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Industrial Development Report 2005

Capability building for catching-up

Historical, empirical and policy dimensions

EXECUTIVE SUMMARY

UNITED NATIONS
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Executive Summary

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tries' prospects for catching-up with more advanced countries in productivity and income hinge increasingly on their ability to rapidly build up competences. This places domestic knowledge systems at the core of industrial development strategies. This is not new, but has acquired far greater importance in recent times.

Owing to the cumulative nature of learning, differences in the rate of accumulation of technological capabilities have an inherent tendency to translate into gaps in economic prosperity across countries. Narrowing these gaps has required sustained catch-up efforts of various kinds. Pivotal among these efforts has been the swift accumulation of technological capabilities. Contrary to views once popular among economists, domestic knowledge generation has been a requisite of catching-up. Tapping into the global pool of knowledge and building domestic knowledge systems go hand in hand.

Collective learning, both within single organisations and at more aggregated levels, is a vital feature of domestic competence building. Indeed, the effectiveness with which a firm is able to participate in and benefit from the generation of technologies is largely given by factors that lie outside the scope of the individual enterprise. The institutional environment within which a firm operates determines its incentives and opportunities and thus affects the scope of the capabilities it needs to master. The intervening factors include incentives to innovation, conditions of access to various kinds of inputs (including finance, skills and knowledge) and to relevant markets and regulatory requirements. Behind many of these factors lie the capabilities of a multiplicity of organisations, including input suppliers, educational and training institutions, research organisations, financial institutions, regulatory agencies and specialised service providers. Clearly then, both the quality of firms' technological capabilities and the scope for acquiring new capabilities can only be properly understood by considering the context within which both are shaped. The process of competence building is hence not only cumulative at an individual level but also systemic in character.

Effective public policies must aim not just at creating a functional S&T infrastructure adapted to the specific needs of the productive sector, but also at enabling the emergence of a domestic demand for technological capabilities. In the private sector of the economy such demand depends on how far business firms internalise innovative activities as a key ingredient of their competitive performance. This critical pre-condition entails addressing the interplay and complementation between the incentives framework and the services of the S&T infrastructure, on the one hand and, on the other, the impact of various kinds of externalities (technological, informational, coordination) on companies' ability to conduct the risky business of exploring new production areas and new markets.

Critical factors for catching-up: assessing the evidence

The idea that social capabilities lie at the heart of economic development processes is not new. Until recently, however, attempts to rigorously assess the critical factors affecting catching-up potential – a precondition for effective policy design in developing countries – were handicapped by insufficient data and lack of relevant metrics.

The Report shows that this gap can be narrowed by applying factor analysis to recently collected data, by discerning broad dynamic trends for a cross-section of countries and identifying factors that affect growth.

Overall, the variables considered depict various facets of technological capability, institutions, policies and geography, which are broadly aligned with various theories of growth and convergence found in the economic literature. When common vectors underlying these variables are extracted from the data, five composite factors emerge. The first one is *knowledge*, by far the most important one, comprising variables highly correlated with the creation, diffusion and use of knowledge, such as research and development (R&D) and innovation, scientific publications, information and communications technology (ICT) infrastructure, quality management and education. The second factor is *inward openness*, which comprises indicators of import trade and inward foreign direct investment (FDI). The third factor, *financial system*, concerns overall aspects of market capitalisation, country risk and access to credit. Together with *governance* and the *political system*, as well as a range of control variables covering geography and history, these factors are used to probe the issue of catching-up empirically.

As expected, social capabilities – including knowledge, governance and financial structure – are found to be positively and significantly associated with development level. The stock of knowledge seems to be a major source of difference in income levels across regions in 2002. Most strikingly, almost 60 per cent of the difference in income level between Sub-Saharan African (SSA) countries and the industrialised countries can be attributed to the difference in the stock of knowledge. However, low current levels of social capabilities do not necessarily mean that low-income countries are doomed to stay poor.

In fact, initially low levels of development (measured either in terms of income or knowledge stock) can signal a larger *potential* for faster growth and catch-up. Whether this potential for catching-up is or not realised depends on the rapid accumulation of capabilities. Low-income countries can be expected to grow more than two percentage points faster than the rich ones, other conditions (such as knowledge and governance) being equal. However, these other conditions are often not equal: the developing countries' higher potential for technological catch-up may be more than offset, for instance, by the better quality of the financial system and faster growth of knowledge in the rich countries. Hence, the difference in gross domestic product (GDP) per capita between rich and poor countries may end up widening rather than narrowing. In other words, in addition to facing the challenge of coordinating capability building policies across a wide range of areas, developing countries must also keep adjusting their aim to a moving target, due to the rapid growth of capabilities within rich countries.

Although the initial gap in income suggests a greater growth potential for the least developed countries (LDCs), in the model used in the Report this is actually more than offset by the other factors taken into account. The result is a growth rate 2.1 percentage points lower than that of the successful industrialising countries of East Asia. The three factors cited – the financial system; governance; and the knowledge gap, a good proxy for overall social capabilities – account for approximately 80 per cent of the income growth differential between the two regions.

Empirical evidence presented in this Report suggests that countries wishing to strengthen their competitive position and to catch-up need to invest steadily in the generation of knowledge. This is a clear priority for development, but it is not sufficient. Well-developed knowledge capabilities need to be supported by an enabling environment such as a well-working financial system and governance capabilities. The historical and descriptive evidence presented in Chapters 3 and 4 provide further insights into the role of domestic capability building in catching-up.

Catching-up and falling behind: accounting for success and failure over time

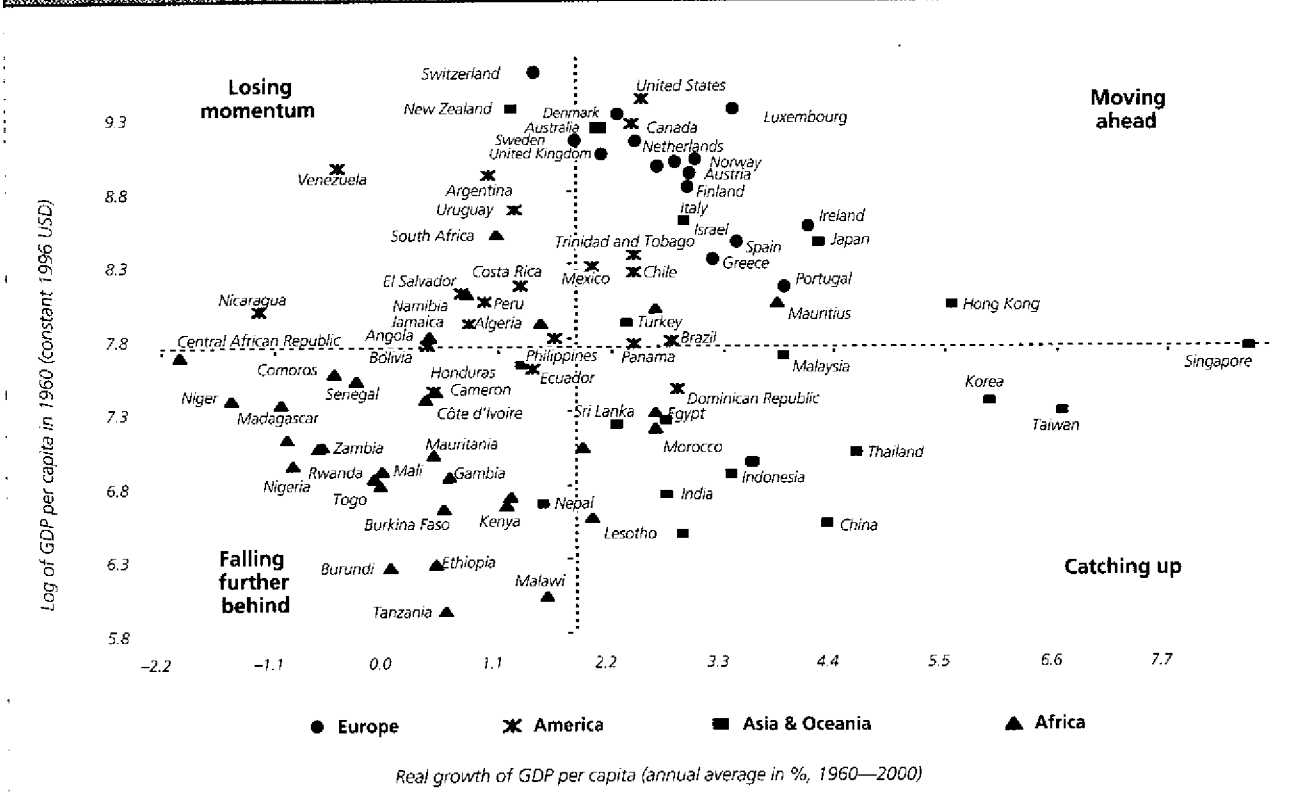
What determines success or failure in the bid to catch-up? This question has intrigued policymakers, academics and industrialists for more than a century. At the extremes, the long-run trend since the Industrial Revolution seems to be towards divergence, not convergence, in productivity and income. But, in accordance with the empirical evidence provided above, what history shows is that in the few countries that have managed to catch-up with, even overtake, the leaders at different points in time, the key driving forces were technology and the environment that fosters it.

Data on per capita income across countries and regions since 1820 shows a long-run tendency towards divergence in the global economy. Not only have high-income countries grown faster on average than those with low income, but the distribution has also widened, so the gaps between the richest and poorest have grown. While the period between 1820 and 1950 was one of divergence in economic performance between the leading advanced countries, the decades that followed were characterised by 'club convergence' in income and GDP per capita among the industrialised economies, and further divergence between them and the lower-income economies. In particular, this tendency seems to have gained momentum after 1980.

Probably the most striking feature of the long-run evidence is the great variation in performance between countries with comparable initial levels of productivity and income. That said, the data helps to distinguish clearly between four groups of countries (Figure 1):

- countries that, having started with high level of initial income, are still *moving ahead* with high growth rates,
- high-income countries that have started to *lose momentum*,
- countries that, having started with low levels of income, enjoy high growth rates and are in the process of *catching-up*, and
- countries that are *falling further behind*.

Figure 1. Convergence vs. divergence in GDP per capita over 1960s–1990s



Source: Penn World Table Version 6.1 (Heston, Summers and Aten, 2002).

Productivity catch-up requires higher-than-average growth for a sufficiently long time. How long this period must be depends on the size of the initial gap with respect to the target level. However, the aim of catching-up efforts cannot be expressed solely as that of achieving higher-than-average levels of GDP per capita. In order to better account for patterns of convergence and divergence, it is necessary to undertake a historical assessment of institutional developments that have influenced the accumulation of technological and social capabilities in catching-up countries.

Role of knowledge systems in catching-up experiences

The diversity of growth processes at the country level reflects differences in institutional patterns, interactions between the social actors and the pace at which social and technological capabilities have been accumulated. A privileged vantage point to assess the role of institutions in catching-up scenarios is that of focusing on the components of domestic knowledge systems such as higher education, technical and vocational training, research, technical associations, standards, metrology and technical regulatory bodies and institutions that support the interactions between training and research activities in the public sector and the formation of entrepreneurial and technological capabilities in emerging industries.

The institutional evolution of domestic knowledge systems in countries such as Germany, the United States (US) and Japan in the 19th century as well as in Taiwan Province of China and the Republic of Korea more recently illuminates the role of collective competence-building in economic catch-up. In all these cases significant institutional adaptation and innovation took place in response to particular local conditions. Amid the resulting diversity, however, important similarities are found, which provide useful lessons for contemporary policies. The success of the respective policies often relied on achieving a balance between rapid accumulation and enhancing the demand for technological skills and capabilities.

Since the 19th century catching-up experiences have often involved significant increases in enrolment in tertiary education – especially in science and engineering fields – as well as important adaptations to the needs of emerging industrial sectors. Not only was access to education greatly broadened, but also the scope of academic education, both by advances in natural science research and changes in attitude towards professional training. The international movement of students made another important contribution to the spread of S&T during the 19th and 20th century, coupled with movements of skilled industrial personnel. These changes coincided with the emergence of science-based industries – such as chemicals and electrical equipment – and of formal R&D laboratories in firms in these industries, both of which had an impact on the concept of the contribution expected from modern universities. Public policies and especially public funding often helped bring about greater closeness between industrial practice and academic education. The experiences from countries such as Japan and the US show that, while it is important to ensure continuity and pertinence, it is also necessary to strike a balance between supporting research that responds to the current needs of industry and making sure that part of the funding is allocated more flexibly to research with potential future returns.

Creating a domestic supply of scientists and engineers may not be sufficient to induce the emergence of private sector demand for their knowledge. Particularly during the early phase of industrial development, the creation of an effective technological infrastructure is likely to require a set of complementary policies and institutions to support private entrepreneurial efforts. A crucial determinant of an effective relationship between university and industry is the degree of responsiveness of educational curricula and activities to the emergence of new areas of industrial technology or specialised sectors. This often entails establishing effective networks between institutions of higher education, technical and vocational training, research units, technical associations and industry.

Competence building policies in Taiwan Province of China and the Republic of Korea provide useful examples of the design of institutions and investment in capabilities for which there is little initial demand. Imbalances in the national supply and demand of skilled personnel in these economies were remedied through private-sector development and policies that struck a balance between catering to current needs and anticipating the future needs of industry. Particular attention went to the efforts of public research labs in transferring and disseminating technology – such as the Industrial Technology Research Institute (ITRI) in Taiwan Province of China and the Korea Institute for Electronics Technology (KIET) in Republic of Korea.

The scope of the contributions of universities and public research institutes to capability building in a sector must evolve in tune with the nature of the technological activities carried out by national firms, their access to other sources of technological knowledge, and the structural characteristics of the evolving industry. Skill formation in the private industrial sector has been a critical component of the technological capability building efforts in virtually all catching-up countries. Public policy has often helped to shape these efforts, both by means of legislation on accreditation and certification and by encouraging skill formation through the use of levies and incentives. Another institutional set-up for which a wealth of experience exists is the establishment of industry research organisations such as the Engineering Research Associations in the United Kingdom (UK) and Japan, which were important means of raising technological capabilities across the board in a given industry by facilitating the exchange of technical information and the creation of opportunities for risk and cost sharing between participants. Entrepreneurship development policies, including incubator programs and venture capital support can also, given appropriate framework conditions, greatly assist in encouraging innovative activity.

The role played by standards, quality and metrology institutions in the formation of innovation systems is a much under-studied aspect of technological infrastructure. Chapter 4 closes with a review of the role of such infrastructure in the recent catch-up experiences in Taiwan Province of China and the Republic of Korea, which suggests that the capabilities embedded in these institutions can also promote industrial deepening and technological catch-up.

Accessing and mastering knowledge

Unequal access to codified information has been at the centre of public debates on the so-called knowledge divide. These debates have coincided with an explosive growth in the stock of codified S&T knowledge. The amount of new information stored on various forms of media doubled between 1999 and 2002, implying a 30 per cent yearly growth rate. Information flows through electronic channels have also increased at breathtaking speed, a phenomenon fuelled partly by the growth in the number of Internet users and the amount of information stored on the web. What is the potential significance of this trend for developing countries' strategies and prospects?

Specific features of these trends create challenges and opportunities for developing countries, whose development prospects are at least partly defined by their ability to adopt and adapt technologies (physical and social) originated elsewhere, that is, their ability to learn to apply S&T knowledge to the implementation of locally innovative economic activities. This in turn depends on the systematic nurturing of indigenous technological capabilities and the development of a domestic technology infrastructure, which can foster greater access to the available sources of codified knowledge.

Developing countries face two kinds of challenges in this respect. The first one arises from barriers to access that often accompany the codification of knowledge, imposed by the sources of that knowledge. Among these, pricing is pivotal. The second challenge is posed by the limitations on the use of codified knowledge, even when access is granted. Access to codified knowledge may be opened, but IPR enforcement may substantially restrict its use.

From a developing country's standpoint, the impact of the Trade-Related Intellectual Property Rights (TRIPS) agreement results from a balance between two forces: the marginal impact on domestic learning and innovative activities from increased access to patent disclosures, and the consequences of the creation or strengthening of IPRs on inward technology transfer. With respect to the former, the effect can be expected to be more significant for patenting activities by resident firms or individuals than by foreign holders. As to the latter, stronger IPR protection might curb activities of reverse engineering and imitation of foreign products, but it might also support technology transfer activities structured around licensing agreements.

The capabilities required to take advantage of codified knowledge depend on the intended uses of the knowledge to be acquired. These may range widely, from merely transmitting it to third parties to reproducing it in an experimental setting. There are also differences across sectors regarding how pervasively codified knowledge is available as a carrier of commercially useful technology, and how complex are the capabilities required by the potential users of available knowledge.

Questions arise as to why dissemination is difficult, why advances in scientific knowledge do not lead immediately to new technological applications, and why the effectiveness of both processes varies significantly across sectors. Two fundamental explanations have been put forth. The first one is that the output of scientific research is not information that can be used at trivially low costs in the production and implementation of new technology. Scientific activity relies on a complex enabling infrastructure. Second, the mastery of tacit knowledge affects the efficacy of technology dissemination processes across firms or countries. (e.g. standards and technical regulations, generic drugs and semiconductors)

The capabilities required for exploiting various forms of codified knowledge reside only partly within any given firm. A distinctive feature of an innovation system is the presence of multiple, interacting actors and institutions, whereby firms' capabilities are enhanced by access to those of other actors in the system. The extent to which developing country firms can access and use available sources of codified knowledge depends on the diversity of the collective skills and capabilities they can rely upon in order to introduce locally innovative technologies. A remarkable mismatch is to be noted, however, between the increasing recognition of the need for domestic knowledge systems and a quite generalised recent decline in the allocation of resources to capability building in most of the developing world. This trend runs contrary to that found in the experience of the successful catching-up countries highlighted above.

Policy, knowledge and business innovation

In modern societies development and economic welfare rest on the permanent creation and destruction of knowledge. Rapid acquisition of new knowledge is fundamental to successful economic performance. Seizing opportunities for catching-up depends on the systematic mastery of knowledge and skills. This mastery does not develop more than minimally unless societies invest in acquiring it.

Competence building has yet to be given the centre-stage position it warrants both in the formulation of development policies and in the conceptual framework underlying these policies. This is because, first, theoretical considerations provide a very limited guide for policy and, second, there is a dearth of appropriate tools, metrics, heuristics and needs-assessment methodologies.

Although few would dispute that economic restructuring and productivity growth are increasingly driven by innovation, conventional policy approaches still do not adequately deal with this reality, particularly with the need to match the demand and supply of innovative resources. While the price system understates the demand for innovation because markets tend to under-reward innovation, system weaknesses often block the supply skills and expertise as well as their application to innovative activity.

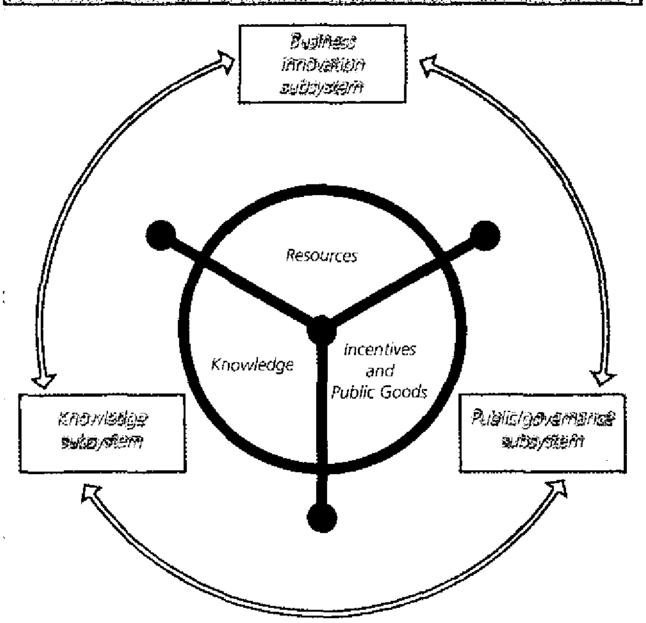
A major inadequacy of conventional policy approaches to development stems from the insufficient attention paid to the dynamic correspondence between competence building policies and private sector development. Policymaking to foster economic transformation from this perspective still awaits formulation both in terms of a general framework and of specific guidelines.

The capability approach provides a privileged vantage point to address these issues. In articulating such an approach for the emergence and growth of innovation systems (IS) in developing economies, key phases of transformation need to be identified.

As poor countries get richer, sectoral production and employment become less concentrated and more diversified. This pattern lasts until fairly late in the development process. Then, incentives to specialise take over as the major force. Beyond a few specialised, export-oriented activities, a similar pattern can be expected in the allocation of resources to technological effort where technological learning tends first to spread across a broad range of activities, to become increasingly specialised and differentiated as the economy attains higher levels of development. Once business enterprises, along with complementary agents, have acquired broad-spectrum innovative competences, can they afford to seek more specialised innovative capability development tracks.

Information externalities, asymmetries and complementarities call for non-market interventions to overcome hurdles in the process of innovative development. These hurdles give rise to various kinds of mismatches in the pace of advance of capability building in the domestic knowledge, the business innovation and the policy/governance subsystems. Only when these subsystems advance in step does a potential for catching-up emerge (see Figure 2). This potential normally develops along sectoral lines, in the context of conducive overall framework conditions, including those relevant to economy-wide innovative capability development.

Figure 2 Steering the transformation of the innovation system



Source: UNIDO.

Three phases can be discerned in IS growth. They consist in: first, establishing threshold conditions for the emergence of IS; second, promoting innovation-based growth; and third, prompting the growth of differentiated and specialised functions to generate systemic innovative responses to emerging opportunities. As we move across these phases, strategic priorities shift from stimulating generic innovative skills in the business sector to generating a critical mass of innovative small- and medium-sized enterprises (SMEs), to the emergence of a venture capital/private equity industry market. Similarly, the private sector's share of total R&D increases, whereas the emphasis of the support infrastructure shifts from basic vocational training, information diffusion, metrology and standards to fostering specialised infrastructures and frontier technologies.

The experience of Ireland and the successful Asian catching-up countries highlight the fact that, although the respective strategies may differ in their degree of reliance on FDI and ways of mastering technology and skills, catching-up is highly unlikely to take place in the absence of openness to international trade, investment and technology flows. Developing-country policymakers must operate under severe limitations that did not exist back in the 1970 and 1980s, particularly those relating to stronger IPRs and the prohibition of export subsidies. These constraints do pose very stringent demands on the ability to assimilate technology and to export. However, the loss of policy autonomy ought not be exaggerated.

The crucial constraint on the pursuit of catching-up policies today resides in the national capability to articulate the co-evolution of the domestic knowledge, business innovation and policy/governance subsystems so as to move IS forward. The emergence of this capability depends essentially on indispensable domestic factors such as social consensus and framework conditions. These conditions are not confined to the generic public goods of the conventional discourse (macroeconomic stability, rule of law, good governance) but also comprise stimuli to technological capability formation and innovative development.

Standards, technical change and catching-up

Technical standards help focus the direction of technological search efforts by limiting product diversity and speeding up selection. This entails the need for policy to watch the balance between gains in innovative efficiency and reductions in the necessary degree of diversity of innovative endeavours.

The ensuing challenges for policy are not trivial. For instance, a new technology may have a lower potential for improvement than an old one it intends to replace, or the costs of shifting to a new, more promising technology, may be perceived as higher that those of continuing with the old one. As policymakers are rarely able to anticipate technological change and time their decisions optimally, they are normally left with the responsibility of creating appropriate framework conditions for standardisation, letting private committees manage the standard-setting process.

The nature of the incentives provided by standards and IPRs differs sharply. The former are largely market-driven devices for collective processes of innovation convergence, which promotes selection, while the latter are aimed at rewarding individual inventions, thus fostering diversity. Since they influence the trade-offs between the public and private dimensions of knowledge differently, a potential for conflict ensues. Such is the case when applying standards requires the use of proprietary technologies with high patent and standards intensities.

While potentially moving towards the coordination of technologies, standardisation has also been taking a more pivotal role in the knowledge-creation process. The influence of IPR pooling is heightened by the increasing intensity of patenting in particular areas such as mobile telecommunications and semi-conductors. The ensuing effects on the use of IPRs and standards, combined with trends such as market integration across borders, convergence of technologies and the increasing pace of technological change have put them on a collision course.

IPRs and standards may be designed to complement one another, thus fostering the creation and diffusion of knowledge; or IPRs may be used to block standards; or the conflicts may be mitigated by efficient licensing mechanisms such as equitable patent-pool schemes allowing IPRs to be factored into standards without infringing property rights. This is an emerging intermediate scenario.

The key conclusion coming out of this analysis is that only firms that possess technological assets to trade will be placed in a position to exert influence on the outcome.

From the perspective of countries attempting to catch-up, actual disadvantages in this field may be offset, at least partially, by paying particular attention to the early integration between R&D and standardisation activities at the project, program and institutional levels. A window of opportunity in this respect arises when building up new research and standardisation capabilities, in contrast with the often broken-up systems in industrialised countries, which are just beginning to address the problem.

The extent to which developing country domestic firms can influence the specification of international standards will depend largely on the quality of their own patent portfolios.

As technological pace-setters, advanced countries exert great influence on developing-country standardisation processes. Yet, involvement by developing-country experts in international standard-setting activities contributes to enrich their tacit knowledge – in addition to the access to codified knowledge that the standards themselves entail. However, these experts cannot be expected to exert much influence over them. While accounting for the overwhelming majority of ISO members, for instance, developing countries account for just three out of the 12 members of the Technical Management board and are responsible for barely five per cent of its Technical Subcommittees, which set policies, actions and standards. In contrast, the US, Germany, the UK, France and Japan hold among them 65 per cent. The remaining 30 per cent is held by other developed nations. Nevertheless, active involvement in international standardisation processes may contribute to developing countries' awareness about developed-country preferences. Since standards are shaped not just according to technological requirements, but also to market needs and users' preferences, this may ultimately have a knock-on effect on the final specification of international standards and on the competitiveness of developing-country firms.

From a developing, potential catching-up country standpoint, the information and the practices and routines entailed by standards (particularly those relating to quality management) are an input for improved competitiveness, credibility and reputation. As is only to be expected for the case of a standard-follower country, this occurs pretty much across the board, rather than just in frontier technology areas. Because of the very recent and rapid diffusion of public technical standards in developing countries, governments have a key role in helping set up the necessary standards and conformity assessment infrastructure as part of the threshold framework conditions for private-sector development. An efficient infrastructure of this kind, still largely absent in most of the developing world, is indispensable to offset the competitive disadvantages suffered by manufacturing firms from latecomer countries.

Standards are also important for developing countries embarking upon high-technology sectors whose products and services are becoming rapidly diffused globally. Adoption of standards in this case may entail important trade-offs requiring careful monitoring of technological trends.

Because of the different role of standards in advanced and developing economies, the policy implications also differ greatly. While in the former public policy issues are largely about stimulating the private sector to better handle the production and distribution of knowledge by means of the necessary institutional innovations, in the latter they are essentially about investing in capability building and in creating the incentives and institutions for the development of a responsive standards and conformity-assessment infrastructure to help enhance firms' quality management and international competitiveness. Only in very few cases are potential catching-up countries beginning to play a role in standard-setting in emerging technology fields. This experience may show the way for the countries that follow and for that reasons it calls for close monitoring.

Building Capabilities for Food Safety

Forty per cent of world trade in agricultural products (US$583 billion in 2002) comes from developing regions (WTO, 2003). While the international debate has largely focused on the controversy over agricultural subsidies in trade negotiations, much less attention has been paid to the capability building needs of developing countries in the face of ever more stringent requirements to the trade in agricultural products. As the volume of international trade in agricultural products originating from developing countries suggests, much is at stake, even after discounting the effect of trade distortions created by subsidies.

The ability to compete in agricultural and food products is increasingly about meeting safety, quality, and environmental requirements (above and beyond price and basic conditions). In the last decade, changes in how the risks involved in the food chain are perceived by the public and approached by the scientific and policymaking community have resulted *in increasingly stringent standards and regulations*. Not only is there greater scrutiny of production and processing techniques, but there are also stricter traceability and labelling requisites across the food supply chain. While most Sanitary and Phytosanitary Measures (SPS) measures, such as those relating to human health and safety, are embodied in technical regulations, there is also a discernible upward trend in the *development of private standards*, as retailers in developed economies, motivated by commercial strategies of mitigation and differentiation, impose conditions along the supply chain.

While many in the developing countries perceive the increasing requirements as a potential and significant barrier to trade, the ability to raise capabilities in this field also presents *a major opportunity for upgrading and catching-up* with other high-value food-exporting developing countries. Unfortunately, while costs are immediate and easy to account for, the benefits from compliance tend to be much more difficult to ascertain. Since SPS compliance is also a 'moving target', the three subsystems of the IS – the knowledge, the business innovation and the policy/governance subsystems – *need to co-evolve to keep up with changing* demands.

In order to continue to trade, developing countries need to enhance private firms' ability to comply with these requirements as well as strengthen the institutional infrastructure, that helps demonstrate compliance. SPS-related risks are often not limited to one stage of production or processing. *Dealing with such complex challenges in a dynamic* context requires more than adopting good practices and new technologies – it involves raising domestic capacity to interact with the international system, enhancing the knowledge base, building legitimacy and trust in the domestic institutions and guiding the direction of search, experimentation and market-building for a growing business innovation system.

Since the requirements of a well-functioning SPS system are relatively complex, it would not be realistic to expect that all the actors and sub-sectors in developing economies (and especially the least developed ones) to evolve concurrently in a smooth fashion and to achieve sufficient capabilities to undertake a decisive approach to food safety in a short period of time. *In fact, even in semi-industrialised economies with* developing IS, growth of capabilities in the food safety area are uneven.

As a result, interventions are required not only at the final product-testing level but also upstream of the supply chain for effective quality and food safety control. This involves:

- *Building policymaking capabilities, including the updating* of legislation to enable food safety control agencies to respond to current challenges that go beyond basic control of hygiene and supporting participation in international standard setting and planning activities. Critically, the way in which risk management is handled by food safety institutions and reflected in relevant legislation can drastically enhance or diminish the potential for technological and entrepreneurial innovation in the private sector.
- *Reinforcing the technological capabilities within the institutions of the domestic knowledge subsystem*, particularly those of the food standards and quality control agencies, through investments to upgrade their testing and measurement, risk analysis and certification capacity, R&D efforts, ICT resources, training and organisational changes for enhanced performance.
- *Setting and fine-tuning public-private cooperation for the* effective functioning of the food safety system. This is largely due to the need to adapt the technologies to local conditions, so catching-up in this area requires indigenous capabilities to co-evolve within the firms as well as within the technological support infrastructure to help absorb and adapt necessary technologies to the local needs.
- *Helping to build capabilities in the private sector to deal with* increasingly stringent standards and to gain competitive advantages. The business innovation subsystem is a critical but often the weakest component of an emerging developing-country IS. An emerging IS assumes a threshold level of technical competence such as those required to introduce new production methods to comply with SPS measures and *other requirements involving technological choices, in addition* to financial resources and legal/technical knowledge about how to access low-cost technologies and transfer them. Support to the business sector should promote experimentation and new market formation by enabling investments in Hazard Analysis and Critical Control Points (HACCP), Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP), *information systems for traceability* and labelling, and uptake of environmental technologies.

A UNIDO-sponsored needs assessment exercise conducted in cooperation with SENASA (Servicio Nacional de Sanidad y Calidad Agroalimentaria) in Argentina reveals cost estimates of *the upgrading needs of the Agency based on reactive and* proactive strategies. The investments in the case of the reactive scenario would require US$53.4 million over five years whereas the proactive scenario would require US$ 133.6 million. These figures represent increases of 32 per cent and 80 per cent, respectively, on the current budget of US$ 33.5 million. While some one-off investments are required initially to *upgrade existing capacity, recurrent expenditures are* also essential to ensure that dynamic capabilities are built to manage emerging needs. Such resource mobilisation is a necessary but not a sufficient condition to build a legitimate and trusted institution, which calls for significant policy/governance capabilities as well as effective links with the business innovation subsystem.

Comparing the assessed needs of a single country with the US$65 to 75 million spent worldwide by bilateral and multilateral agencies in recent years to build trade-related capacities, it is clear that there is a strong rationale for significantly extending and improving the delivery of international technical assistance for specific supply-side constraints and conformity with requirements.

SECTION II

A Review of World Industry

The review focuses on salient features of global industrial performance during 1990-2002. Quantitative assessments are obtained by the use of six industrial indicators. The narrative addresses industrial performance in three dimensions: activity, industry and technology.

Levels of industrial activity are measured and discussed under two aspects and with reference to the pivotal development indicator of per capita income. The first aspect is domestic and involves the potential of 'manufacturing income' of each economy. The second is international and introduces the perspective of comparative advantage in industry, which is associated with the potential of 'manufacturing trade'.

Structural characteristics are used to assess economies in the other two dimensions. The industry dimension is represented by the weight of industrial production and trade in the entire economy, which provides an indicator of 'industrial advance'. The technology dimension is assessed via the weight of medium- or high-technology branches in industry, which provides an indicator of 'technological advance'. The rationale behind emphasizing this view of structural traits is the key role of industry-*cum*-technology for economic growth.

Activity levels

Between 1990 and 2002 developing economies increased their share in world production from less than 16 per cent to more than 23 per cent. While this is a formidable rise of industry in the developing world as a whole, its result still falls short of the 'Lima target' of a quarter of global output. Changes in the other two broad country groups were also significant: transition economies saw their share halved over the twelve years, and that of the industrialised economies – still the lion's share – shrank nearly five percentage points to less than three-quarters of world industrial production.

The performance of individual regions and countries within the above broad categories varied widely – particularly so between the geographic regions of developing countries. East and Southeast Asia, already the leading region in 1990, doubled its share in world production by 2002, reaching a percentage three times larger than that of the runner-up region, Latin America. Unlike all other regions, with the exception only of Sub-Saharan Africa, Latin America even experienced a slight decline of its share. In addition, there was a faint sign of improvement visible for the LDCs, whose share in world industry remains, however, still minuscule.

When industrial production is related to the number of people who benefit from it, directly or indirectly, the global picture is one of glaring unevenness. Differences are overwhelming in comparisons between individual countries. The same is true for the gap between the industrially richest and poorest parts of the world, a gap which, moreover, has been significantly widening rather than narrowing. A comprehensive assessment of global industrial unevenness, however, produces a picture that is less dark and in which significant improvements can be traced. In this context, the special position of China in today's world development can be seen in the light of its impact on reducing industrial unevenness.

In comparisons between individual countries or geographic regions, industrial production per capita is the natural indicator of the level of domestic activity and, more broadly, of the level of industrial development at large. Here too, differences between country groups and regions are striking. Industrial activity in the industrialised economies is at a level ten times higher than that of transition economies and sixteen times that of developing economies. Among the developing regions, too, gaps in activity are wide, with a ratio of about nine between the highest and the lowest regional averages. The highest level of per capita output throughout the period is that of Latin America. By 2002, East and Southeast Asia had attained the second place with activity not far below that of the leading region. The Middle East and North Africa hold a middle position, whereas South Asia and Sub-Saharan Africa rank at the low end.

Comparisons between countries reveal an almost unimaginably broad range of activity. The ratio between the level of the leading economy (Switzerland) and the trailing economies is of the order of one thousand. And for only a handful of developing economies, the so-called Asian Tigers, GDP per capita is higher than Switzerland's industrial output per capita. While the size of gaps is certainly exacerbated by the standard method of international comparison chosen here, their qualitative nature remains unchanged when measurement changes.

The same holds for the salient features of the core ranking of countries by industrial output per capita. All the industrialised economies are found in the highest quarter of this ranking. So are three of the four Asian Tigers, and Malaysia. In this connection, the outstanding performance of Singapore is underscored by its being the only developing economy among the top ten in terms of domestic-activity level. The second quarter of the ranking contains a number of large developing countries, among them China, which attained a position close to the middle (the median) of the global distribution by activity levels. In the lowest quarter all the LDCs are clustered with activity levels below a sixth of the average of all developing economies.

When economies are compared with respect to the international level of industrial activity, Singapore moves to the top of the world ranking. Apart from individual cases such as that of the star-performing Asian Tiger economy, the international ranking is quite similar to that produced by the domestic assessment. With respect to both, the evidence is that of high levels of industrial activity being the prerogative of the industrialised economies – with the most impressive exceptions to this rule constituted by a handful of Asian economies.

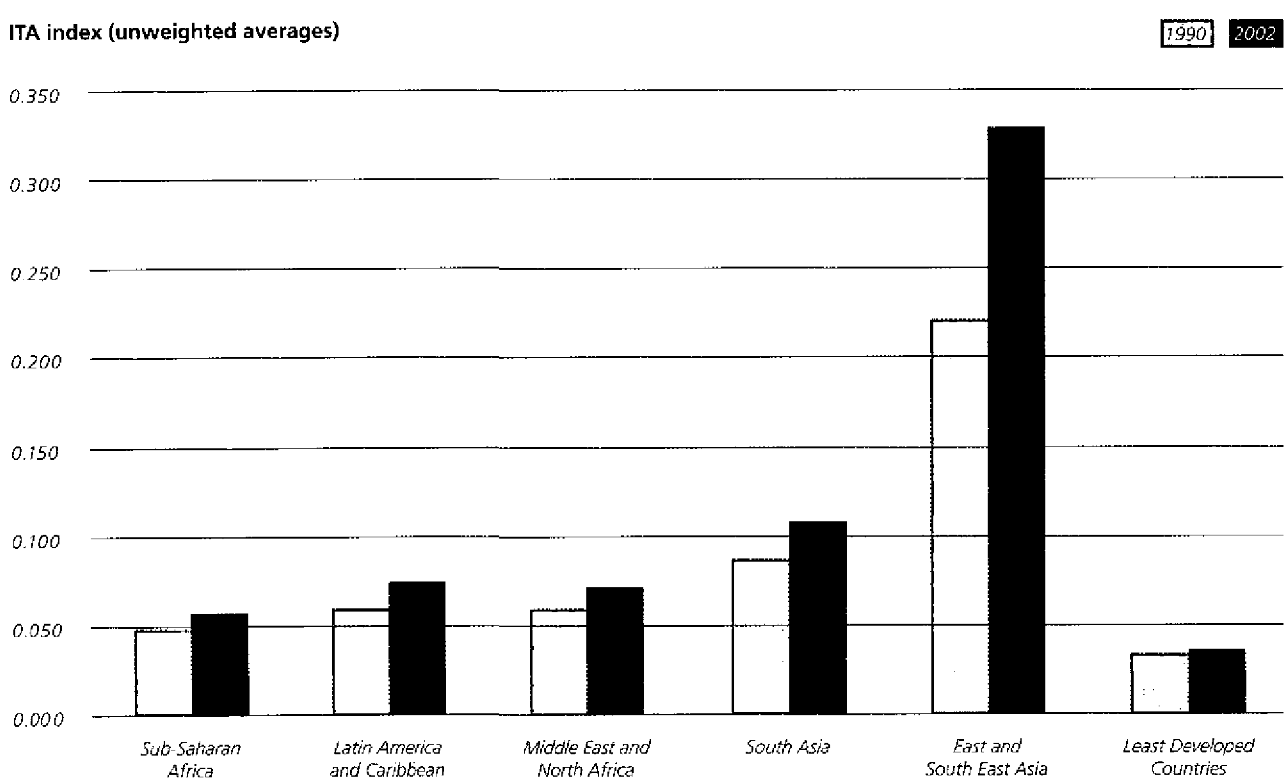
Structural traits

Four out of the six indicators used in this review reflect structural properties of an economy. Two of them measure the relative importance of industry within the entire economy. Their combination gives rise to an indicator of 'industrial advance', a tool for assessing the position of an economy in the industry dimension. The other two capture, in analogous fashion, technology within industry as well as 'technological advance' and allow for country assessment in the technology dimension. The interaction of industrial and technological advance yields a new indicator, the 'industrial-*cum*-technological-advance' (ITA) index.

The joint criteria of industry-*cum*-technology lead to assessments of country groups and of individual countries that parallel those based on activity levels. In particular, within the developing world structural differences between regions are immense. In an assessment by the ITA index, East and South-east Asia clearly leads among the developing regions, whereas differences among other regions are modest. For the latter as a whole, the average ITA value remains below a third of the level of industrialised economies, despite a remarkable increase of developing economies ITA over the 1990s. By contrast, a sample of LDCs average an ITA value of only about half the level of developing economies (excluding East and South-east Asia) (Figure 3).

It is, again, the inter-country comparison that bears out the full variation of structural differences in the industry and the technology dimensions. For the roughly one hundred countries assessed in the review the index of 'industrial-cum-technological advance' ranges from a maximum of slightly over

Figure 3 Industrial-cum-technological advance, by developing region (1990 and 2002)



Source: UNIDO.

Note: The definition of the ITA index is provided in the text. Each regional figure is the unweighted average across those countries in the region, for which data were available for both 1990 and 2002. For country coverage, table A2.2 of the annex tables can be consulted.

0.5 to a minimum of virtually zero. Once more Singapore takes the lead, ahead of industrialised economies, and three other Asian economies are among the top ten in the world. Overall, there has been 'industry-cum-technology advance' between 1990 and 2002, as the number of economies in the upper half of the ITA range increased from 22 at the beginning to 28 at the end of the period. In this increase, economies from East and Southeast Asia (among them China) are prominent. By and large, the North-South divide observed for activity levels is reproduced with respect to structural characteristics. Industrialised economies still dominate the upper half of the ITA range while Asian star-performers are moving in rapidly. In the ITA interval between 0.25 and 0.125 – that is, half of the upper half – economies from all groups and regions are found, including large countries like Turkey, Indonesia and the 'giant' India. On the other hand, all the LDCs (except Bangladesh) covered in the review are clustered around the low end.

Of the two constituents of the notion of 'industrial-*cum*-technological advance', the industry dimension plays the conventional part, both conceptually and with regard to measurement. This is reflected in the ranking of countries by 'industrial advance'. Nevertheless, this 'conventional' assessment produces some surprise results. Thus, among the top ten economies in the ranking, eight are East or Southeast Asian countries, while most industrialised economies are found in lower ranges. And for half of these surprise-countries, which include China, the unexpectedly high ranks are the result of a spectacular increase in the 'industrial advance' indicator over the 1990s. Another astonishing fact is the highly mixed composition of the lower half of the country distribution by industrial advance, which includes even four industrialised economies.

The 'modern' component of the ITA index – that of 'technological advance' – produces a considerably wider range and a different ranking of economies. While Singapore is again the leader, the top ten economies are equally spread between industrialised and (mostly Asian) developing countries. The highest quarter of the technological-advance ranking 'belongs' to a large extent to the industrialised economies. However, about a third of the economies in these high ranks are of developing countries. At the low end of the 'technological-advance' ranking there are countries from all developing regions, except East and Southeast Asia. All the LDCs in the sample are found there, though with some variation in the values of the corresponding indicator.

Finally, taking up the time-honoured analysis of structural change, the association between the central structural measure – that of 'industrial-cum-technological advance' – on the one side and the income level on the other is examined. The results lend plausibility to the notion that 'industrial-cum-technological advance', as indicated by the ITA index, starts from a low level at low incomes, reaches high rates of progress over a fairly wide middle range of income and levels off at the highest income levels – which bodes well with the evolution of IS depicted in Chapter 6.

The Industrial Development Report 2005, UNIDO's flagship publication, addresses two key questions. First, why have most developing countries failed to narrow the gap in income and productivity with more advanced economies? Second, what strategies and policies can those countries adopt to build the capabilities that are necessary for catching-up under the current international environment?

From the perspective of domestic policy making and international cooperation, more effort – both in terms of ideas and resources – needs to be directed to structural issues so far largely neglected, where substantial degrees of freedom remain vis-à-vis the WTO rules. These issues largely relate to the building and co-evolution of domestic institutions that promote private sector development and domestic capability building. In a world increasingly driven by innovation, framework conditions that are a prerequisite of economic catch-up have been transformed so as to encompass the various dimensions of innovative development as key ingredient.

With this in mind, the Special Topic Section of the Report first takes stock of lessons learned throughout modern history. On this basis, it then provides a framework for operational policy analysis as well as a methodology for the assessment of capability building needs to help overcome clear limitations in the current understanding of economic development.

The Second Part of the Special Topic focuses on the interactions between the knowledge, business innovation and policymaking subsystems, and addresses the policy capabilities that are necessary to overcome the often intractable problem of matching demand and supply of innovative resources. Two specific areas – food safety requirements and standards – are explored to highlight these interactions and test the suggested policy analysis framework.

The Second Section of the Report reviews industrial activity worldwide including measures of technological advance following the tradition of previous Industrial Development Reports. The interaction of industrial and technological advance yields a new indicator, the industrial-cum-technological-advance index, which highlights the significant structural differences between and within regions.

About the cover illustration:
The graph on the cover, generated by means of a fractal geometry model, simulates a pattern formed by three ring vortices playing catch up with one another (also called 'chaotic leapfrogging').

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