout the world are presented as a source of inspiration.

What Is Innovation?

In this volume, *innovation* means technologies or practices that are new to a given society. They are not necessarily new in absolute terms. These technologies or practices are being diffused in that economy or society. This point is important: what is not disseminated and used is not an innovation. Dissemination is very significant and requires particular attention in low- and medium-income countries.

Box O.1 provides examples of innovations in developing and emerging economies, ranging from the dissemination of new methods of eye care to the production of information technology (IT) components. Innovation, which is often about finding new solutions to existing problems, should ultimately benefit many people, including the poorest.

For understanding innovation, distinguishing high technology from low technology is not very useful, particularly in low- and medium-income countries.² High technology may not generate jobs and wealth, while low-technology developments and the exploitation of indigenous knowledge can lead to significant economic growth and improve welfare. The use of high technology in all sorts of products, processes, and services can be more important than producing it.

Innovation is distinct from research and in fact need not result from it. Innovations come from the entrepreneurs who make them happen and ultimately depend on a society's receptiveness. Innovation, therefore, is fundamentally a social process. The focus in this volume is on technological innovation, which is often accompanied by organizational and institutional innovation at both the micro- and the macrolevels.

The volume is a set of complementary chapters that form a structured whole. It offers a fairly exhaustive perspective on what innovation policy consists of and how it might serve concerned policy-making communities, from governments at the highest levels to managers of relevant organizations such as training institutions, R&D centers, or technological services.

Based on a better understanding of innovation, we now summarize the book contents, chapter by chapter. The volume is organized in three main parts that present the innovation policy concept, its functions, and the conditions of its implementation.

Box 0.1 A Few Examples of Innovations in Developing and Emerging Economies

- India's Aravind Eye Hospital deals with blindness in general and the elimination of needless blindness in particular in rural India. It reaches those most in need—the traditionally unreachable—through 20–25 weekly screening camps in villages. It also makes use of Internet kiosks in remote locations, where the information is sent electronically to a clinic for diagnosis. The Aravind eye-care system treats 1.4 million patients a year and, since its inception, has performed over 2 million operations and handled over 16 million outpatients.
- To regain prominence as a leading center of learning, the Bibliotheca Alexandrina, in Alexandria, Egypt, is playing a central role in the design, planning, and launch of a world digital library, in partnership with the U.S. Library of Congress and many other libraries around the world. This initiative, which includes digitizing its expertise, will make significant primary materials from cultures around the globe available on the Internet to people everywhere. These materials are to be accessible free of charge and in multilingual format.
- The Malaria Research and Training Center in Bamako, Mali, is internationally recognized for its contributions to research on malaria and the improvement of public health standards. Its researchers participate in both international (National Institutes of Health, Institut Pasteur) and local networks. It works with traditional doctors to create a source of immediate care in the Bandiagara region and has helped reduce the mortality rates of young children significantly.
- Intel's construction of a US\$300 million semiconductor assembly plant in Costa Rica came as a surprise to many. Twelve years after the decision to invest was made, the initial investment had created many benefits, some of them unexpected. Intel's two plants employ 2,900, but the industry in Costa Rica now employs 12,000. The local support businesses for Intel alone reflects a base of 460 suppliers. The investment decision was the catalyst for a realignment of Costa Rica's competitive platform as an investment location, which led to newly secured FDI in other targeted sectors.
- Tiny Estonia, a small Baltic state close to Finland, with a population of only 1.4 million, is leading an Internet revolution: its parliament has declared Internet access a basic human right. Estonia's well-educated, wired workforce and its liberal economic policies, low taxes, and low wages have helped make it an attractive business destination, especially for Sweden and Finland. It is also nurturing domestic innovation through key partnerships with Nordic neighbors. These include the development of devices such as doc@home, a hand-held electronic health kit that monitors blood pressure, stress, and weight and sends an alert to both patient and doctor in case of any sudden changes.

Policy Concept

Part One addresses the general approach to policy concepts, with a focus on two fundamental questions: (1) Why promote innovation? and (2) How to promote innovation? These chapters offer a historical perspective on innovation in

economic and social development and how government can promote innovative activity.

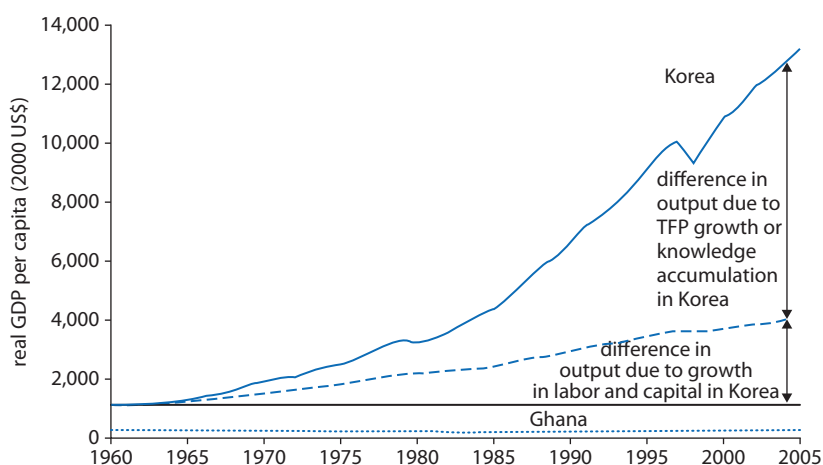
Chapter 1: Why Promote Innovation?

Innovation has always played a decisive role in the economic and social development of countries: it is the main source of economic growth, it helps improve productivity, it is the foundation of competitiveness, and it improves welfare. Figure O.1 presents an example of the effect of innovation on the economies of two countries and shows that two-thirds of the differences in the growth performance of Ghana and the Republic of Korea over four decades are attributable to technology-related improvements.

In today's "poly-crisis" context, innovation is imperative. Innovation capabilities are seriously challenged both in the developed and in the developing worlds. Economically advanced countries need a more solid foundation than growth driven by financial speculation as well as a truly innovative evolution of their economies and societies. Developing countries need ways to achieve broadly inclusive growth and innovation to benefit their many poor and not simply a narrow elite. More generally, adaptation to climate change, adjustment to limits of natural resources, and protection of biodiversity require fundamentally new patterns of production and consumption worldwide.

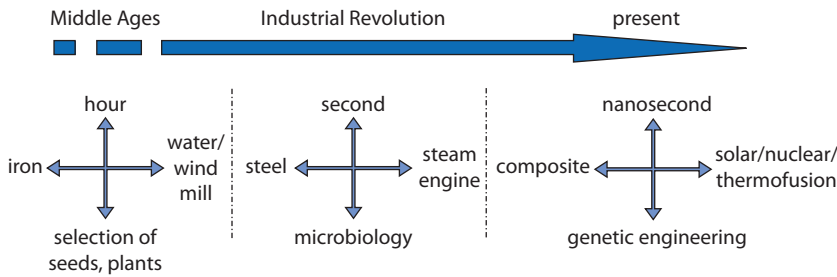
Finally, a more general reason to pay renewed attention to innovation is the current transformation of the world technological system in the wake of earlier transformations: the agricultural revolution in the Middle Ages and the Industrial Revolution in more recent centuries (see figure O.2). The four poles

Figure O.1 How Innovation Contributes to Growth: A Comparison of Ghana and Korea, 1960–2005



Source: World Bank 2007.

Note: TFP = total factor productivity.

Figure 0.2 Major Technical Systems from the Middle Ages through the Present

Source: Gaudin 1993.

around which technological systems are structured—energy, matter, life, and time—are affected by these upheavals.

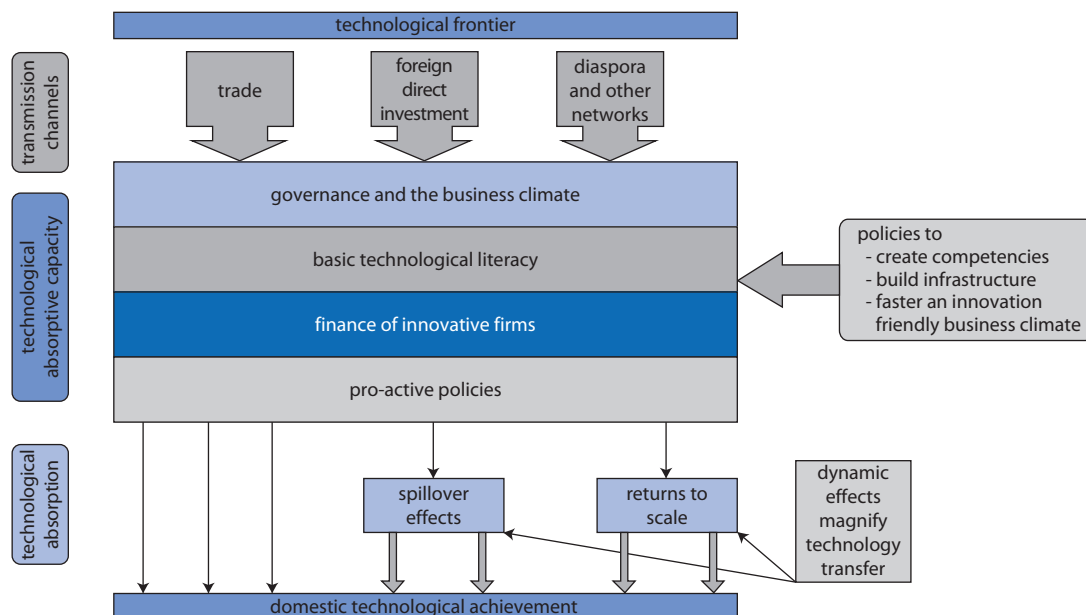
In the long term, all production systems are affected by such changes. They result in a cognitive revolution, which has today taken the form of a knowledge economy or knowledge society. The present situation is characterized by very rapid scientific and technical developments, and advances in science are making it possible to engineer new life forms and materials. The pervasive use of new technologies in all industries and activities requires new skills and new types of knowledge. Higher levels of education and greater flexibility in policies and institutions are necessary to take advantage of the innovation potential of such advances and to build the foundations of the so called knowledge economy (World Bank 2007).

Chapter 2: How to Promote Innovation?

Governments have traditionally played an important role in promoting technology, sometimes by directly supporting the development of technologies (in space, defense, and the like) or more indirectly by creating a climate favorable to innovation through various incentives or laws. Every society has to find the ways and means to innovate that correspond to its needs and capabilities. Its innovation climate is largely determined by its overall macroeconomic, business, and governance conditions. Despite the nature of these conditions in low- and medium-income countries, well-designed and -implemented innovation policies are very relevant. Moreover, they can be an efficient policy tool for triggering change and improvement in the country's overall framework conditions (this question is discussed in detail in chapter 8).

Figure O.3 depicts the diverse factors that influence developing countries' innovation capabilities. These countries can make considerable economic and social progress by tapping into globally available knowledge and technologies and adapting them to local contexts. Sources of foreign knowledge and technologies include trade activities such as imports of equipment and goods, multinational corporations, and skilled diasporas.

Figure 0.3 Determinants of Technology Upgrading in Developing Countries: Domestic Absorptive Capacity Both Conditions and Attracts External Flows



Source: World Bank 2008a.

Innovation processes germinate and develop within what are called “innovation systems.” These are made up of private and public organizations and actors that connect in various ways and bring together the technical, commercial, and financial competencies and inputs required for innovation. It is on such systems that government innovation policies are focusing.

Avoiding misconceptions about the source and process of technological innovation, often wrongly perceived as deriving mechanistically from research and science, is important. Fundamentally, innovations are carried out by entrepreneurs who exploit existing knowledge and technology to propose new products or practices and disseminate them. The sources of their ideas are more likely to be users, suppliers, and customers than scientific research. Therefore, the role of governments is to facilitate this process:

- By supporting innovators through appropriate incentives and mechanisms
- By removing obstacles to innovative initiatives
- By establishing responsive research structures
- By forming a creative and receptive population through appropriate educational systems.

One may compare the tasks of governments to those of a gardener who should (a) water the plants, (b) remove the weeds and pests, (c) fertilize the

soil, and (d) more broadly, prepare the ground so that plants can grow (see figure O.4). These four generic functions are detailed in Part Two.

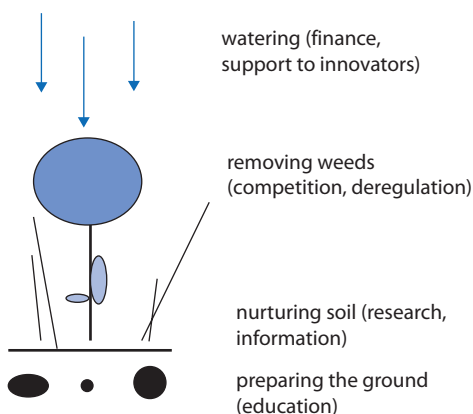
Moreover, the government can intervene in areas of particular importance. In industrialized countries, for example, large-scale programs have targeted defense, space, and health, among others. This volume focuses on the promotion of competitive activities in agriculture, industry, or services; the development of innovative sites (industrial zones, technology parks, new cities); and the stimulation of innovation in, or for, poor communities. Issues and experiences relating to specific applications are discussed in Part Three.

It is clear from the above that innovation policy is broader than, and different from, science and technology policy, with which it tends to be merged. It also takes place as part of an overall trend toward knowledge-based economic strategies (see figure O.5). Innovation policy requires action in many different policy areas—education, trade, investment, finance, and decentralization, among others—and it is the right combination of interventions in these diverse domains that creates a fruitful innovation climate.

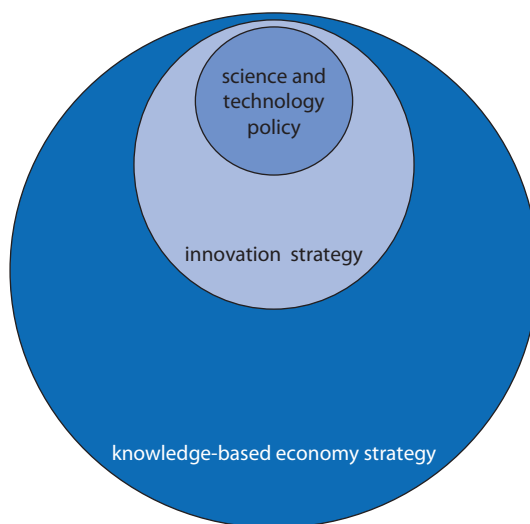
This approach to innovation policy reflects the evolving understanding of innovation policies in countries of the Organisation for Economic Co-operation and Development (OECD) over several decades (see box O.2). It explicitly recognizes the role of proactive and comprehensive government policies in establishing the overall framework and in fostering interaction among the actors, including different parts of government.

This fundamentally horizontal and interdepartmental innovation policy calls for a “whole-of-government” approach. It depends on the establishment of efficient government machinery able to ensure the needed coordination. Although its mechanisms must be adapted to existing institutional frameworks and to cultural backgrounds, models that placing a powerful coordinating

Figure O.4 Gardening Innovation



Source: Author.

Figure 0.5 Innovation Policy in a Broad Perspective

Source: Jean-François Rischard (personal communication).

Box 0.2 Innovation Policies in OECD Countries—50 Years of Experience

Innovation policy has come into its own with some difficulty, as it was crushed between two ideologies with very active lobbies. The scientific ideology promoted the idea that technology derives naturally from science so that governments need do no more than build a good science base. The market ideology considered that innovation occurs naturally in a good business climate and that governments should concentrate on this aspect. They need only maintain an open, competitive environment and, in addition, fund public goods such as basic research, which the private sector is unable to finance.

Although these two views acted in coalition to promote their interests, governments felt the need to take specific measures to promote innovation. Their efforts took advantage of World War II initiatives and governments' strong involvement in the development of defense technologies.

Government efforts in the 1960s and 1970s were largely inspired by a linear model of innovation and the idea that science and research needed to be pushed toward technological and industrial applications; many policy initiatives therefore aimed at supporting enterprises in their R&D efforts or at improving university-industry collaboration. Concomitant large-scale space and defense programs facilitated the development of breakthrough technologies that were later used in civilian applications.

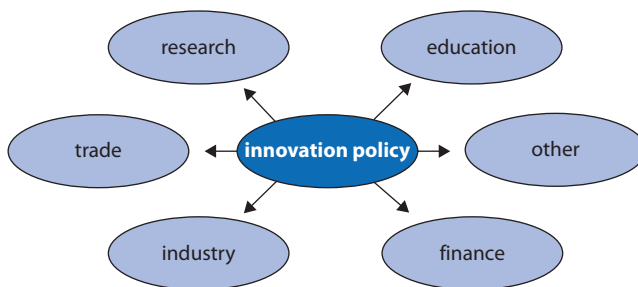
Recognition of the importance of interactions in innovation processes led to the concept of innovation systems, which was introduced in the literature in the late 1980s. This concept has been particularly fertile and has been variously understood. Most often, it defines the sets of interacting actors and institutions that provide the knowledge and financial resources required for the successful development of innovations.

Box 0.2 continued

Therefore, the first generation of innovation policy was replaced by a second generation in which innovation policy became more complex and aimed at facilitating interactions between the various actors and institutions involved in innovation processes: universities, research laboratories, banks for venture capital, and government agencies in charge of various sectors.

The boundaries of an innovation system legitimately include the “framework conditions” that encompass elements as apparently distant from the innovation process as the educational system or the macroeconomic environment. The OECD, for instance, explicitly includes framework conditions in its reviews of innovation systems. Thus, a third generation of innovation policy has appeared. It is inspired by a “whole-of-government” approach, in which all departments are potentially concerned.

Figure 0.6 Model for a Strong Innovation Policy



Source: Author.

body at the center of government allow innovation policy to have a pervasive influence (see figure O.6).

As *innovation* takes place primarily in local milieus with a concentration of knowledge, talents, and entrepreneurs; *innovation policy* is an important concern of sub-national governments that set up appropriate bodies (discussed in chapters 3 and 8).

Policy Functions

Part Two addresses the four “gardening” policy functions described earlier. It discusses how government can provide basic support to innovative activity (chapter 3), reduce obstacles to innovation (chapter 4), sponsor appropriate R&D (chapter 5), and foster a receptive and creative population (chapter 6). This part also considers the important functions of policy evaluation and monitoring (chapter 7).

Chapter 3: Supporting Innovators

Supporting innovators effectively requires putting the necessary technical, commercial, and other services as close as possible to them. Such services should therefore be organized locally through the efficient mobilization of concerned authorities and with the active participation of concerned “clients.” Services of strategic relevance for innovation policy include basic industrial services like promotion, marketing, and internationalization; technology extension services; metrology, standards, testing, and quality control; innovation in organization and management; and information and communication (see box O.3 for details of such services).

Supporting innovators also requires adequate financial support. Innovation expenses increase as projects develop and near commercialization. As such projects advance, government support should be increasingly based on the potential for commercialization and provided on a reimbursable basis.

Government measures in this policy area are many and varied. The difficulty in low- and medium-income countries is an overall lack of transparency and insufficient ability to evaluate projects. OECD countries often provide the

Box O.3 Business Services for Innovators

The following services potentially have strategic relevance for innovation policy:

Basic industrial services (promotion, marketing, and internationalization). Examples include assistance for direct investment abroad; assistance for inward investors; legal and financial assistance; financial services such as accounting and tax assistance; market information or other economic data; organization of and participation in trade fairs and other promotional events; partner search; and assistance for tenders of the European Union, World Bank, and other international organizations.

Technology extension services. Examples include assistance for patenting and licensing, for grant applications, for in-house R&D activities, and for subcontracting to research institutes; competitive intelligence (technological benchmarking, technology maps, information on emerging technologies); innovation diagnosis; review of current or proposed manufacturing methods and processes; participation in and organization of technology exhibitions; and technology brokerage.

Metrology, standards, testing, and quality control. Examples include calibration of equipment; quality certification; domestic standard; compliance with the International Organization for Standardization; technical assistance; demonstration centers and test factories; energy audits; materials engineering.

Innovation in organization and management. Examples include assistance for enterprise creation; interim management; logistical assistance; organizational consultancy, quality and training; productivity assistance; and incubation services.

Information and communication. Examples include advanced services for data and image transmission; assistance on communication strategies, telecom network connections and for the implementation of electronic data interchange systems; and database search.

business sector with fiscal incentives such as tax rebates to stimulate R&D and innovation-related efforts. Such incentives, which work best for medium- and large-scale industry, are generally not adapted to the situation of low- and medium-income countries, which lack sufficient accounting capabilities and have a large informal sector of small firms with no R&D expenses (for a more detailed discussion see chapter 5).

A key issue is support for the incubation stages of innovation. While the financing of the initial stage, invention, is the responsibility of the public sector and the financing of the late stage is clearly the responsibility of the private sector, difficulties arise in the intermediary stages: prototype testing, product development, market research, and the like. For these middle stages, public-private networks or groups that can bring innovation projects to fruition by gradually mobilizing private money and management competencies, marketing opportunities, and other essential elements are critical.

Chapter 4: Improving the Legal and Regulatory Framework

Removing obstacles to innovation means fighting anticompetitive and monopolistic practices, suppressing bureaucratic hurdles, and adapting the regulatory framework to support the search for and diffusion of novelty. It is a task that by nature should mobilize many areas of government—taxes, customs, procurement, and standards, for example—and requires vigilant action. This task is particularly necessary, but difficult, in developing country contexts.

The World Bank investment climate assessments and *Doing Business* surveys can help identify such obstacles. It is important to pay attention to those obstacles that are especially relevant to promoting innovation and entrepreneurship. These can vary widely from transfer of pension rights for academics who become entrepreneurs to customs rules affecting technology imports or inappropriate safety regulations. Equally important is the establishment of durable institutional mechanisms that are able to improve the regulatory and legal framework in this regard. The maintenance of competitive pressure on firms (especially on state-owned firms in transition economies) and of all forms of incentives to innovate is also an essential element of innovation policy.

The design and implementation of effective procurement policies is a major instrument for promoting innovation. The experience of OECD countries offers a few valuable principles: define performance standards rather than set technical requirements; maintain fair competition in tendering procedures; and offer small and medium firms a share of contracts (perhaps 10 percent). Such principles could be usefully applied by low- and medium-income countries, particularly for infrastructure projects, which are generally financed largely by multilateral or bilateral partners.

In international commerce, fair-trade rules should be strictly applied. Developed economies should abolish the practice of taxing processed products (with added value) more than raw materials imported from developing

countries, as it undermines the efforts of developing countries to climb up value chains.

Current international intellectual property rights regimes also need to be reconsidered. Regulations on access to technologies should be less stringent for developing countries, which cannot maintain costly protection systems or afford high licensing fees. Open-source regimes are also better adapted to the evolution and use of new technologies in software, genetic engineering, and related fields.

Chapter 5: Establishing Responsive Research Structures

Developing countries should focus their research efforts on what has already been accomplished and take good advantage of it. OECD countries, particularly the largest, account for the bulk of R&D effort worldwide, although Brazil, China, India, and Russia are also becoming significant investors in R&D.

In developing countries, public and university laboratories are often ivory towers, cut off from local needs and poorly funded and staffed. Establishing a responsive research infrastructure depends principally on creating adequate competencies and laboratories with adequate funding mechanisms. These should ensure an appropriate proportion of stable financing with other funding from contracts with industry, communities, or the government. When research activities are partly dependent on external resources linked to explicit demands, the research structures are more attentive and more responsive to economic and social demands. Research structures should be linked to global centers of excellence and should work with local communities to satisfy basic economic or social needs.

Public research laboratories play a fundamental role in developing countries and should be equipped to respond efficiently to the need for technical research, technical assistance, certification, and quality control—functions that the business sector, which has low R&D capabilities in developing countries, is unable to perform. It is not advisable to privatize (former public) research structures to perform such tasks. For its part, the university sector should pursue high-quality research, and the results should be assessed through international peer reviews.

Incentives in OECD countries that facilitate collaboration by the university or public research structure with the business community, such as joint R&D projects partly funded by government agencies, could usefully be adapted to low- and medium-income countries if their transparency is ensured. Transferring intellectual property rights to universities or public laboratories that perform government-funded R&D (as in the United States under the Bayh-Dole Act) can be an effective incentive for engaging in innovation efforts, but such practices can also undermine long-term research efforts of collective interest and of a public good nature. The issue becomes more complex when multinational corporations are involved, as they often are in developing countries.

Promotion of R&D in the business sector is important for stimulating adaptive research as well as for helping firms face global competition successfully, a growing concern for a number of emerging and developing economies. Table O.1 summarizes the incentives and mechanisms at the disposal of governments, with their respective advantages and disadvantages.

Chapter 6: Forming a Creative and Receptive Population

No recipe can “make” innovators through education. Everything that facilitates the combination of the complementary competencies needed for innovation, such as engineering, design, and business, however, can help, especially in postsecondary education. Moreover, in addition to “hard” skills, people need “soft” skills such as problem solving, communication, and teamwork and

Table O.1 Direct Support for Business Sector Research and Development

Instrument	Advantages	Disadvantages or shortcomings
Tax incentives for R&D	<ul style="list-style-type: none"> • Functional intervention, not picking winners • Less distortion, more automatic • Generally requires less bureaucracy to implement, although advisable to have monitoring and spot checks 	<ul style="list-style-type: none"> • Fiscal costs not clear in advance, may be high • Difficult to ensure additionality • Not very relevant for start-up firms that do not yet have taxable revenue streams • Blunt instrument, cannot target specific companies, although it can target specific sectors
Grants for R&D projects	<ul style="list-style-type: none"> • Allows specific targeting on case-by-case basis • Can control amount of subsidy granted • Can be given in tranches against defined goals • Can be structured as matching grants, which may help improve quality and efficiency 	<ul style="list-style-type: none"> • Requires large bureaucracy to administer • May not select the best project • Also difficult to ensure additionality
Accelerated depreciation for R&D equipment	<ul style="list-style-type: none"> • Reduces the capital costs of R&D projects 	<ul style="list-style-type: none"> • Does not provide incentive for noncapital costs such as personnel and material inputs
Duty exemption on imported inputs into R&D	<ul style="list-style-type: none"> • Reduces cost of world-class inputs if country otherwise has high import duties 	<ul style="list-style-type: none"> • Loss of tariff revenue • Is distortionary to the extent that it favors R&D over other activities
Venture capital to facilitate commercialization of research results	<ul style="list-style-type: none"> • Helps overcome financial market failure in making capital available to start-ups with no collateral or track record 	<ul style="list-style-type: none"> • Requires detailed knowledge of sectors to evaluate technical and commercial prospects • Often not successful because of limited deal flow and shortage of techno-entrepreneurs • Also requires developed stock market so that investors can sell off shares and reinvest in new projects

Source: Author.

a good work ethic. These skills are important for innovation, as well as more generally in the economy, as innovators need to interact with both the business sector and the community.

The rapid expansion of knowledge-based industries has increased demand for more highly skilled labor. Because most new jobs will go to “knowledge workers,” nurses in hospitals, farmers in automated stables, and workers in computerized factories will need to be able to manipulate symbols, read instruments, and interpret measures and data.

Today’s workers and innovators therefore need a broad set of platform skills based on a good general education beyond primary schooling. This requirement implies interventions in primary and secondary education. Vocational training also plays a vital role in preparing workers for the labor market but has often received too little attention from policy makers. A country’s youth must acquire—in addition to basic skills such as writing, counting, and the like—“functional literacy,” a good “technological culture,” and an ability to “think outside the box.”

The timely acquisition of basic literacy conditions the effectiveness of subsequent lifelong learning, which individuals will need to function effectively in a knowledge economy. Lifelong learning requires a new pedagogical model, which may include customized learning, learning by doing, and teamwork.

On-the-job training assumes an important role in the lifelong learning system: it builds on the acquired soft and hard platform skills, adds specific skills necessary for the job, and helps upgrade skills continually. Especially for low-income countries, education policy should include skills development in the informal sector, which can represent 30 percent or more of nonfarm employment in a number of developing economies. An appropriate focus is improving traditional apprenticeship training, as it is responsible for more skills development than all other types of training combined in developing countries, particularly in the least developed.

The biggest challenge to educational reform is a deeply rooted model of schooling. That model, characterized by traditional teacher-dominated classrooms and strong emphasis on rote learning, determines practices both inside and outside the education community. A second challenge is to make educational strategies part of a broader innovation agenda, an effort resisted by vested interests such as existing institutions and teacher organizations. The challenges for most developing countries are more complex than for developed countries, as they must deal simultaneously with problems of provision and quality under serious financial and institutional constraints.

In investing in a well-educated workforce, low- and medium-income countries necessarily face the risk of a large-scale brain drain. Experience shows, however, that appropriate mechanisms can facilitate a “brain circulation” process by which talented migrants reconnect with their country of origin as

efficient drivers of innovation in various forms: as creators of enterprises, openers of new markets, sources of venture capital, or facilitators of institutional reforms.

Chapter 7: Assessing Innovation Systems and Policies

Like any government policy, innovation policy needs to be properly monitored and evaluated at two levels: the monitoring of innovation systems and the assessment of innovation programs and policies. To monitor countries' innovation capabilities at the macro level, a number of international bodies, including the World Economic Forum with its competitiveness indexes and the World Bank with its Knowledge Assessment Methodology, have developed benchmarking based on regularly updated databases. Benchmarking helps countries position themselves with respect to their competitors and observe their progress over time.

These macro-benchmarking approaches, however, have to be complemented by more detailed indicators that monitor and assess innovation systems, specifically, firms' resources and performance in research and innovation and their diffusion of specific technologies. These indicators should be systematically documented through the use of regular surveys, possibly limited to well-defined samples, but rigorously conducted.

Measuring the impact of policy programs as well as their relevance is indispensable. Industrialized countries have significant experience with measuring the impact of schemes such as tax incentives for business R&D or public R&D support on innovation efforts and performance. Quantitative methods, based on field experiments, are also being implemented specifically for use in the developing world. They help countries decide whether to scale up programs that prove effective.

Overall, the most appropriate methods for evaluating innovation policy are the peer review processes that were initially developed in economically advanced countries, notably by the OECD, and that are gradually and successfully being disseminated in low- and middle-income countries. Such national reviews can serve as a tool for shaping policy initiatives and triggering policy reforms (as discussed in chapter 8).

Policy Implementation

Putting in place an innovation policy is a daunting challenge, as economically advanced countries have learned in the past decades, especially because established agencies and departments supposed to carry out innovation policy functions have crowded the field. Implementing innovation policy is even more daunting in developing countries where the institutional context is more difficult, resources are necessarily limited, and managers able to carry out these programs and policy measures are lacking.

A long-term strategic approach, based on a clear long-term vision, for gradually implementing the necessary changes is therefore useful. This step-wise approach focuses on interventions in specific industries, sites, or communities. These chapters in Part Three first describe elements of the strategic framework (chapter 8) and then examine the promotion of competitive industries (chapter 9), the building of innovative sites (chapter 10), and the support of innovation in, and for, poor communities (chapter 11).

A Strategic Framework for Change and Policy Making (Chapter 8)

The rationale for innovation policies is that they aim to boost technological change, which is considered the basic factor of economic growth, social development, and environmental adaptation. Countries differ considerably in their assets and capabilities, however, and developing countries are seriously affected by governance problems, lack of resources, insufficient infrastructure, and other constraints. It is therefore crucially important to provide orientations for making innovation policy work in different policy contexts, including the most difficult ones. This effort involves two complementary issues: the design of efficient and pragmatic policy agendas and the formation of institutional virtuous circles within an “evolutionary” perspective.

When designing pragmatic agendas for local contexts, policy makers should focus broadly on the sectors, sites, and groups of people with the greatest chances of successful development in view of their competencies, comparative advantages, and networking. Specific strategies will depend on the scientific and technological level of the country and the situation of its institutions and governance climate (see table O.2). In addition, it is important to distinguish between “prime movers’ agendas,” which entail starting from scratch with pioneer innovators, and “critical mass agendas,” which largely entail attracting newcomers to a going concern. The objective in all cases is to favor a successful “self-discovery process” through appropriate combinations of public and private actors that take the best advantage of the situation, whatever its constraints and opportunities.

Clearly, government priorities and policy actions will differ considerably according to the country’s technological competence and the nature of its business environment. For countries well equipped with R&D competencies and infrastructure and with a good business climate, it makes sense to pursue advanced research broadly along the frontier of technology, while facilitating—through encouragement of venture capital, technology brokering services, and training platforms—the development of innovation clusters in industries with international competitors.

For their part, low-income countries with limited knowledge endowments and a poor business and governance environment can focus their efforts on exploiting those endowments. They can tap into and adapt global knowledge and technology for their needs and support budding entrepreneurs through

Table 0.2 Three Types of Country Contexts and Their Strategic Focal Points

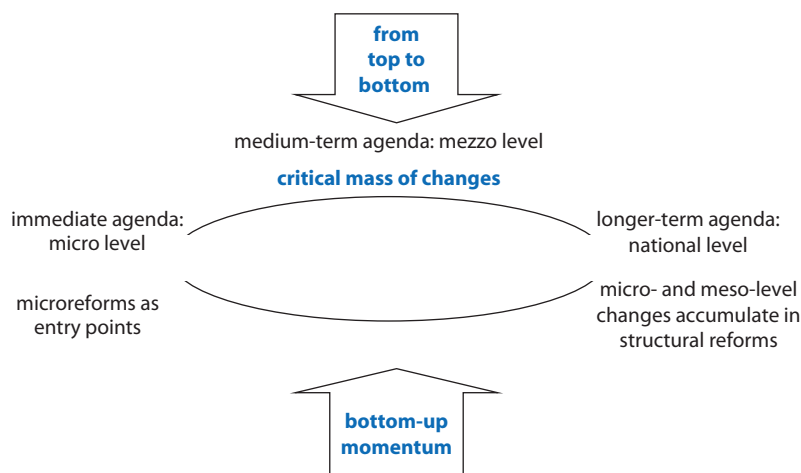
Technology capabilities	Strong institutional framework—innovation leaders' agenda	Tolerable and improving institutional environment—critical mass agenda	Weak institutions and investment climate—prime movers' agenda
High (frontier technology creation)	Development of proprietary technology through promotion of innovation clusters	Increase of value added of natural resources wealth and technology commercialization	Leveraging pockets of dynamism
Medium (adaptation of technologies available worldwide)	Development of innovation clusters and high value-added supply chains	Development of innovation clusters and high value-added supply chains	Leveraging pockets of dynamism
Low (adoption of technologies)	Creating knowledge endowments through higher education and attraction of foreign technology and expertise	Using exports as springboard to developing nontraditional exports as entry points for institutional and technology assets	Creating basic institutional infrastructure through a diversity of entry points

Source: Author.

well-focused measures (technical assistance, mobilization of intermediaries, building of export networks, and the like). These activities do not preclude undertaking some frontier research, but because their R&D capability is limited, they must focus carefully on needs that cannot be addressed by existing knowledge. In other words, the issue for developing countries is to strike the right balance between using or attracting existing technology and knowledge, adapting them to local contexts, and pursuing focused research, including on frontier technology when appropriate. This balance will of necessity be country specific.

Various instruments are available for creating conducive institutional frameworks through virtuous circles, engaging actors in the self-discovery process, and building problem-oriented networks. Examples include well-designed matching funds, foresight exercises, federal contest funds, and other means that are not very costly but that do involve collective mobilization of motivations and the knowledge of targeted communities.

A well-defined strategy should then be articulated to move gradually from micro- to macroreforms (see figure O.7). Change often begins with effective microreforms, which then serve as models or sources of motivation for building a critical mass of initiatives through a combination of top-down and bottom-up actions. As the intermediate level between microreforms and structured national policy reform, the mesolevel is critical for scaling up these reforms, because it creates the base for major reforms. Mass media should be actively mobilized throughout the process to generate public support.

Figure 0.7 Scaling Up Institutional Change from Microreforms to National Reforms

Source: Author.

Chapter 9: Promoting Competitive Industries

Developing competitive industries is a key element in the approach to strategic policy making proposed above. As a source of wealth, competitive industries are a matter of national pride, and it is therefore important to understand how governments can efficiently intervene to promote them.

The goal is not to pick winners but to create a dynamic and receptive climate in which innovative initiatives in specific industries can be articulated and implemented. A competitive industry cannot simply be created: what is needed is not direct support so much as it is indirect interventions at determining points. All sectors are concerned: agriculture (of crucial importance in developing countries both as a source of exports and for subsistence), manufacturing (where low-income countries with low labor costs have a competitive advantage), and services (where a wide spectrum of opportunities involve tourism, information technology services, and creative industries, among others). As illustrated by the success stories featured in the chapter—coffee in Rwanda, textiles in China, tourism in Costa Rica, IT services in Vietnam—a holistic approach is necessary to ensure that all the activities in an efficient value chain are properly functioning and delivered.

The development of innovative and competitive industries implies, as a prerequisite, an adequate infrastructure as well as a friendly business environment. The government also works closely with the concerned trade and professional groups to ensure that key technological services are provided and to facilitate active cooperation with research, education, and other sources of knowledge to raise the technological level and the knowledge content of products and services.

The development of competitive sectors clearly requires the engagement of high-level leadership and the formulation of a mobilizing vision, collectively elaborated, to attract essential investment, remove obstacles, and launch pilot initiatives. Such actions should be directed toward creating a climate for broad reforms (as discussed in chapter 8).

Chapter 10: Developing Innovative Sites and Cities

The successful development of specific sites—including techno-parks, industrial zones, or even new or renovated cities—depends primarily on the accumulation of a critical mass of talents and entrepreneurs, well connected to the global economy. The prerequisites are an efficient infrastructure, a lack of red tape, an attractive environment, and world-class knowledge institutions.

Technology and science parks are favored by policy makers, as they make innovation efforts highly visible. Experience shows, however, that few are successful. Success results from a series of conditions: a focused project, good positioning of specific technology and ambition, a clear and transparent agreement among partners (the business community, local and central authorities, and academic institutions), adequate integration in the urban structure (infrastructure, access), and good financing packages (including for start-ups).

For low- and medium-income countries, the creation of special economic zones, or industrial export zones, to which foreign subsidiaries are attracted with specific incentives, well-developed infrastructure, and a friendly business environment makes sense to the extent that it is part of broader national experimentation and learning processes, as China has shown in the past decades. Such zones require specifically designed mechanisms to facilitate transfer of technology and management competencies to local firms.

Innovative firms tend to develop today in what are called “industrial clusters,” that is, concentrations of firms in loosely defined geographic areas, with complementary rather than competitive assets, which operate through networks. They tend to be spontaneous developments resulting from business initiatives. Governments, however, can play a decisive role as “brokers” by setting frameworks for dialogue and cooperation and developing incubating and training instruments.

Cities are becoming critical platforms for innovative activities and competitive centers in the global economy (World Bank 2008b). Essential to their success are a strong identity and a clear strategy for exploiting a comparative advantage or for creating it by attracting a critical mass of talent, while mitigating the factors that negatively affect their attraction as centers of innovation. A holistic view of the city is important.

Chapter 11: Stimulating Pro-Poor Innovation

Four billion people, a majority of the world’s population, form the bottom of the economic pyramid. They have an annual income of less than US\$3,000 in

local purchasing power. The promotion of pro-poor innovation, or inclusive innovation, is essential.

Innovation can be encouraged in poor communities in two ways: first, through the organization of formal links with the surrounding research, education, or business sectors; and, second, through the exploitation of the specific knowledge and entrepreneurial drive present in such communities. Appropriate policy mechanisms are those discussed in the various chapters of Part Two, particularly in chapters 3 and 4.

Initiatives by businesses, academic institutions, or nongovernmental organizations (NGOs) to develop innovations in response to poor communities' needs exist throughout the world. Such initiatives require establishing close and durable connections with those communities and their innovative individuals and groups. The international community can be a great help through well-designed and -implemented support. A number of NGOs, for example, are assisting artisans in design, trade, and exports and are helping social entrepreneurs with funding and business management. When well designed, these programs have had very high social impact.

Poor communities have considerable resources in their traditional, indigenous knowledge. This potential remains unexploited except in a few areas such as pharmacology, generally to the benefit of multinationals. Systematic search, development, promotion, and protection (patent rights) of this potential are, however, not only possible but also fruitful as has been demonstrated in Africa, India, and elsewhere.

Poor communities in rural areas need help in ensuring their survival and preventing massive exodus to urban areas, even if urban concentration can pay off in the long term by raising gross domestic product per capita (see World Bank 2008). Maintaining populations in rural areas calls combining technological support; provision of equipment, seeds, and fertilizers for improving agricultural productivity; diffusion of health-care practices, schooling, and training efforts; and some infrastructure investments. Innovation policy thus becomes part of a broader, comprehensive plan.

Conclusion

Innovation is at the heart of economic development, social welfare, and protection of the environment. Today, the need for innovation is greater than ever, and the challenge to make these three objectives compatible is formidable.

Why Now?

Leveraging innovation is particularly important today, in what is the most severe global economic crisis since the Great Depression of the 1930s. By all indications, this crisis will last longer than most past crises because it is global in scope. No large region, therefore, will be able to lead a recovery by

increasing its demand for imports. Moreover, the reaction to the excesses of the financial markets will be to price risk higher and to raise the price of capital. That increase will have a negative effect on all countries that rely on foreign capital, particularly capital-scarce developing economies. Taken together, these factors will lead to lower investment and consequently to lower growth. The higher cost of capital will also mean less investment in R&D because of its relatively long gestation period and risk. It will therefore be necessary to make more efficient and innovative use of existing resources and existing knowledge.

The Need for Green Technology

People around the world are increasingly aware of natural resource and energy constraints on growth and of the environment's limited capability to absorb pollution and CO₂ emissions. These conditions put a premium on innovations that can help conserve energy and resources and on the development of more resource- and energy-efficient technologies and non-carbon-based technologies. Yet, the demand for green technology comes precisely at a time when the capital needed for its development has decreased sharply. Clearly, more cross-national efforts to find innovative ways to deal with this and other issues of global public goods are urgently needed.

Innovation in a Time of Crisis

History has shown that times of crisis are also times of innovation when institutional, mental, and other obstacles are more easily removed. The time is thus ripe for mobilizing creativity and entrepreneurship to meet the challenges ahead. Government and other leaders have a key role to play. Government can innovate in public goods and in finding ways to carry out its business more effectively. Most important, it should help provide the right environment for innovation. Although this volume has stressed the role of government and the need to adopt a whole-of-government approach to many aspects of innovation policy, most innovation occurs through firms, families, and individuals. Government needs to partner with the private sector and with individuals in support of innovation and to avoid interfering with the innovative efforts of firms or individuals.

While innovation remains fundamentally the work of private economic agents, governments facilitate the emergence and success of innovative initiatives by removing obstacles, by providing the necessary support to entrepreneurs, by investing in the needed technology and research infrastructure, and by carrying out appropriate reforms in education, the investment climate, and trade.

The Purpose of This Book

The volume describes the main elements of policy measures and offers an overarching strategic framework for implementing a pragmatic innovation

policy with a broad, long-term vision. This book argues that innovation policy should be at the core of government action and a focal point for mobilizing a country's agents of change. It is up to these public and private sector actors, working together, to determine what will best fit their specific context and leverage their country's innovation potential.

This book is meant to serve as a guide for policy makers, businessmen and -women, and the general public in developing countries and others interested in leveraging innovation to improve the performance and social welfare of their country, region, or organizational unit. It has presented a conceptual framework that includes a broad definition of innovation as the effective use of something that is new to a country, a region, a sector, or a firm. Innovation is the main source of increased performance—of getting more out of limited resources, of finding new ways to use existing resources and to mobilize people to produce better goods and services or to produce and deliver them more efficiently.

Finally, it is not possible to say, in a book of this size or even larger, which innovation policies might work best in widely different country and regional contexts. This volume simply aims to serve as a guide by providing a framework for thinking about and informing action in developing and emerging economies, to give helpful guidelines, and to provide concrete examples of what has been done in different circumstances. Ultimately, it is up to the policy makers, entrepreneurs, and individuals in a given situation to determine what they can do to leverage the potential of innovation for addressing their needs. The authors hope that this book will help guide that process of trial and error, which is also an intrinsic part of innovation.

Notes

1. This book complements other practically oriented documentation prepared in other parts of the World Bank, notably, the Science, Technology, and Innovation Capacity Building Toolkit and the Technology Commercialization Handbook prepared by the World Bank Science and Technology Coordinator Unit to be available online.
2. The technology level of goods is determined, in international statistics, by the R&D intensity of industries that produce them. High-technology industries are defined as those that spend (approximately) more than 3 percent of their turnover on R&D (OECD standards).

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