1 New technologies, new systems, new rules

THE INDUSTRIAL SCENE IS CHANGING QUICKLY—DRIVEN BY constantly emerging, rapidly spreading new technologies that are altering the relationships between enterprises and other entities and influencing how enterprises are organized and managed. National and international rules and regulations are also changing, improving the functioning of markets. Although many of these changes offer enormous benefits to developing countries that can use them in their economic interest, countries that cannot could be marginalized and excluded. Countries at all levels of development face the same challenge: ensuring that industrial enterprises become and remain internationally competitive.

Becoming internationally competitive can be much harder than it sounds. Why? Because industrial competitiveness does not result from merely opening economies to global trade, investment and technology flows—though, if done carefully, that can be important. Nor does it mean cutting wages—a response that is, at best, a short-term defensive strategy (often termed the "low road") incompatible with sustained growth. Instead, industrial competitiveness requires building capabilities in the use of new technologies (the "high road").

To develop those technological capabilities, countries have to acquire enterprise-specific knowledge, skills and practices through an incremental learning process. This process can be slow and difficult. Depending on the country and the technology, it can involve heavy costs and great risks and uncertainties. But if countries fail to build the capabilities to compete internationally, they can become bystanders at the technological feast, stuck with the crumbs—stuck with simple manufacturing activities that do not lead to sustained, diversified growth.

Capability development takes place primarily in enterprises. It is, however, strongly conditioned by the environment in which enterprises operate. Responding to market, policy and technological signals, enterprises are sensitive to macroeconomic changes, growth prospects, national security issues and physical and intellectual property rights. They need a variety of inputs from markets, institutions and other enterprises to build and strengthen capabilities. These inputs—including finance, skills, machines, information and technical knowledge—have to keep pace with rapid technical change and intense competition. Thus capability building requires complex interaction among actors. The policy challenge for developing countries is to foster dynamic competitiveness.

The complexity of the capability building process varies by industry. It also varies by a country's level of industrial development. With industrialized countries constantly increasing their competitiveness and strengthening technology systems, capability development is crucial in developing countries—and requires strong policy support. Policy needs are even greater in the world's least developed countries. This chapter assesses the opportunities and challenges that the new industrial scene creates for the the process of industrialization in developing countries.

Assessing technical progress—its promise for growth

Recent scientific and technical advances provide a wealth of productive knowledge. Such knowledge, applied properly, can raise incomes and employment in developing countries. A rice producer in India, a goods transporter in the United Republic of Tanzania, a small fruit processor in Thailand, an automobile component manufacturer in Brazil—all can benefit from new technologies. The rapid pace of technical progress shows no signs of slowing, and its reach is pervasive, affecting nearly every aspect of life.

Except if directly taught, productive knowledge can move from innovator to user only if it is codified into transmittable form—into information. New technologies facilitate such codification and transmission, allowing knowledge to spread faster and cheaper than ever before.[1] Moreover, it is not only

Box 1.1 Technology and innovation

Opportunities

- The technology structure of production and exports matters for long-term development.
- With adaptive capabilities, technology can be upgraded to increase competitiveness in all countries and industries and at all technological levels.
- Technological upgrading can be achieved by pursuing a strategy of innovation based on linking, leveraging and learning.
- Technological upgrading is facilitated by entering into high-tech global value chains, even at the assembly level (for export-oriented operations).

Challenges

- Stricter intellectual property rights have raised the "entry fee" for technological upgrading.
- Low-tech, low-wage, resource-based industrialization is a slow-growth strategy. Sustainable growth requires rapid increases in wages and productivity.
- Large-scale investments are required in information and communication technologies, infrastructure and capabilities.
- Narrowing the "economic divide" requires bridging the "digital divide".
- Replicating East Asia's rapid, technology-led growth will be difficult given the new global setting, new rules, different preconditions and new competition from China and India.

knowledge that moves more easily: so do products, money, skills, machines and other inputs into production. Thus industry remains the focal point of technical change and diffusion. Accordingly, this report's main concern is to determine why many developing countries are unable to use new industrial technologies efficiently.

With falling costs of distance, the economic world is shrinking rapidly and irreversibly. *Globalization,* the term that describes this process, has huge technological potential to change—and improve—economic life. But it also carries costs and risks (box 1.1).

The ability to move information easily does not mean that productive technologies spread easily or that their benefits are distributed equally. On the contrary, resources tend to flow to relatively few countries—those able to use them efficiently and profitably. Because globalization lacks inherent forces to balance such divergence, it is not always an engine of beneficial and sustainable economic integration.[2] Indeed, it can also be a powerful force for deprivation, inequality, marginalization and ecological disruption.

Statistics on global deprivation and inequality, though well known, are worth reiterating. About half of the world's people—around 3 billion—live on less than $2 a day. Around 1.2 billion people struggle on less than $l a day (the yardstick of extreme poverty). Some 15 percent more people live in poverty in developing countries than 10 years ago; 800 million lack access to health care; and 500 million are not expected to survive to age 40. Women and children suffer the most: 10 million children under five died in 1999, mostly from preventable diseases.[3] In 1960 per capita incomes in the richest 5 percent of countries were 30 times those in the poorest 5 percent. By 1997 they were 74 times as high.

Inequality has also increased in the manufacturing industry, both between industrialized and developing countries and within the developing world. In 1985 per capita manufacturing value added in the most industrialized 5 percent of countries was 297 times that in the least industrialized 5 percent—while in 2000 it was 344 times as high. The industrial leaders among developing countries did quite well. But in 1985 per capita manufacturing value added in the five leading developing countries was 276 times that in the five laggards—and in 2000 was 437 times as high.

To the extent that manufacturing remains a driving force in sustained development—and the next section argues that it does—the growing divergence in manufacturing performance presages a similar divergence in economic performance more generally. But if the international economy is to promote political and social stability, it cannot sustain this pattern for long. The broad acceptance of global integration in a democratic framework requires that the process benefit all participants—and that the benefits be reasonably equitably distributed. This is not the case today, creating hardship and raising resistance to further reform. Unless the divergence is reversed, the promise of growth based on technical progress may remain just that—a promise that marginalized people no longer believe in.

Being competitive in manufacturing—the imperative

Is industry still important for economic development? Most analysts would say yes. Since the industrial revolution, manufacturing has been the main engine for growth and for transforming the economic structure of poor countries. It has been the catalyst for shifting them from simple, low-value activities with poor growth prospects to activities with high productivity, increasing returns and strong growth potential.[4] The rapid growth of technology-driven economic activity does not change this, despite the rising share of services in income and

the much-hyped growth of the "new economy". Indeed, rapid technical progress makes industrialization even more important for developing countries (box 1.2).

With globalization and liberalization on the rise, countries must be internationally competitive to survive and grow. That was not the case when industrial development started in today's industrialized countries and most newly industrializing economies. Many governments used import protection, subsidies, procurement and other measures to promote industrial enterprises and catch up with the leaders. The leaders, in turn, tried to protect their positions through measures such as prohibiting the emigration of skilled workers and even (in early nineteenth century England) banning the export of machinery.[5] In the early days of industrialization, high transport and communication costs also provided natural protection. In addition, different countries adopted different technical standards, and governments rarely bought goods from foreign suppliers. Finally, consumers often knew little about competing foreign products.

Things are very different today. Governments have reduced or are reducing restrictions on trade, international finance and foreign direct investment (FDI). Domestic liberalization is being strengthened by new international rules of the game for economic activity. Production across national boundaries is being integrated under common ownership or control—often in the

Box 1.2 Industry as the engine of growth

Industry has long been the main source, user and diffuser of technical progress and associated skills and attitudes. No other productive activity comes close. Industry's special role can be understood only in a world of dynamic learning and technical change, where large enterprises strive to increase their size and capabilities to realize economies of scale and societies constantly transform their structures and habits. In this world the manufacturing industry is not just an ingredient of development—it is the essential ingredient.

Applying technological progress to production. Manufacturing is the main vehicle for applying technological progress to production. Agriculture also benefits from technical progress, but at a much slower pace than manufacturing. Manufacturing can apply a limitless variety of inputs and equipment. Moreover, many industrial technologies involve increasing returns to scale and offer enormous potential for further learning and incremental improvements. That is why the shift from low- to high-productivity activities always involves a shift from agriculture and traditional services to industry. In recent years information and communication services have also attracted innovative activity. But that innovation was only possible because of technological advances in the hardware of information processing and telecommunications.

Driving innovation. Manufacturing is the main source of innovation. Research and development by private industrial enterprises accounts for the bulk of innovation in industrialized countries; these enterprises also finance significant research and development in universities and other laboratories. Moreover, formal research and development is only part of the technology development process. A significant portion occurs in the engineering, production, procurement, quality management and other departments of enterprises. The scope for such innovation is enormous in manufacturing, perhaps more so than in other activities.

Diffusing innovation. Manufacturing is often the hub for diffusing innovation to other activities, providing capital goods and transmitting new technical and organizational knowledge. Historically, the capital goods sector served as such a hub; today the electronics industry is the hub. In particular, the use of information technologies by all activities involves the considerable spread of new technologies, accompanied by close interaction between suppliers and users.

Developing new skills and attitudes. Manufacturing is a vital source of new skills and attitudes, transforming traditional economic structures. It creates an industrial work ethic, spreading the discipline and organization required in modern societies. It fosters entrepreneurial capabilities, with small enterprises as the springboard, and it develops new managerial and technological capabilities, the core of modernization and competitiveness.

Leading institutional development. Manufacturing has led the development of modern institutions and legal structures such as joint stock companies, accounting standards and corporate governance norms.

Producing beneficial externalities. The innovation and skills created in manufacturing provide large benefits for other activities. Agriculture gains from richer consumers, better equipment and inputs, and improved storage, transport, distribution and processing facilities. Services gain from better equipment and skills.

Stimulating modern services. Manufacturing provides the direct demand that stimulates the growth of many modern services. It is often the largest customer for banking, transport, insurance, communications, advertising and utilities. It creates markets for new services and skills, particularly important for finance, education and logistics. It is also the source of new service enterprises, many of them originally part of manufacturing enterprises and hived off to provide design, logistics, maintenance, training and other services.

Generating dynamic comparative advantage. Manufacturing is the main source of dynamic comparative advantage, the shift from primary to more advanced—and generally more dynamic and higher-value—manufactured exports. Manufacturing now accounts for about 90 percent of global visible trade, a share that has grown steadily over time. Terms of trade for manufactures have also improved steadily. Although modern service exports are also growing, much of this growth comes from industrialized countries that have built modern skills and capabilities through manufacturing. Few countries are able to sell high-value services (excluding tourism) without first undergoing industrial development.

Internationalizing economies. The internationalization of an economy often follows the spread of transnational manufacturing corporations, banks, transport providers, advertisers and so on setting up shop around the world to serve their customers. The current phase of globalization, with integrated facilities across countries, is led by manufacturing enterprises.

Modernizing enterprises. The exposure to foreign markets, enterprises, skills and practices that manufacturing brings can be the catalyst for modernizing national industrial enterprises, as in the Tiger economies of East Asia. Without industrial development, such modernization would not have been possible.

Sources: UNIDO; Chenery, Robinson and Syrquin (1986).

hands of a small number of large private companies—making it even more difficult to isolate countries from world market forces. Technical change is underpinning these processes. The result is that enterprises are exposed to global competition with an immediacy and intensity rarely seen before.

Thus it is essential for enterprises and countries to deal with the increase in international competition. To compete internationally, enterprises not only have to be efficient, they also require a supportive economic and business environment.

- Governments must provide appropriate conditions: political security, good macroeconomic management, sound and enforceable legal and property rights, transparent and predictable policies, well-functioning institutions and a business environment with low transaction costs.

- Suppliers of physical and service inputs and infrastructure must meet international standards of cost, quality and delivery.

- Markets for labour, capital and information, along with their supporting institutions, must work reasonably efficiently.

- Enterprises must be encouraged to invest in building new capabilities, mounting competitive strategies and developing networks and clusters for achieving efficiency and dynamism.

The needs of competitiveness thus stretch well beyond the front-line enterprises that face international rivals, encompassing other enterprises, activities, institutions and policies—and applying to developing and industrialized countries alike. For latecomers to industrialization that lack the required capabilities, structures and institutions, globalization can pose considerable challenges. But countries that can address these challenges have enormous opportunities for growth. How well countries cope depends on their ability to link with foreign partners and leverage additional resources—particularly technology and knowledge—for development. But success in these areas requires investing in and facilitating learning efforts to adopt, adapt and improve on the resources acquired.

Competition is constantly taking new forms. Low costs are important—but so are innovation, flexibility, reliability, service and quality. In industrialized countries new products, processes and services are the main drivers of competitiveness. Enterprises in developing countries do not innovate in this sense and cannot rely on these mechanisms to achieve competitiveness. They compete by using imported technologies together with lower labour and other costs—and, where relevant, natural resources. Using new technologies efficiently, however, requires considerable technological and managerial effort.

Mastering technologies to competitive standards requires new skills, technical information, organizational techniques and marketing and supply chain methods. The hardware of new technologies, along with blueprints and instructions, can be imported. But its efficient deployment necessarily involves local learning. This process is continuous, because technologies change constantly. Industrial development also entails a constant shift from simple to complex technologies—only then can wages and living standards rise. This means moving both across industries (from low- to medium- and high-tech) and within industries (from low to high value-added activities).[6]

None of this is easy, even for countries that do not innovate at the frontier. It is not easy because achieving technical and managerial efficiency takes considerable effort. Opening the economy to world markets does not, in most developing countries, ensure that enterprises will secure the right technologies and, more important, use them at best practice levels. A user of new technologies—new to the user, that is, rather than the world—has to master their tacit elements to achieve best practice. In this process the user has to build new skills, collect new information, set up new systems and forge new links with other actors.

This process, often requiring costly and risky learning, is in many ways similar to real innovation in industrialized countries. The content, risk, cost and duration of the effort vary—by technology, industry, actor and context. Becoming competitive requires widespread technological effort, which is a constant process of innovation and learning. The efficiency of this innovation and learning determines the success or failure of industrial development. How this occurs in developing countries is the theme of this report.

That the world's industrial setting is changing is evident, but many changes are not new by historical standards. In some ways the global economy was more open a hundred years ago. There were fewer barriers to trade and investment, and there was greater certainty about security and exchange rates. Technical progress, however, has integrated the world economy much more closely today, and the interaction of several factors has created a qualitatively different setting for industrial activity. Product, service, financial and information markets are better linked, each in a state of constant ferment.

The many features of the new setting can be grouped in three clusters: those driven by new technologies, those driven by new innovation, managerial and organizational systems in

enterprises and those driven by new international rules and regulations.

Exploring and exploiting new technologies

Today's technical change is unprecedented in pace and scope. Information and communication technologies are at the core of such change, making spectacular advances. In 1930 a one-minute telephone call from New York to London cost $300 in today's prices; today it costs a few cents.[7] The cost of 1 megahertz of processing power fell from $7,600 in 1970 to 17 cents in 1999—a 99.9 percent decline over the same period. The cost of sending 1 trillion bits fell from $150,000 to 12 cents. The entire contents of the U.S. Library of Congress can now be transmitted across the country for $40; soon it may be stored on one computer chip. All of this is revolutionary, but the pace of innovation continues to accelerate. Thus it is not surprising that there is so much interest in knowledge societies and the "weightless" economy.[8]

Information and communication technologies, the most visible face of technical progress, also affect the pace of innovation. Today information can be processed at rates unthinkable just 10 or 20 years ago.[9] But these technologies are also important in mundane low-tech activities, often opening unexpected opportunities to entrepreneurs in developing countries (box 1.3).

Information and communication technologies can also significantly boost economic performance, though there is much debate about their precise effect on recent economic growth.[10] Developing economies with fast growth in consumption of information and communication technologies—India, the Republic of Korea, Taiwan Province of China and Thailand—also appear to have the fastest growth in productivity and gross domestic product (GDP). In Canada, the United Kingdom and the United States between 1990 and 1996, about half the growth contributed by fixed investment is estimated to have come from information and communication technologies.[11] Accelerating the adoption of these technologies are their falling prices, which are dropping faster than those for other capital goods.

Information and communication technologies can change—and improve—innovation by integrating diverse production systems and formerly unrelated technologies.[12] They can also change the geography of industrial activity, bringing together locations once separated by high communication and transport costs. In addition, they can create new opportunities for learning in developing countries, using electronic links to access global knowledge on an unprecedented scale. Distance learning, if properly organized, can be quite successful.[13] It is partly in response to these possibilities that many governments are opening their economies to international flows of products, knowledge and resources.

Quite apart from the massive increase in the use of information and communication technologies, the information content of industrial activities is rising rapidly. About half of the value of a new car lies in its information content—design, process management, marketing, sales and so on. In industrialized countries the weightless part of economic activity seems set to dominate life,[14] but it is also going to play a larger role in industrial activity in developing countries.[15]

Can information and communication technologies facilitate leapfrogging and catching up by developing countries? Can latecomers without industrial bases jump to the forefront without going through traditional industrialization? The Internet became economically useful to enterprises in industrialized countries only around 1997, and its potential is just beginning to be exploited. Countries with no background in information and communication technologies and without a large traditional industrial base can use the Internet to promote growth and employment. Developing countries' lack of old computer systems is an advantage. New technologies that do not require fixed communication networks may enable developing countries to leapfrog stages of technological development. In Africa satellites and new wireless technologies may make it possible to bypass fixed telephone landlines (box 1.4). Moreover, as computing reaches mobile telephony, millions of users in Africa may come online.

Still, the evidence so far does not offer great hopes for leapfrogging. As noted, most countries that have succeeded

Box 1.3 Innovative uses of information and communication technologies in developing countries

In rural southern Ghana, petrol stations place orders by telephone—a task that entailed travelling to Accra. In Zimbabwe a company generated $15 million in new business by advertising on the Internet. In the mountains of Lao People's Democratic Republic and Myanmar, drivers of yak caravans use mobile telephones to call ahead and find the best route to deliver their goods to market. Fishers off the shores of Kerala, India, make phone calls from 7 kilometres out to sea to determine which market is paying the most for their catch, then sail there. Farmers in some remote Indian villages get weather and price information on the Internet. And in Bangalore, India, a non-profit trust is promoting a $200 computing device to provide rural dwellers with the same information.

Source: Baxter, Perkin and Mulligan (2001, background paper).

Box 1.4 Internet access in Ghana—impressive but expensive

Africa boasts many technology success stories and centres of excellence. One of them is Ghana, which aspires to be an Internet and rapid communications hub for West Africa. Although there is no "one size fits all" solution for the best adoption of these technologies, Ghana suggests basic principles for all developing countries. Ghana was the fourth Sub-Saharan country to go online, after South Africa, Botswana and Zambia. Accra's only full-service Internet access provider, Network Computer Systems (NCS), offers a gateway to global communications.

NCS pioneered Internet access in Ghana in late 1994, before many users in Europe had even heard of the technology. NCS subscribers are a cosmopolitan blend of embassies, chief executives, non-governmental organizations, companies and ministries. Ghana's government, which began promoting the adoption of the technology in 1995, deserves some of the credit for Accra's Internet preeminence.

Ghana's Internet structure and capacity are ahead of those in the 14 French-speaking countries of West Africa, where electronic networking consists primarily of email, bulletin boards, database access, news feeds and small file transfers. Ghana's true Internet connectivity offers much more, including instant access to messages, browsing through hypertext links, access to newsgroups on thousands of subjects and even video transfers.

Costs continue to be an issue, however. NCS charges an annual registration fee of $100 and a monthly use fee of $100. But with the average Ghanaian journalist earning less than $150 a month, the cost of a laptop computer is equal to a year's salary. So, while Internet technology appears promising and tantalizing, it is unaffordable for all but the richest people in Ghana.

To broaden access, cyber cafés have mushroomed all over Accra, and in 2001 the number of Internet users doubled to about 100,000. Similar growth is expected over the next two or three years. But Ghana faces hurdles to developing a thriving online economy. Although there is high demand for basic services, headier ambitions have been thwarted by Ghana's economic crisis. In addition, dreams of e-commerce and international online trading have not been realized.

Source: Baxter, Perkin and Mulligan (2001, background paper).

with information and communication technologies (in both hardware and software) have been relatively industrialized. Effective use of these technologies requires massive investment in infrastructure and, more important, in new skills and capabilities—investment that is beyond the means of most developing countries.[16] Moreover, industrialized countries show that considerable time can pass before the benefits of information and communication technologies are realized. A critical mass of technology diffusion—in coverage, organizational adaptation and learning—is needed for widespread productivity gains.[17]

Organizational and managerial changes at the industrial level, redesigning processes and developing new business cultures, are also needed. Productivity gains often arise not directly from technologies but from the higher productivity of new systems, procedures, skills and attitudes. In many developing countries the critical mass of information and communication technologies and the necessary skills and organizational and managerial capabilities—the main determinants of productivity gains—may not exist for some time.

Using new systems for innovation, management and organization

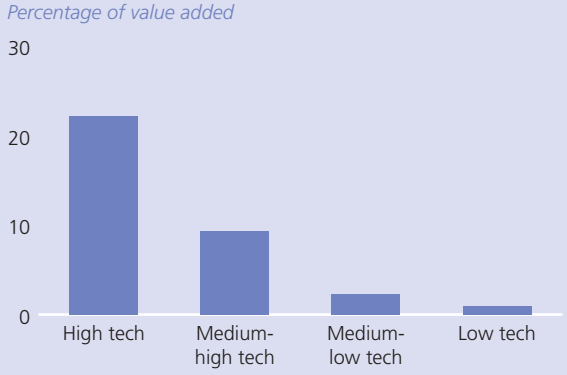
New innovation systems are widening differences between enterprises, industries, countries and regions. At the same time, new managerial and organizational systems are changing relationships between and within enterprises.

Main actors in innovation

With rapid technical change, the growing divergence in technological opportunities between activities leads to rising differences in innovative activities between industries. One good indicator of innovation is spending on research and development (R&D).[18] In 1994 high-tech industries in the countries that form the Organisation for Economic Co-operation and Development (OECD) spent nearly 25 times more of their value added on R&D than did low-tech industries (figure 1.1). In industrialized countries high-tech and medium-high-tech industries account for nearly three-quarters of business R&D.

Innovative activities introduce new products, create new demand and substitute for old products more rapidly than do stable activities. As a result R&D-intensive output and exports grow faster than other industrial activities.[19] Between 1980 and 1997 medium- and high-tech exports grew faster than other manufactured exports. These complex products now

Figure 1.1 Research and development spending by industry, OECD countries, 1994



Source: Baxter, Perkin and Mulligan (2001, background paper).

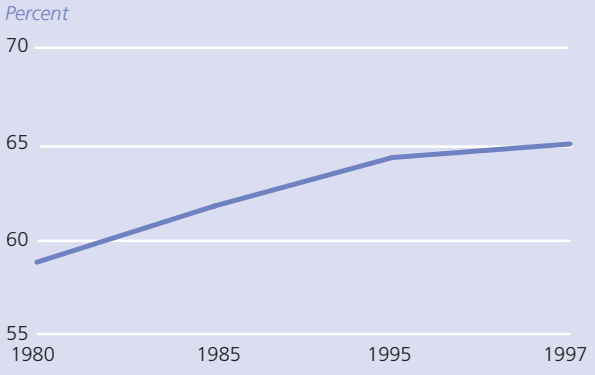
account for two-thirds of the world's dynamic exports, gaining ground on low-tech and resource-based activities (figure 1.2).

The most high-tech products—advanced electronics, aerospace, precision instruments, pharmaceuticals—have grown much faster than all other groups.[20] The five fastest-growing products in world trade during 1980–1997 were high-tech information and communication technologies, driven by a flood of new products and their growing application in other activities. But the high-tech industry is highly cyclical. Like many investment goods, it takes the lead in both downward and upward business cycles. And with the world economy slowing, it is heading downwards.

Enterprises have always been the main investors in new technologies, particularly in industrialized countries. In OECD countries enterprises conducted 69 percent of total R&D in 1997, up from 66 percent in 1981. The share of higher education institutes remained constant at 17 percent, while that of government fell from 15 percent to 11 percent. Private non-profit institutions account for the rest.[21] Among enterprises, manufacturing remains the main source of R&D. But the share of services, driven by software, is rising—accounting for 15 percent of the OECD total in 1997.[22] Distinctions between manufacturing and services are somewhat arbitrary, however, as the lines between them blur and industrial enterprises contract functions to independent enterprises.

To cope with global competition and the growing complexity of knowledge, enterprises are specializing in their core competencies. As a result large enterprises no longer develop all their innovation in-house, but increasingly procure it from other enterprises. Several channels, discussed later in the report, provide access to the required knowledge. Innovation surveys suggest that inter-enterprise collaboration is the most important.[23]

Figure 1.2 Share of medium- and high-tech products in global dynamic exports, 1980–1997



Source: UNIDO calculations based on Comtrade database.

Enterprises share innovation in two ways. The first is with enterprises in the same value chain, such as for automobiles. Major manufacturers work with first-tier suppliers in developing new models, expecting them to design and develop new components and sub-assemblies.[24] This process facilitates faster, riskier and more expensive innovation. It also raises the technological distance between first-tier suppliers, generally with strong R&D capabilities, and suppliers that lack such capabilities. This can have implications for enterprises in developing countries supplying (or hoping to supply) global value chains. The increasing use of information and communication technologies for business-to-business relations makes it easier for such enterprises to plug into supply chains. But the tightening technological links between lead enterprises and first-tier suppliers threaten to exclude them from the upper echelons of the supply hierarchy.

The second way enterprises share innovation is between competitors in and across countries. This trend is driven by the rising costs and risks of innovation (particularly in the basic, pre-commercial stages), which lead to more frequent use of strategic alliances and research consortiums. Some 5,100 strategic alliances were formed between 1990 and 1998—mainly by enterprises from the United States, which are part of 80 percent of known agreements (half with a partner from outside the United States). Enterprises in Europe participated in 42 percent of the alliances, and those in Japan in 15 percent, along with some enterprises from elsewhere.[25] Governments that would otherwise oppose such collaboration on antitrust grounds now often permit or support it, even when they maintain stringent antitrust measures.[26]

Faster technical change, growing industrial links with science, multiple nodes of innovation and falling costs of transmitting information raise the significance of innovation networks.[27] Such networks are spreading over wide areas. Geographic agglomeration remains important for some technologies and types of interaction that require direct contact—Silicon Valley is an excellent example—but it is becoming less so for others. Some networks spread across cities, others over regions, still others around the globe. Plugging into the relevant network, or concentric series of networks, is critical to competitive technology development.[28]

Given the risks and economies of scale, R&D tends to be concentrated at the enterprise level. In the United States the top 100 enterprises, in terms of turnover, accounted for nearly two-thirds of R&D in 1995, and in 1997 the top 20 accounted for one-third. Of the 35,000 enterprises doing R&D, just 1

percent performed nearly 70 percent of the total.[29] Not surprisingly, R&D is even more concentrated in small industrialized countries. In Switzerland three enterprises accounted for 81 percent of R&D in the 1980s, and in the Netherlands four accounted for nearly 70 percent. But technical change is reducing concentration.[30] In addition, the list of leading enterprises for R&D is changing rapidly: in the United States some 40 percent of the top performers in 1994 were not on the list 10 years before.

Interactions between industrial innovators and external agents—such as research laboratories and universities—are also changing. New technologies need closer links to basic science even for commercial innovation, with biotechnology as a good example. Technology clusters near knowledge centres with significant concentrations of universities and research centres are an important competitive advantage. As a result industrial enterprises are spending more to sponsor R&D in such centres and tap their expertise.

In many industries, relations with technology institutions—such as standards and metrology bodies and support agencies for small and medium-size enterprises—also become important in enterprise technological activity. Most industrialized countries have an array of institutions providing specialized technical inputs to industry. Given the public goods that they produce, many depend on government subsidies, as with Germany's Fraunhofer institutes (box 1.5). Industry associations, export agencies and the like can also provide support and technical assistance. Together these institutions create an environment rich in various kinds of information—crucial for fostering sustained growth in industrial innovation and learning (chapter 8).

Box 1.5 Cooperative contracting for research and development in Germany

Many countries recognize the need for research centres that can conduct technological work for industry and combine it with publicly funded long-term research. One of the best models, Germany's Fraunhofer-Gesellschaft, was created in 1949 and has become Europe's leading organization for institutes of applied research. It performs research for industry, services enterprises and the government, providing rapid, economical and practical solutions to technical and organizational problems. In addition, within the framework of technology programmes in the European Union, it participates in industrial consortiums to make industry in Europe more competitive.

Fraunhofer-Gesellschaft's 56 specialized institutes—funded by Germany's central government, regional governments and private industry—help develop new technologies for industry and other uses. It has nearly 11,000 staff members (mainly scientists and engineers) and an annual budget of about 900 million euros (just under $1 billion), more than 80 percent of which comes from contract research. About two-thirds of contract revenue comes from industrial and publicly financed research projects and one-third from the federal and Länder governments. Small and medium-size enterprises account for a large portion of research contracts: in 2000, enterprises with fewer than 100 employees provided nearly 25 percent of Fraunhofer's budget and those with fewer than 500 employees about 45 percent. Research for the government is aimed at longer-term social and economic problems, such as the environment.

Fraunhofer scientists specialize in a broad range of complex research. When needed, several institutes pool their expertise to develop system solutions. Researchers move easily between science and industry, and more than half of the institutes are headed by academics. Fraunhofer institutes can handle clusters of technologies that universities cannot, and their practical orientation makes them valuable to clients. Companies of all sizes and types use the institutes as high-tech laboratories for development work, special services and organizational and strategic issues. In addition, the Fraunhofer institutes increasingly collaborate with affiliate institutes in Asia, Europe and the United States.

Source: http://www.fraunhofer.de/english/index.html.

New ways of organizing and managing enterprises

New technologies affect relationships between enterprises—that is, industrial structure and organization. They also affect relationships within enterprises—the way they are managed. Both developments influence the organization and management of global production systems and encourage global enterprises to cut inventory costs and ensure reliable procurement and delivery (box 1.6). The just-in-time system is the best-known manifestation of this, but there are others.

Changes between enterprises

Pressures for specialization, increasing the reliance on suppliers, mean that manufacturers have to manage supply and value chains.[31]

These new organizational systems are not easy to set up and manage, particularly in developing countries. The systems require advanced infrastructure, new contracting mechanisms, greater trust and openness, and new skills and management techniques.[32] To manage supply chains effectively, many large enterprises in OECD countries have had to broaden their managerial and technological competence. Information flows, logistics and networking are the new weapons in the competitive armoury, with large potential benefits from lower costs and increased flexibility. In many developing countries, however, policy and business cultures are not conducive to these changes.

For two reasons, electronic commerce technologies offer faster, more efficient and potentially more cost-effective ways of connecting enterprises.[33] First, these technologies are cheaper and easier to automate in ubiquitous processes such as distribution, sales, after-sales service and inventory management. Electronic data interchange is especially

Box 1.6 New ways of organizing and managing enterprises

Opportunities

- Clustering, networking and specialization increase efficiency and productivity.
- New managerial methods and production techniques also enhance efficiency and productivity.
- Information and communication technologies provide access to new knowledge on management methods, production techniques, marketing and export opportunities (e-commerce).

Challenges

- Increased competition at all levels in both export and domestic markets due to trade liberalization.
- New skills and capabilities required to master information technology—especially for new design, production and marketing systems.

suited to supply chain management but may be replaced by the Internet for small suppliers. Second, e-commerce technologies can be applied all along the value chain in an integrated manner—something not possible with earlier technologies.

Efficiency gains through e-commerce applications include:

- *Lower sales costs.* In the past, errors forced large enterprises to rework about a quarter of their orders. E-commerce now allows enterprises to check that orders are internally consistent and that orders, receipts and invoices match. General Electric's Trading Post Network, for example, significantly reduced ordering errors. It also cut material costs by 5–20 percent because competition increased among suppliers and the length of the procurement cycle was cut in half.
- *Cheaper customer support.* Cisco Systems, the world's largest supplier of routers for Internet traffic, has moved 70 percent of its customer support online—eliminating 250,000 telephone calls a month and saving more than $500 million, about 17 percent of its operating costs.
- *Cheaper, faster procurement.* Typical procurement orders cost $80–125 to process for low-value requisitions and much more for complex orders (in some cases exceeding the value of the purchase). The use of electronic data interchange can cut these costs by 10–50 percent. MCI has cut its personal computer purchasing cycle from 4–6 weeks to 24 hours, while Bell South has shortened the time required to approve an expense account from 3 weeks to 2 days.
- *Smaller inventories.* In the United States the average value of inventories is 2.3 percent of annual (non-farm) sales and 4.2 percent of final goods sales. Each stage of the value chain holds significant inventories: 37 percent by manufacturers, 25 percent by wholesalers and 27 percent by retailers. E-commerce can also significantly reduce costs on inventories held.
- *Better forecasts of consumer demand.* E-commerce enables more accurate forecasts of consumer demand and increased customization of orders. Collaborative forecasting is expected to cut inventory levels in the United States by 25–30 percent, or $250–300 billion (OECD 2000a, p. 48).

Another change is the growing importance in several industries of the geographic clustering of enterprises, particularly small and medium-size enterprises.[34] The benefits of agglomeration arise from external economies such as the availability of information or proximity to pools of suppliers, customers and skilled workers. Clusters are more advanced than passive agglomerations, where enterprises realize external economies just by being there. Combining networking, specialization and joint action,[35] clusters could overcome many of the disadvantages associated with small size.

Many high-tech clusters have emerged in industrialized countries, inspiring much analysis and policy.[36] Many active, competitive clusters also exist in developing countries.[37] But their technological dynamism is often limited,[38] posing severe challenges in the emerging competitive setting. Such clusters need to shift from realizing largely static external economies to building dynamic capabilities based on new technologies, skills and networks.

Changes within enterprises

Enterprises are experiencing important changes in internal management and organization. The need to facilitate information flows is causing enterprises not only to introduce information and communication technologies but also to cut management hierarchies and build new tools to handle information—calling for new skills throughout.[39] On the shop floor the use of new technologies requires new skills—and more continuous training, multiple skills, work teams and the close involvement of workers in quality and productivity improvements.[40] Information technology is now pervasive in work methods, plant layouts and process control, quality management, continuous improvement, lean production and just-in-time inventory systems. Other information technology applications include computer-aided design, manufacturing and engineering, manufacturing and enterprise resource planning, product data management, automation, robotics

and flexible manufacturing systems. Information and communication technologies are also being used to automate design, manufacturing and coordination—changing and improving the innovation process.[41]

None of this is easy, even in industrialized countries with sophisticated enterprises, ample skills and strong support institutions. The need for new systems and increased interaction with external agents is disruptive to the internal organization of enterprises.[42] But enterprises that master the new culture and technologies find it easier to manage operations over long distances. Information and communication technologies also make it feasible for enterprises to separate functions and processes—locating them, almost regardless of distance, where cost, efficiency and market needs dictate.

By better managing global networks and spreading activities around the world, enterprises can minimize costs and optimize flexibility and logistics. These possibilities also apply to other activities in the value chain—services, marketing, R&D—that are also relocating within tightly coordinated international systems. Of all the activities in the value chain, R&D is the slowest to shift, but here too there are signs of change.

For several reasons, these activities are not relocated evenly across countries. For example, some activities have to be concentrated in a few sites to reap the benefits of scale economies, agglomeration economies, skill and supplier availability and logistics possibilities. Others can be spread more widely because there are fewer scale or cluster economies—or because of the need to be near material inputs or final customers. Other reasons for choosing certain locations may be strategic, including the locations of competitors, need to spread risk, access to innovative work and benefits of first-mover advantages. Countries that insert themselves into the global value chain early can develop skill, technological, supply and infrastructure advantages that build up over time. Moreover, the success of a few sourcing activities can attract other transnational corporations, as direct suppliers or as followers, looking for locations with good images and reputations.

In addition, several traditional factors make certain locations more attractive for foreign direct investment—political and macroeconomic stability, welcoming policies and so on. Low wages for unskilled workers increasingly count for less in all but the simplest low-tech activities.

Globalized production and new global enterprises

Globalization means different things to different people. In this report it signifies the tighter links between all markets affecting industrial activity—for final products and for inputs such as raw materials, intermediate goods, machinery, finance, technology and, in many cases, high-level skills. It has many manifestations: increased trade, investment, licensing, joint ventures, alliances, networks and subcontracting activities. In most the lead players are transnational corporations from industrialized countries, the main drivers of technical change and the most important agents for transferring technologies and production across the world. But enterprises from newly industrializing economies are also enthusiastic participants.

The international role of transnational corporations has been rising steadily, with growing shares of global production, trade, technology transfer and investment. In manufacturing perhaps the most visible manifestation of their activity is the rise of global industrial value chains, linking the entire sequence of activities—raw material extraction, production, design, R&D, marketing and delivery. Of course, many industrial value chains have long been global in the sense that their materials, components or products have been traded across national boundaries. But some distinct organizational features of emerging global value chains are worth noting:

- Value chains are organized internationally under the common governance of private enterprises. These enterprises may hold an equity stake in activities in different countries, thus becoming transnational. Or they may have other market or non-market links with local enterprises (through subcontracting, joint ventures, strategic alliances or buying arrangements). Where economies of scale in innovation, production, logistics and marketing are important, the number of key players tends to fall over time. With policy liberalization, the key players rationalize production facilities across countries, often reinforcing their central role. The organization of the global value chain and the strategies of the leading players can affect the entry, upgrading and dynamism of the constituent units.

- The role of transnational corporations in global value chains (of ownership stakes in activities overseas) is rising, though there are significant differences by industry. In low-tech activities, where it is relatively easy for local enterprises to achieve best practice, arrangements tend to be loose and diverse. Some transnational corporations set up affiliates; others contract local enterprises. Independent buyers often control significant segments of the market, contracting local enterprises and providing specifications, technical assistance and inputs. In high-tech activities, by contrast, links tend to be much tighter because of the need for close coordination, rigorous quality and training needs and the desire to keep valuable technologies within the enterprise. In some of these industries, market leaders are taking specialization to its logical conclusion by

renouncing manufacturing altogether. They confine themselves to R&D, design, marketing and after-sales service, letting contract manufacturers handle the entire production process.[43] Even in high-tech industries the production systems of transnational corporations are not closed: there is a growing tendency to outsource functions and inputs to capable suppliers. Thus transnational value chains can encompass local enterprises in host countries, with the spread and nature of the links depending on the technologies used, the capabilities of local enterprises and the strategy of the competitors.

- Industrial activities are being disintegrated across countries by function and stage of production, while remaining tightly linked to ensure the efficiency of the process. Thus an enterprise may design a semiconductor in the United States with an affiliate in India, buy the wafer from a foundry in Taiwan Province of China, assemble and test the chip in the Philippines and use an independent logistics company to ship it to Germany and market it all over Europe. Accounting may be in one country and back-office functions in another. These divisions, taking advantage of small differences in cost, logistics, skills and efficiency, are made feasible by new communication and management techniques.

- Different stages of the chain have different levels of value added and technology and so impose different capability needs for participants. Those at the bottom of the chain, with the simplest requirements, are most vulnerable to the erosion of competitive advantages (if the location offers primarily cheap semiskilled labour, it will tend to lose as wages rise). Thus there is constant pressure to upgrade products and processes within value chains, whether facilities are foreign owned or not.

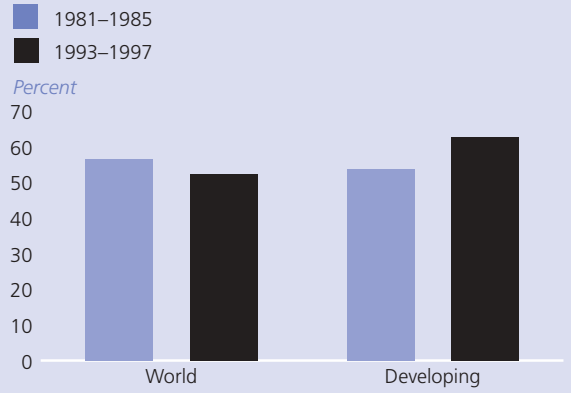
- That capital and technology are mobile does not mean that local capabilities cease to matter. If anything, they matter more because other factors are so mobile and require strong immobile factors to attract them to particular sites.[44] The factors that matter to investors using new technologies and looking for competitive locations are specialized skills, modern infrastructure, strong institutions, low transaction costs, efficient local suppliers, clusters of enterprises and providers of business support services. Thus the spread of transnational corporations promises much to developing countries in investment, technology, skills and market access. But flows of FDI are highly uneven and concentrated. The share of the top five recipients of FDI has declined for the world but risen for developing countries (figure 1.3). Part of this unevenness is due to political, social and policy factors that may deter investment. Part, however, is due to structural economic factors that lead transnational corporations to concentrate in countries.

These structural factors affect FDI location as political and other framework factors converge. Clusters again emerge as an important factor in attracting transnational corporations in activities where complementary factors and capabilities agglomerate. They are particularly important in knowledge- and skill-intensive activities, where the proximity of specialized suppliers, consultants and research and teaching institutes can be critical to competitive dynamism. The evidence suggests that FDI location is increasingly based on such localized factors rather than on general factors of the host country.[45] Governments seeking to tap FDI for industrial development have to pay attention to this new reality.

Transnational corporations look for efficient complementary factors in making their location decisions, but they also invest in raising the quality of local factors once they have invested. They train employees in new skills, help develop local suppliers, interact with and improve local institutions and so on. In 1989 Hewlett-Packard, one of the world's leading electronics companies, started operations in Bangalore, India, with about 10 people, basically to sell hardware. Still growing, it now employs more than 1,000 engineers. Apart from its sales arm, it has two large software development and R&D operations, one in Bangalore and another in Chennai. The second centre collaborates intensively with the locally owned Tata Consultancy Services.

Hewlett-Packard has forged strong links with other local enterprises—including 25 small and medium-size enterprises—and local research institutions. Its Bangalore affiliate interacts closely with the Indian Institute of Science and funds research in universities around the city. It also helps colleges in the locality develop courses and train teachers. Its

Figure 1.3 Share of top five countries in foreign direct investment receipts



Sources: World Bank (2000); UNCTAD (1995, 1999) and national statistics.
Note: Annual averages calculated for available data for 1981–1985 and 1993–1997.

engineering employees, who receive six months of rigorous in-house training, are encouraged to take out patents on their research (some 60 have been granted). Many travel regularly to Israel and the United States, where the enterprise also has R&D centres.

There is a minimum of capabilities in host countries below which it is not economical for transnational corporations to locate facilities or invest in further upgrading. The more advanced the technologies and functions being deployed, the higher the local capabilities required. It is up to the host country to ensure that it reaches the critical level. Moreover, it has to ensure that as wages and other costs rise, the quality of local factors improves to attract more complex technologies and functions—such as design and R&D. In other words, successful participation in the systems of transnational corporations requires constant efforts to build and improve local capabilities. The spread of global chains intensifies this need as more countries compete for high-value FDI.

Several features of recent FDI are of direct concern to industrial development:

- *Fast growth.* FDI flows are growing faster than other economic aggregates such as GDP, world exports and national gross fixed capital formation. As a result the share of international production—that under the control of transnational corporations and their affiliates—in global production is steadily increasing. If production by independent enterprises linked to transnational corporations is added, the share is rising even faster.

- *World trade dominance.* Transnational corporations dominate the world's visible trade, handling about two-thirds. This share is growing rapidly in activities with significant scale economies in innovation, production and marketing. These are the high-value end of the manufacturing spectrum, and countries that want to enter these dynamic segments increasingly have to rely on transnational corporations.

- *Global production systems.* Of the visible trade in the hands of transnational corporations, about one-third is within corporate systems—between different parts of the same enterprises. Important parts of such internalized trade are integrated international production systems, where transnational corporations allocate different functions or stages of production to different countries. In several high-tech activities (semiconductors, hard-disk drives) the bulk of world trade is within such systems.

- *Beyond production.* Transnational corporations are also placing accounting, engineering and marketing in affiliates—often high-value activities that boost local competitiveness and capabilities.

- *Even research and development.* Though one of the least mobile functions internationally, R&D is also being transferred overseas. Many transnational corporations, particularly those from small countries, have long conducted R&D abroad. For instance, more than half the patents filed by transnational corporations from Belgium, the Netherlands, Switzerland and the United Kingdom originate in their affiliates.[46] In many host countries foreign affiliates account for large parts of enterprise R&D. More than half of industrial R&D in Ireland, Malaysia and Singapore occurs in affiliates of transnational corporations (figure 1.4).[47] Even so, developing countries still account for a small share of overseas R&D by transnational corporations. Developing countries account for less than 10 percent of R&D for transnational corporations in the United States (UNCTAD 1999). The pattern is probably similar for other industrialized countries. This is not surprising: R&D is highly skill-, scale- and linkage-intensive, and most developing countries lack the necessary capabilities.[48]

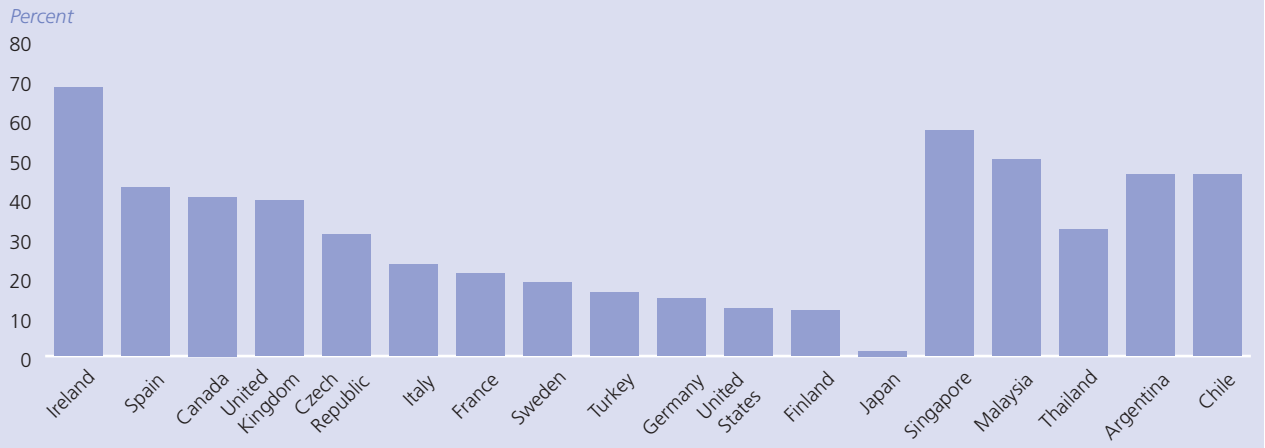
- *Innovation dominance.* Innovation is dominated by large transnational corporations. Many are unwilling to part with valuable technologies without a substantial equity stake—making FDI the most important, and often the only, source of advanced technologies.

- *Exports.* Transnational corporations are often central to local exports of technology-intensive products. Many such products are difficult to export independently because of the advanced technologies involved and the need for expensive branding, distribution and after-sales servicing. About two-thirds of consumer electronic exports from the Republic of Korea and Taiwan Province of China are original equipment manufacture.[49] Transnational corporations are also active in exports of low-tech products, where market information, branding, distribution and design are important.

- *Preferences for entry by mergers and acquisitions.* Cross-border mergers and acquisitions are the preferred mode of entry for transnational corporations, particularly in industrialized countries.[50] In 2001 the recession and falling share prices slowed mergers and acquisitions, cutting FDI in industrialized countries by about 40 percent (UNCTAD estimate). The decline is less marked in developing countries but still likely to cause some fall in FDI.

- *Even services.* FDI in services is rising rapidly as formerly homebound providers (as in utilities) privatize and globalize.

Figure 1.4 Shares of foreign affiliates in research and development, 1996–1998



Source: OECD (1999b) and national sources.

Telecommunications, power and water enterprises are good examples.

Heeding new international rules and regulations

Rules for international economic activity are changing, allowing it to respond as much as possible to market signals. Opaque rules and differences in trade and investment barriers impede the flow of products, capital, technology, information and skills across countries. New rules are designed to minimize costs and barriers—and to lead to more uniform national policies (box 1.7).

The best-known rules are those negotiated multilaterally under the General Agreement on Tariffs and Trade (GATT), now administered by the World Trade Organization (WTO). The WTO administers and embodies three main agreements: the updated version of the 1994 GATT, the General Agreement on Trade in Services (GATS) and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). (The WTO also administers four plurilateral agreements—on government procurement and on trade in civil aircraft, dairy products and bovine meat—not conditional on WTO membership.) The main agreements are complemented by multilateral agreements on safeguards, antidumping, subsidies, state trading enterprises and balance of payments measures. WTO agreements also include rules on the treatment of goods when they enter importing countries, including customs valuation, technical barriers to trade and import licensing. These agreements are intended to prevent the use of these measures for protectionist purposes.

GATT was a provisional agreement among contracting parties and was not a legal institution. In contrast, WTO agreements are ratified by member countries and are permanent, with a sound legal basis. The three main agreements—the 1994 GATT, GATS and TRIPS—form the WTO's institutional structure and are subject to a single set of rules and a single system for resolving disputes. Unlike with GATT, WTO members automatically commit to all WTO agreements, with only a few minor exceptions.

Other, less formal rules on trade, FDI and financial liberalization have been issued by the World Bank, International Monetary Fund (IMF) and aid donors. There are also international conventions on minimum labour standards. Several rules result from standards set internationally (for example, the International Organization for Standardization, or ISO) or by dominant regions or countries (such as the European Union or the United States). In addition, some rules are negotiated in regional trade agreements or bilaterally. (Most FDI rules are bilateral.)

Box 1.7 New international rules and regulations

Opportunities

- By aiming to level the playing field, new rules encourage enterprises to spread their operations across the globe and domestic competitors to improve their capabilities.
- More uniform rules and regulations facilitate the globalization of industry.

Challenge

- Eliminating policies that foster learning by infant industries hinders the development of new technological capabilities.

The new rules offer benefits but also impose costs. They reduce the scope for intervention in trade and investment—important because in many developing countries such interventions have been costly and inefficient. Increased reliance on markets can improve resource allocation and stimulate efficiency and dynamism. By reducing the risk, uncertainty and transaction costs associated with international transactions, the new rules may also raise the quantity and quality of FDI in developing countries. In addition, by strengthening intellectual property rights, the new rules may stimulate innovation and facilitate technology transfer.

The costs result from liberalizing when markets and supporting institutions are deficient, as they often are in developing countries.[51] The judicious use of infant industry protection, local content rules, FDI restrictions and lax intellectual property rights has yielded spectacular benefits in East Asia.[52] Strong intellectual property rights can raise the cost of products and technologies and restrict a valuable avenue for local learning without promoting innovation. Rapid liberalization can impose additional costs, giving an economy too little time to prepare for full market competition. Without the capabilities to attract and use technologies and resources productively, and facing the full forces of competition, poor countries may not draw enough of either. Instead they may lose part of the productive structure they have built up. By renouncing tools that foster learning, they may retard the development of new capabilities.

The net balance of benefits and costs remains unclear—particularly because it can vary by country and period. The underlying issue is whether the costs of market failure exceed those of government failure, and if the balance can be changed (an issue not explored here).

New standards and quality regulations

Although most countries are cutting tariffs and quantitative restrictions on trade, standards and various forms of certification have emerged as new entry barriers. Most of the new barriers relate to processes (not, as with tariffs, to products) and include quality standards (ISO 9000), environmental standards (ISO 14000) and labour standards (SA 8000). In addition, many countries have technical regulations, industrial standards and testing and certification procedures designed to protect public safety and health.

Standards offer many potential benefits for developing countries. They can be a source of technology transfer and a means of monitoring markets and obtaining information on competitors (box 1.8). They can also be a means of rationalizing costs based on codified best international practices, and can reduce technical transaction costs, information asymmetries and uncertainties between sellers and buyers, possibly enabling them to foster innovation.

Box 1.8 New standards and quality regulations

Opportunities

- Standards can facilitate technology transfer based on codified best international practices.
- Standards can facilitate international market access because they are becoming increasingly important for global buyers and as criteria for awarding contracts.

Challenges

- Standards can substantially increase the costs of entering international markets.
- Skills and capabilities must be substantially upgraded to meet the new standards, master new technologies and establish the required institutional information.

But standards can also impose costs on developing countries, forcing them to upgrade skills and capabilities, master new techniques and establish an institutional infrastructure (accreditation, metrology, standardization and technical support and information). If these costs are very high for a country (relative to its economy and exports), standards can pose a barrier to exporting (box 1.9).

More stringent environmental norms and regulations

The growing emphasis on environmental and social norms—such as child labour—can affect industrial and export development in developing countries. Pressures from consumer groups, non-governmental organizations (NGOs) and other bodies have led buyers to impose higher environmental standards on suppliers from developing countries, imposing compliance costs on enterprises. But compliance can also benefit society and the competitive positions of enterprises in developing countries (box 1.10).[53] Moreover, the private costs of compliance have not been very high, at least in industrialized countries. In the United States, for example, they are estimated at 0.6 percent of production value. Although there are no data on the costs of environmental compliance for industry in developing countries, case studies suggest that the costs would be similar or even less.

The key to using environmental pressures for competitive benefit lies in building the capabilities to transform a potential cost into an opportunity. Countries with weak capabilities may find that compliance costs damage competitiveness. It

Box 1.9 Standards and technical regulations as barriers to developing country exports

Standards and technical regulations provide many benefits to producers and consumers, not least of which is their information value. But they can also create trade barriers and segment markets—as when, for example, countries impose standards for colour televisions that differ from international norms, or protect domestic producers by issuing tailor-made standards such as requiring imported cars to have rain wipers on their headlights.

Different countries have different incentives to use standards and technical regulations for protection purposes. For some countries with low tariff protection, liberalizing standards and technical barriers can provide greater economic benefits than further tariff reductions. Whether standards help or hinder exports of developing countries depends on the products being exported and on a country's level of established standards. Exports can also be affected by higher costs resulting from duplicative testing performed by importers to assess conformity with standards. These duplicative tests are sometimes a response to the perceived weaknesses of standards organizations in developing countries.

A recent example shows the effect that standards can have on exports from developing countries. The European Union (EU) banned imports of fish caught in Kenya's Lake Victoria because salmonella was detected in a shipment and, later, because cases of cholera emerged in Kenya. Because of the ban, EU fish imports from Kenya dropped 25–37 percent—a serious blow because the EU market accounted for 95 percent of Kenya's fish exports. Improving hygienic conditions to reduce the risks of similar actions was estimated to cost $5.8 million.

Many country-specific technical regulations and industrial standards, created to protect public safety and health, instead become barriers to trade. To avoid such barriers, the WTO developed the Agreement on Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade. The Agreement on Sanitary and Phytosanitary Measures recognizes the right of member countries to introduce regulations that protect human and animal health from food-borne risks, human health from animal- and plant-carried diseases, and animals and plants from pests and diseases. These regulations should be based on scientific principles, should not be maintained without sufficient scientific evidence and should not be applied in a way that constitutes a disguised restriction on international trade. The agreement also states that when determining sanitary and phytosanitary protection, members should minimize the negative effects on trade. But are developing countries in a position to identify when this occurs? And when they identify such instances; are they in a position to challenge decisions by industrialized countries "based on" scientific principles?

The Agreement on Technical Barriers to Trade states that product standards adopted to protect public health and safety, preserve the environment and serve other consumer interests should not pose unnecessary obstacles to international trade. The agreement encourages member countries to use international standards but does not require them to change their levels of protection. It also sets out a code of good practice to guide central government bodies in preparing, adopting and applying standards and describes how local government and non-governmental bodies should apply their own regulations.

The agreement's overarching principle is non-discrimination. Fair and equitable procedures must be used when deciding whether a product conforms with national standards, and methods that would give domestically produced goods an unfair advantage are discouraged. To avoid duplicative testing, the agreement also encourages countries to recognize each other's testing procedures.

Manufacturers and exporters need to know the latest standards in their prospective markets. Developing standards and technical barriers requires a powerful scientific and technical base, which can take decades to build and which industrialized countries have established. Thus it is not surprising that these countries have the highest number of new standards notifications to the WTO.

In countries with low levels of protection, standards and technical regulations may provide more protection than traditional trade barriers. Nevertheless, many standards and technical regulations appear to be applied to heavily protected goods—particularly in industrialized countries. These include agricultural and agroindustrial products as well as textiles, clothing and footwear. Thus any industry- or trade-related technical assistance from international organizations should be complemented by careful analysis of the traditional trade barriers facing the main exports of the countries receiving such assistance.

Developing countries face serious difficulties in implementing the Agreement on Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade. A September 2001 WTO document includes several proposals to facilitate and reduce the costs associated with the implementation and administration of several WTO agreements, including these two. But the proposals do not go far enough, offering at best marginal improvements to an issue that appears to require a complete rethinking. Indeed, a huge gap exists between these reforms and the needs of developing countries.

Source: UNIDO.

Box 1.10 More stringent environmental norms and conditions

Opportunity

- Environmental compliance has positive effects on society and on the competitiveness of complying enterprises through increased innovation, lower costs, better resource use and first-mover advantages.

Challenge

- Developing countries lack expertise with accrediting and auditing systems for environmental compliance.

then becomes attractive for them to engage in a race to the bottom, lowering environmental standards to attract or retain industrial activity. Many developing countries—particularly the least developed—lack the capabilities to use environmental technologies. They even lack the basic capabilities to run the institutional (accreditation and auditing) framework for environmental compliance.

Stricter intellectual property rights

Industrial and technological development will be influenced by the TRIPS agreement. The agreement could affect invest-

Box 1.11 Stricter intellectual property rights

Opportunity

- Stricter intellectual property rights should stimulate innovation, learning and risk taking in industrialized and newly industrializing economies.

Challenge

- Stricter intellectual property rights can raise the cost of technology imports for developing countries and limit their ability to reverse engineer and learn from foreign technologies.

ment, technology transfer and innovation—and thus the accumulation of technological capabilities (box 1.11). Predicting its net result is difficult. Empirical evidence is scanty, the processes are complex and the effects are highly context-specific. It is widely accepted that stricter intellectual property rights can have negative effects on developing countries, particularly those low on the industrial and technological ladder.[54] Such rights may not stimulate local innovation and may not promote overseas innovation relevant to these countries' needs. They are also likely to raise the cost of technology imports—through higher licensing fees and product prices, more advanced skill needs to manage the new regime and greater scope for monopolistic practices by holders of intellectual property rights. Finally, stricter intellectual property rights can constrain technology development through copying and reverse engineering—activities used to great effect by newly industrialized economies and, earlier, by many industrialized countries (box 1.12).

At the same time, the TRIPS agreement offers benefits.[55] Stricter intellectual property rights stimulate innovation—in industrialized countries and newly industrialized economies and even in least developed countries with nascent technological activity. Stricter rights can also boost FDI and sales of advanced technologies (by innovators who need to protect proprietary knowledge). Still, the net benefits will depend on a country's level of industrial and technological development. In the least developed countries the benefits may take a long time to materialize, and in present value terms (future values discounted at an appropriate interest rate) the costs may outweigh the benefits. Many developing countries are understandably concerned about this important topic, which requires further investigation.

Box 1.12 The case for strong protection of intellectual property rights

Protection of intellectual property rights has played an ambiguous role in technological and industrial development. Many of today's industrialized economies relied on slack intellectual property rights to promote the technological development of their enterprises, shifting to stricter rules only when they had achieved technological parity with the leaders. The most technologically dynamic East Asian Tigers—the Republic of Korea and Taiwan Province of China—used copying and reverse engineering for long periods to promote local enterprises, only recently adopting stricter intellectual property rights.

Protection of intellectual property rights is based on the premise that innovative activity is seriously constrained if innovators cannot reap the fruits of innovation. Thus copyrights protect the rights of authors (books, music, software), trademark registration protects unique trade logos and symbols, and patents protect the rights of inventions with industrial applicability (products as well as processes). For technology development, patents are most relevant.

Patents are supposed to spur innovation. They grant exclusive rights of use, sale and manufacture to owners of intellectual property, compensating them for undertaking expensive and risky innovative activities. But in exchange, owners must disclose the invention on the patent document for "anyone skilled in the art to be able to replicate". Thus patents are a trade-off: a market distortion is created in exchange for disclosing information on the technology. This disclosure is intended to benefit society by disseminating new technologies and encouraging competitors to invent around it, encouraging a second round of innovation.

Advocacy of strong intellectual property rights presumes that the benefits of appropriation for innovators and disclosure for competitors outweigh the drawbacks of market distortions, making intellectual property rights beneficial to society. This presumption, almost impossible to test empirically, remains the subject of debate. Most developing countries, seeing themselves as users of existing technologies rather than makers of new ones, consider it premature to adopt Western models of intellectual property right protection. Indeed, technological catch-up could be constrained if developing countries enforced stronger intellectual property rights. Stricter rights could raise the cost of technology imports and restrict the ability to learn through reverse engineering.

This argument has some merit. In the absence of a domestic industry lobby, low-income countries have strong intellectual property rights. And for obvious reasons, high-income countries also protect intellectual property rights very strongly. Middle-income countries offer the least protection for intellectual property rights.

Two developments may change the shape of things to come. First, investment flows are seeking global destinations, and enterprises' ability to protect their knowledge assets is a critical determinant in choosing destinations. Second, all WTO members that are signatories to the TRIPS agreement have agreed to reform their intellectual property rights regimes by 2004. Though the eventual benefits of this universal protection remain to be seen, for now such reform is a bitter pill for domestic industry and consumers to swallow.

The challenge will be to help developing countries design policies and instruments that are in line with their technology-follower positions—and that balance proprietary motives with access, efficiency and distributional considerations. Doing so would direct attention to drafting competition policies, price regulations and targeted subsidies and other transfer mechanisms that mitigate the potential negative effects of stronger intellectual property rights. Finally, alternative methods of encouraging local innovation may have to be devised to fit particular needs, such as protection and compensation for uses of indigenous knowledge in some societies.

Sources: Based on Chang (2001, background paper) and Luthria (2000).

The case for stronger intellectual property rights is easier to make for economies such as Brazil, India, the Republic of Korea, Singapore and Taiwan Province of China, with their strong technological bases. In these economies weak intellectual property rights can deter transfers of valuable technologies and investments in risky R&D by domestic enterprises. But a case can be made for less stringent application of the TRIPS agreement in the least developed countries, with more exclusions and longer grace periods,[56] so that they can participate meaningfully in global industrial activity.

Notes

1. Dicken (1998); Freeman and Perez (1988).

2. Streeten (2001) argues that globalization is not "international integration": it is partial international integration that, for various reasons, leads to national disintegration. Because industrialized countries have less demand for low-skilled workers, income gaps are widening in these countries. Meanwhile, developing countries seeking to prevent a brain drain are forced to pay higher wages to skilled workers, worsening income distributions in these countries as well. In addition, developing countries have less tax revenue available to pay for social services, though the need for them is rising. Moreover, elites in developing countries are adopting the values of their counterparts in industrialized countries and so neglecting essential social services such as education and health care. And minorities are trying to break away to share directly in the benefits of globalization. In sum, "globalization has led to polarization" (p. 54).

3. World Bank (2001b).

4. Chenery, Robinson and Syrquin (1986).

5. Reinert (1995).

6. Chenery, Robinson and Syrquin (1986).

7. *The Economist* (2000b), p. 10.

8. Quah (1999).

9. Dodgson, Gann and Salter (2001).

10. Gordon (2000); Pohjola (1998).

11. OECD (2000a, p. 39).

12. Cantwell and Santangelo (2000).

13. *Financial Times,* 18 June 2001.

14. Quah (1999).

15. Dicken (1998).

16. Pigato (2001).

17. Freeman and Perez (1988).

18. OECD (1999b) defines high-tech industries as manufacturers of aircraft, office and computing equipment, pharmaceuticals and communications equipment. Medium-high-tech industries are professional goods, chemicals (excluding drugs), electrical machinery, non-electrical machinery, motor vehicles and other transport equipment. Low-tech industries are paper, textiles and apparel, leather, food, beverages, tobacco and wood products. The remaining activities fall in the medium-low-tech category.

19. In 78 countries accounting for more than 95 percent of global production, high-tech production grew 5.9 percent a year in 1980–1997, compared with 2.7 percent for other manufacturing activity, and high-tech exports grew 10.8 percent, compared with 7.3 percent for other manufactured exports (NSF 2000).

20. Lall (2000).

21. Data are from OECD (1999b). Business accounted for a larger share of R&D in Japan (73 percent), Sweden and Switzerland (68 percent each) and the United States (64 percent). But its share was lower in Canada, France, Italy, the Netherlands and Spain, where government accounted for more than half of R&D.

22. In the United States, for example, the share of service enterprises in R&D rose from 4 percent in 1980 to 20 percent in 1997. In some countries the share of services is far higher—hitting 37 percent in Canada and 32 percent in Denmark and Norway. But among other industrial leaders, such as Germany and Japan, manufacturing still accounts for a large share of innovation, and services account for only about 4 percent of R&D funding.

23. OECD (2000a, p. 32).

24. Humphrey (2000).

25. In Europe the most active participants were enterprises from the United Kingdom (1,036 alliances), Germany (994), France (715) and the Netherlands (680). Other participants included enterprises from the Republic of Korea (119), former Soviet Union (90), China (86), Australia (63), Israel (51) and Taiwan Province of China (48). Data are from NSF (2000, pp. 2–57).

26. OECD (2000a, p. 33).

27. Mansell and Wehn (1998); OECD (2000a).

28. Dicken (1998); Radosevic (1999).

29. NSF (1998).

30. Concentration of innovation between countries is also very high. See chapter 3 for data on developed and developing countries separately.

31. The supply chain approach—which came first—focuses on activities that include getting raw materials and assemblies into a manufacturing operation smoothly and economically. The value chain approach has a different focus and a larger scope. Value chain analysis looks at every step from raw materials to the end user, down to disposal of the packaging or product after use. The goal is to deliver maximum value to the end user for the least possible cost. Thus supply chain management is a subset of value chain analysis.

32. Mansell and Wehn (1998).

33. OECD (2000a).

34. Best (1990); Humphrey and Schmitz (1998); Nadvi (2001); Schmitz (1999a).

35. Pyke and others (1990).

36. Swann and others (1998). Recent research on geographic agglomeration suggests that agglomeration economies develop cumulatively through an accretion of learning, skills and networks (Krugman 1991; Venables 1996).

37. Schmitz and Nadvi (1999).

38. Bell and Albu (1999).

39. ILO (2001).

40. ILO (1998).

41. Dodgson and others (2001).

42. Pavitt (2001).

43. The trend is most marked in electronics enterprises in the United States, but it is spreading to other industries and countries. By early 2000 contracted manufacturers accounted for about 11 percent of the market for electronics hardware. The largest, Solectron, was set to sell $20 billion in products by the end of 2000. See *The Economist* (2000a) and Sturgeon (1997).

44. Narula and Dunning (2000).

45. UNCTAD (2001).

46. Cantwell and Janne (1998).

47. The data come from OECD (1999a), Wong (2000), Rasiah (2000) and private communications from Peter Brimble on Thailand and Daniel Chudnovsky on Argentina and Chile.

48. R&D in developing countries tends to be concentrated in a few economies. For transnational corporations from the United States those economies are Argentina, Brazil, Hong Kong Special Administrative Region (SAR) of China, Malaysia, Mexico and Taiwan Province of China.

49. Hobday (1995). In 1985 more than 40 percent of the Republic of Korea's exports were original equipment manufacture, and in 1990 about three-quarters of its electronics exports were original equipment manufacture (Cyhn 2001).

50. Though it is difficult to compare data for FDI and mergers and acquisitions, about 80 percent of recent FDI in OECD countries has been in mergers and acquisitions (UNCTAD estimate). Mergers and acquisitions have also been important in Latin America and, since its financial crisis, in East Asia.

51. Stiglitz (1996).

52. Lall (1996).

53. Environmental standards can trigger innovation not just in greener production but also in new ways of cutting costs and material and energy waste. Such standards can also create first-mover advantages for regulated enterprises.

54. UNDP (2001); UNCTAD (1996); Maskus (2000); World Bank (2001a).

55. Maskus (2000).

56. World Bank (2001a).