CHAPTER 4

Unleashing human creativity: national strategies

No country will reap the benefits of the network age by waiting for them to fall out of the sky

The technology revolution begins at home—yet no country will reap the benefits of the network age by waiting for them to fall out of the sky. Today's technological transformations hinge on each country's ability to unleash the creativity of its people, enabling them to understand and master technology, to innovate and to adapt technology to their own needs and opportunities.

Nurturing creativity requires flexible, competitive, dynamic economic environments. For most developing countries this means building on reforms that emphasize openness—to new ideas, new products and new investments. But at the heart of nurturing creativity is expanding human skills. For that reason, technological change dramatically raises the premium every country should place on investing in the education and skills of its people.

Many developing countries are in a good position to exploit the opportunities of the technology revolution and advance human development. Others face significant hurdles, lacking the kind of economic environment that encourages innovation, lacking the skills and institutions to adapt new technologies to local needs and constraints.

But sound public policy can make a difference. The key is to create an environment that mobilizes people's creative potential to use and develop technological innovations.

Creating an environment that encourages technological innovation

Creating an environment that encourages innovation requires political and macroeconomic stability. Take the Asian success stories, built on a strong commitment to education and health coupled with low inflation, moderate fiscal and balance of payments deficits and high levels of savings and investment. It is not just big firms that demand stability. Small businesses and family farms also depend on a stable financial setting where savings are safe and borrowing is possible. And they are where innovation and adaptation often start.

While such stability is necessary, it is not enough. Proactive policies are required to stimulate innovation.

- Technology policy can help to create a common understanding among key actors about the centrality of technology to economic diversification.
- Reforms to make telecommunications competitive are vital for giving people and organizations better access to information and communications technology.
- To stimulate technology-oriented research, governments can promote links between universities and industry—and provide fiscal incentives for private firms to conduct research and development.
- Stimulating entrepreneurship is also essential, and venture capital can be important in fostering technology-based start-up businesses.

Creating a vision for technology

Governments need to establish a broad technology strategy in partnership with all key stakeholders. Several governments have promoted technology development directly. Some have subsidized high-technology industries—with industrial policies that have been widely criticized because government does not always do a good job of picking winners. But what government can do is identify areas where coordination will make a difference because no private investor will act alone—say, in building infrastructure. Here, some governments have done a credible job.

Many countries are conducting "foresight studies" to create more coherent science and technology policy and to identify future demands and challenges, linking science and technology policy to economic and social needs. The process creates awareness among stakeholders about the state of technological activity in the country, emerging trends worldwide and the implications for national priorities and competitiveness. Involving civil society in areas relating to new technological developments with potentially strong social and environmental impacts helps build consensus on a response. India, the Republic of Korea, South Africa, Thailand and several Latin American countries are now involved in such exercises. In the United Kingdom the exercise has led to resource allocations and incentives to promote new technologies in a mature economy (box 4.1).

Governments have not always led the process. In Costa Rica businesses took the lead in the effort that led to Intel's decision to invest there. Costa Rica was able to attract technology-intensive foreign direct investment because of its social and political stability, its proximity to the United States and its highly skilled labour force, built up through decades of emphasis on education (box 4.2).

BOX 4.1

Technology foresight in the United Kingdom—building consensus among key stakeholders

The UK technology foresight programme, announced in 1993, is forging a closer partnership between scientists and industrialists to guide publicly financed science and technology activity. More market oriented and less science driven than similar efforts elsewhere, the programme has had three phases.

First it set up 15 panels of experts on the markets and technologies of interest to the country, each chaired by a senior industrialist. Each panel was charged with developing future scenarios for its area of focus, identifying key trends and suggesting ways to respond. In 1995 the panels reported to a steering group, which synthesized the main findings and identified national priorities.

Next the steering group produced a report distilling its recommendations under six themes: social trends and impacts of new technologies; communications and computing; genes and new organisms, processes and products; new materials, synthesis and processing; precision and control in management, automation and process engineering; and environmental issues.

The steering group assigned priorities to three categories: key technology areas, where further work was vital; intermediate areas, where efforts needed to be strengthened; and emerging areas, where work could be considered if market opportunities were promising and world-class capabilities could be developed.

Now the recommendations from the exercise are being implemented. For example, research in the four priority areas—nanotechnology, mobile wireless communications, biomaterials and sustainable energy—is being supported through a research award scheme. Another example is its application in Scotland. Scottish Enterprise hosts the Scottish foresight coordinator, who focuses on promoting foresight as a tool for business to think about and respond to future change in a structured way. The coordinator works with a wide range of public, private and academic actors. While a key goal is to help individual companies better manage change, this is being achieved by channelling efforts through a range of trusted business intermediaries—industry bodies, networks and local delivery organizations—that have a sustainable influence on company activities. All panels and task forces address two underpinning themes: sustainable development and education, skills and training.

On education and skills, the ethos of the foresight programme is captured in one of its statements: "The roots of our learning systems—classrooms and lecture theatres—can be traced back to the needs of the 19th century industrial age. At the start of the 21st century we need to re-engineer the learning process. While many existing educational institutions will remain, they will look very different to those of today. They will become more social environments in which to support effective learning, and will perform new functions and have different responsibilities."

Source: UK Government Foresight 2001; Lall 2001.

Making telecommunications services competitive

Telecommunications and Internet costs are particularly high in developing countries. Monthly Internet access charges amount to 1.2% of average monthly income for a typical US user, compared with 614% in Madagascar,[1] 278% in Nepal, 191% in Bangladesh and 60% in Sri Lanka (figure 4.1).[2]

With high costs and low incomes, community access is key to Internet diffusion in much of the developing world. Computers, email accounts and Internet connections are often shared by several individuals or households. Telecentres, Internet kiosks and community learning centres make telephones, computers and the Internet more accessible and more affordable for more people.

In the United Republic of Tanzania Adesemi Communications International is providing the first reliable telephone service. It has installed durable, user-friendly units capable of connecting local, long-distance and international calls. The company's wireless system allows the flexibility to install payphones where they are most needed, regardless of whether landlines exist. Small businesses dependent on communications have reaped tremendous benefits.[3] In Peru Red Cientifica Peruana, the largest provider of Internet access in the country, has set up a national network of 27 telecentres.[4]

A big part of the reason for the high costs is that most countries have had state monopolies for telecommunications services. Without competition, their prices remain high—true for

BOX 4.2

Attracting technology-intensive foreign direct investment in Costa Rica—through human skills, stability and infrastructure

Costa Rica exports more software per capita than any other Latin American country. Two recent decisions by Intel have contributed to the development of the domestic industry. First, Intel decided to invest in a centre to develop software for the company and to contribute to semiconductor design, moving beyond the limits of an older assembly and testing plant. Second, through its venture capital fund, Intel invested in one of the country's most promising software companies. Reinforcing these activities is the presence of internationally recognized centres of research, training and education.

How did Costa Rica achieve such success? The country's long commitment to education has been critical. But human skills, while important, need to be complemented by other factors.

After the economic crisis of the early 1980s, it became clear that the country had to abandon import substitution. So it moved to promote exports (and improve access to the US market) through two systems of fiscal incentives:

- A system of export processing zones allowed companies to import all their inputs and equipment tax free and avoid paying income tax for eight years. This system became key in attracting high-technology multinational companies.
- To help domestic companies become export oriented, firms were given an income tax holiday, the right to import equipment and inputs tax free and a subsidy equal to 10% of the value of their exports. The subsidy was meant to compensate exporters for inefficiencies in such public services as ports, electricity and telecommunications and for the high costs of financial services like banking and insurance.

Technology foresight—through a non-governmental organization

The new export promotion model was supported from the beginning by the Costa Rica Investment and Development Board (CINDE), a private non-profit organization founded in 1983 by prominent businesspeople, supported by the government and financed by donor grants. Its broad aim was to promote economic development, but attracting foreign direct investment was always a top priority.

In the early 1990s CINDE realized that the country was losing competitiveness in industries relying on unskilled labour and that the North American Free Trade Agreement (NAFTA) would give Mexico better access to the US market. So it decided to focus its efforts to attract investment only on sectors that were a good match for Costa Rica's relatively high education levels. It chose electronics and related activities, rapidly growing industries that required skilled labour. Meantime, Intel was starting to look for a site for a chip assembly and testing plant. CINDE campaigned for Costa Rica, and in 1996 Intel decided to locate its plant there. Four factors were key:

- Costa Rica had political and social stability, the rule of law and a low level of corruption; relatively liberal rules relating to international trade and capital flows; a relatively well-educated and technically skilled but low-cost workforce with acceptable knowledge of English; a "pro-business" environment with a favourable attitude towards foreign direct investment; a good package of incentives; and good location and transportation logistics.
- The country's growing emphasis on attracting high-technology foreign direct investment gave credibility to the case that it had the human resources Intel required.
- An aggressive, effective and knowledgeable foreign investment promotion agency (CINDE), with links to the government, arranged successful meetings between Intel executives and public authorities.
- The government understood the importance of an Intel investment in the country. The president met with Intel executives and encouraged the rest of the government to help Intel.

Spillover benefits

Intel's investment has had a big impact on Costa Rica's ability to attract other foreign direct investment in high-technology industries—and on the economy's general competitiveness in skill-intensive industries. Intel's reputation for rigorous site selection has given other companies the confidence to invest in the country.

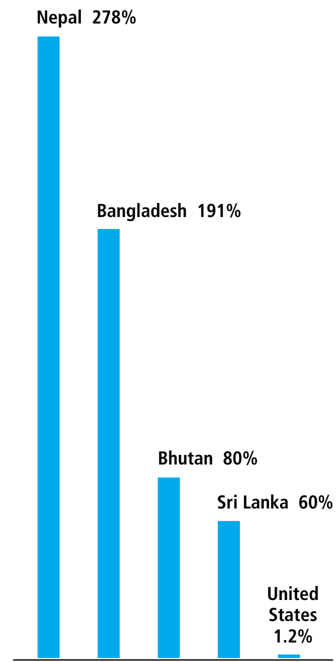
Intel has also contributed by training its own workforce and supporting universities. The Instituto Tecnológico de Costa Rica (ITCR) has gained "Intel Associate" status and several new degree programmes. And Intel's presence has increased awareness of career opportunities in engineering and other technical fields. At the ITCR enrolment in engineering grew from 9.5% of students in 1997 to 12.5% in 2000.

Today the country is following a strategy that appears to enjoy strong support from key stakeholders: recognizing the need to liberalize telecommunications, improving infrastructure through private sector participation, improving the protection of intellectual property rights and improving access to foreign markets through free trade agreements with such countries as Canada, Chile and Mexico. Some reforms have met with resistance and open expressions of disagreement—all part of the policy debate in a pluralistic society.

Source: Rodríguez-Clare 2001.

FIGURE 4.1
The cost of being connected

Monthly Internet access charge as a percentage of average monthly income



Source: Human Development Report Office calculations based on ITU 2000 and World Bank 2001h.

leased telephone lines, Internet service provision and local and long-distance telephone calls. Breaking those monopolies makes a difference. After the US long-distance monopoly provider AT&T was broken up in 1984, the rates for long-distance telephone calls fell by 40%.[5]

In the midst of the Asian crisis the Korean mobile telephony market saw the number of subscribers double each year in 1996–98 despite falling consumer demand.[6] What made the fast growth possible? The entry of five competitive providers into the market, offering easy credit and subsidies for handsets. In Sri Lanka too, competition has led to more investment, more connectivity and better quality service.[7]

Internet service provision is competitive in the majority of countries surveyed in a recent study (table 4.1). But despite the benefits from competitive telecommunications markets, monopolies and duopolies continue to dominate for leased telephone lines and for local and long-distance telephony. And much remains to be done in such newer markets as paging, cable television and digital cellular telephony.

Privatization can make these markets more competitive. But alone, it does not produce a liberalized, competitive sector. In many countries private monopolies have replaced state monopolies. And while many countries have privatized telecommunications quickly, they have built up regulatory capacity much more slowly. The nature and scope of regulatory reform greatly affect performance in telecommunications. For example, by pursuing regulation and privatization simultaneously, Chile has done much better than the Philippines, which put in place a regulatory system at a later stage.[8]

TABLE 4.1
Telecommunications arrangements in various countries by sector, 2000

Sector	Number of countries: Monopoly	Duopoly	Competition	Total surveyed
Local telephony	121	19	44	184
National long distance	134	12	36	182
International long distance	129	16	38	183
Digital cellular	47	28	79	154
Mobile satellite market	32	12	65	109
Fixed satellite market	61	14	59	134
Internet service	13	3	81	97

Source: Center for International Development at Harvard University analysis of 2000 ITU data, as cited in Kirkman 2001.

Stimulating research and development

Governments have a responsibility to promote research and development (R&D). Some R&D needs to be undertaken by the public sector, especially for people's needs that may not be met through the market. But governments are not responsible for doing all the R&D—and they can create incentives for other actors. Two mechanisms have been particularly important in promoting technology-oriented research—links between universities and industry, and fiscal incentives to promote R&D by private firms.

Encouraging links between universities and industry can stimulate innovation

Encouraging links between universities and industry can stimulate innovation. High-technology companies thrive on state-of-the-art knowledge and creativity as well as the scientific and technical expertise of universities. Hubs are created as entrepreneurs purposely establish their businesses near universities.

Tampere University of Technology in Finland links Nokia, the Technical Research Centre of Finland and firms in the wood processing industry. Industrialists in science and technology spend 20% of their time at universities, giving lectures to students in their areas of expertise. The "adjunct professors" work on a challenging interface between industry and academia, and students learn the relevance of technology to industry.[9]

In China too, institutions of higher education support the technological work of enterprises. Tsinghua University established the Chemical Engineering and Applied Chemistry Institute jointly with Sino Petrochemical Engineering Company, which has given more than $3.6 million to support the university's research activities and recruited more than 100 of its graduates.[10] The State Torch Programme encourages enterprises to strengthen their ties with research institutions, to accelerate the commercialization of research results. Chinese universities have also established science parks. The Shanghai Technology Park acts as an incubator for the rapid application of scientific and technological work in industry.

In the 1990s China emphasized the development of high-technology industry through a variety of government programmes to support R&D. Now China is also using R&D to improve the productivity of traditional activities in agriculture. The Spark Programme propagates technologies to the countryside and assists farmers in using them for agricultural development.[11]

Governments use a range of policy options to stimulate enterprise R&D (box 4.3). One is to provide matching funds for R&D. The Malaysian government contributes matching funds equivalent to 125% of the resources committed by private firms.[12] Another is to co-finance R&D through a technology fund. Such funds allocate resources as a conditional loan, to be repaid if ventures succeed and written off otherwise.

Stimulating entrepreneurship

Beyond promoting R&D, strong ties between industry and academia can also stimulate entrepreneurship. The Center for Innovation and Entrepreneurship, an autonomous unit at Linköping University in Sweden, linked to the city's Foundation for Small Business Development, has applied technical know-how and financial resources to stimulate the growth and development of technology-based firms.[13]

BOX 4.3

Strategies for stimulating research and development in East Asia

East Asian governments have used a variety of incentives to stimulate R&D by the private sector, drawing on a mix of public funding and tax breaks to encourage in-firm R&D as well as collaboration among government agencies, universities and the private sector.

Republic of Korea

The Korean government has directly supported private R&D through incentives and other forms of assistance. It awarded firms tax-exempt funds for R&D activities (though the funds were subject to punitive taxes if not used within a specified period). The funds could also be invested in Korea's first venture capital fund, the Korea Technology Development Corporation, or in collaborative R&D efforts with public research institutes. The government has given tax credits, allowed accelerated depreciation for investments in R&D facilities and cut taxes and import duties on research equipment. It has also used other tax incentives to promote technology imports. And the government has given grants and long-term, low-interest loans to companies participating in R&D projects and tax privileges and public funds to private and government R&D institutes.

But the main stimulus to industrial R&D in Korea came less from specific incentives than from the overall strategy—creating large conglomerates (*chaebol*), awarding them finance, protecting markets to allow them room to master complex technologies and then forcing them into export markets by removing protective barriers. Korea's strategy for promoting technology has given the chaebol a strong base for entering into demanding mass production. While many aspects of the chaebol system fostered inefficiencies and are being reformed, Korea is nonetheless one of the most dramatic examples of rapid technological transformation.

Taiwan (province of China)

As in Korea, the main impetus for rising R&D in Taiwan (province of China) came from an export orientation combined with measures to guide enterprises into more complex activities and reduce their dependence on technology imports. But the Taiwanese government did not promote the growth of large private conglomerates. While the "lighter" industrial structure in Taiwan (province of China) meant less growth in private sector R&D compared with that in Korea, it was also a source of strength—leading to innovative capabilities that are more flexible, more responsive to markets and much more broadly spread in the economy.

The government started to support local R&D capabilities in the late 1950s, when a growing trade dependence reinforced the need to upgrade and diversify exports. A science and technology programme, started in 1979, targeted energy, production automation, information science and materials science technologies for development. In 1982 biotechnology, electro-optics, hepatitis control and food technology were added to this list. A science and technology development plan for 1986–95 continued strategic targeting, aiming for R&D totalling 2 percent of GDP by 1995.

Around half the R&D is financed by the government. But enterprise R&D has risen as some local firms have expanded to become significant multinationals. The government has used a variety of incentives to encourage such R&D over the years, including providing venture capital and financing for enterprises that develop strategic industrial products. The tax system provides full tax deductibility for R&D expenses, accelerated depreciation for research equipment and special incentives for enterprises based in the Hsinchu Science Park. The government also requires large firms to invest 0.5–1.5 percent of their sales in R&D and has launched large-scale research consortiums, co-funded by industry, to develop critical products such as new-generation automobile engines and more sophisticated computer memory chips.

Singapore

The Singapore government launched a $1.1 billion, five-year technology plan in 1991 to promote development in such sectors as biotechnology, microelectronics, information technology, electronic systems, materials technology and medical sciences. The plan set a target for R&D spending of 2% of GDP by 1995. A new plan, launched in 1997, doubled expenditure for science and technology, directing the funds to strategic industries to ensure future competitiveness.

Singapore uses several schemes to promote R&D by the private sector. The Cooperative Research Programme gives local enterprises grants (with at least 30% local equity) to develop their technological capabilities through work with universities and research institutions. The Research Incentive Scheme for Companies gives grants to set up centres of excellence in strategic technologies, open to all companies. The R&D Assistance Scheme gives grants for specific product and process research that promotes enterprise competitiveness. And the National Science and Technology Board initiates research consortiums to allow companies and research institutes to pool their resources for R&D. Together these schemes have raised the share of private R&D to 65% of the total.

Source: Lall 2001.

The quality and orientation of education at each level are critical for mastering technology

Venture capital can also stimulate entrepreneurship. It is no surprise that the United States dominates in this. But other countries where innovation has become important, such as Israel and India, also have vibrant venture capital markets.[14]

In 1986 Israel had only two venture capital funds, with less than $30 million in total investable assets. Today about 150 venture capital firms manage up to $5 billion in venture capital and private equity. The market took off in the early 1990s when the government set up a venture capital company, Yozma, to act as a catalyst for the emerging industry. With a budget of $100 million, Yozma invested in local companies and attracted foreign capital from Europe and the United States. The Yozma fund is a model for the state-led emergence of a venture capital and high-technology industry.

In India annual venture capital investments reached $350 million in 1999, with most concentrated in the technology hubs in the country's south and west. The government has developed policy guidelines to encourage venture capital, and the National Association of Software and Service Companies projects that up to $10 billion of venture capital may be available by 2008.

In both India and Israel the government played an important role in establishing the venture capital industry and stimulating innovation, but a sophisticated financial sector was a precondition for attracting venture capital. Also key were strong ties to entrepreneurs and venture capitalists in the United States, and education systems that produce a significant number of highly skilled people, generating a critical mass for innovative activity.

Rethinking education systems to meet the new challenges of the network age

To bring life to an environment of technological creativity, people need to have technical skills, and governments need to invest in the development of those skills. Today's technological transformations increase the premium on such skills and change the demand for different types of skills. This calls for a rethinking of education and training policies. In some countries systems need an overhaul. In others, a redirection of public funds. How much for public education? For science? For formal education? For vocational training? Tough choices, indeed.

Increasing the emphasis on quality

Greater resources and higher enrolments alone are not enough. The quality and orientation of education at each level, and the link with the demand for skills, are critical for mastering technology.

Primary education for all is essential. It develops some of the most basic capabilities for human development. And it creates a base of numeracy and literacy that enables people to be more innovative and productive. Although most countries in the low human development category have net primary enrolment ratios below 60%, most other developing countries have achieved nearly universal primary enrolment (see indicator table 10).

Secondary and higher education are also crucial for technology development. University education creates highly skilled individuals who reap the benefits through higher salaries. But it is also at the heart of creating national capacity to innovate, to adapt technology to the country's needs and to manage the risks of technological change—benefits that touch all of society. In 1995 gross enrolment ratios averaged just 54% at the secondary level and 9% at the tertiary level in developing countries, compared with 107% and 64% in high-income OECD countries.[15]

Increasing the quantity of education is not enough, for it is the low quality of secondary schools that leads to low completion rates in many countries—and then low university enrolments. Korea and Singapore built high university enrolments on high secondary completion rates in good schools. In internationally comparable tests in mathematics, students in Singapore, Korea, Japan and Hong Kong (China, SAR) show the highest achievements. South Africa and Colombia, by contrast, performed significantly lower than the international average.[16] Some differences across countries reflect differences in incomes. But that is not the whole story. Korea ranks higher in test scores than countries with twice the GDP per capita, such as Norway.

International comparisons, despite their problems, have two important advantages. First, they move the debate towards an assessment of outcomes rather than inputs, such as education budgets. Second, they force policy-makers to seek more refined measures to capture the quality of skills. Several countries, for example, have established national and local standards for assessing outcomes. These may not be internationally comparable, but they set important benchmarks. Assessments based on these standards make it clear that at the primary and secondary levels developing countries need to increase instruction time in science and mathematics, critical in improving students' achievement in these subjects.[17]

Chile is taking important strides to improve the quality of education, measuring the quality of outcomes and providing resources and incentives (box 4.4). And East Asia has shown that the technology orientation and content of education are as important as the expansion of resources (box 4.5).

In advanced economies education reform has placed new emphasis on helping people adapt to the new skill demands that come with shifting employment patterns. Students are encouraged to keep their education and career options open. In Denmark general courses in vocational programmes have opened new pathways to higher education. In the United Kingdom examination systems allow students to choose subjects from both general and vocational programmes. In Finland the government has raised the status of vocational education and increased public resources for on-the-job learning. Since 1999 all three-year vocational courses have had to offer six months' work experience to every student.[18]

USING TECHNOLOGY TO IMPROVE QUALITY

With the rapid development of information and communications technology, it has become critical to teach basic computer skills to children. The biggest concern for developing countries is the lack of resources—both physical and human—to ensure adequate equipment and efficient teaching of such skills in schools. A computer costs more than the annual income of most people in developing countries, and teachers need to be trained to use new instructional material.

Yet information and communications technology also provides new possibilities for improving the quality of education at low cost. And there has been a proliferation of imaginative attempts in developing countries to spread new technology to education institutions in cost-effective ways.

- Costa Rica launched a "computers in education" programme in 1998, aimed at raising the quality of education in primary schools. The programme uses an imaginative pedagogical approach to encourage interaction among children and raise cognitive skills. The goal is to help transform education through changes in learning and teaching brought about by the use of

BOX 4.4

A push for education quality in Chile—measuring outcomes and providing incentives

Chile is making a concerted effort to improve the quality of education. The key measures mark a shift in its education policies from a focus on inputs to a concern with outcomes:

- *National evaluation.* A comprehensive standardized testing system—Sistema de Medición de la Calidad de la Educación (SIMCE)—assesses Spanish and mathematics skills every two years for students in grades 4 and 8 and monitors schools' progress in improving outcomes.
- *Positive discrimination.* A government programme known as the P900 Programme targets assistance—from new textbooks and materials to professional support for teachers—to the 900 poorest primary schools..
- *Rewards.* A national system of performance evaluation for government-funded schools—Sistema Nacional de Evaluación del Desempeño de los Establecimientos Educacionales Subvencionados (SNED)—provides bonuses to all teachers in a school on the basis of student outcomes.

Made widely available and published in national newspapers, the SIMCE testing results have several uses:

- Policy-makers use the results to compare school performance nationally and identify schools needing special help.
- Schools use good results to market themselves and attract more students.
- Parents use the results to help them select the best school for their children.

SIMCE data are also used to assess the pace of progress among children attending the schools in the P900 Programme. Schools improving their results enough to "graduate" become part of the mainstream reform efforts for primary school and are replaced in the programme by other schools.

SNED has established competition between schools roughly comparable in student population and socio-economic levels. Around 31,000 teachers received bonuses in each of the first two rounds of SNED awards.

Many parents, teachers and school administrators believe that this system of external standards and evaluation provides a good yardstick for measuring schools' performance. Others think that SIMCE is unfair, especially to schools and students in poor neighbourhoods. Despite the controversy, Chile is clearly moving towards a more quality-oriented education system.

Source: Carlson 2000; King and Buchert 1999; OECD 2000c; Chile Ministry of Education 2001.

computers, the training of teachers and the excitement generated by children's self-directed learning, knowledge creation and problem solving. The programme was designed to reach one-third of the country's primary school children, providing some 80 minutes of access to computers each week. Teacher surveys confirm that student performance has improved.[19]

- In Brazil a community schools programme is equipping young people in poor communities to use computers. The Committee for Democracy in Information Technology (CDI), a non-profit organization, is helping communities develop self-sufficient "information technology and citizenship schools". Communities that want to start a school must go through a rigorous process to ensure that they can sustain the school once CDI assistance ends. CDI provides free technical assistance for three to six months, trains the instructors, works with the school to procure an initial donation of hardware and then helps the school install the computers. After a school

BOX 4.5

Orientation and content as important as resources—lessons from education strategies in East Asia

Over the past four decades the East Asian "tigers"—Hong Kong (China, SAR), Republic of Korea, Singapore and Taiwan (province of China)—achieved rapid development of human skills, equipping them for rapid progress in adapting technologies. Their success suggests strategies that less developed countries could consider and adapt to their own circumstances.

One key lesson: the orientation and content of education are as important as resource allocation. These countries not only invested in basic education but also emphasized a technology-oriented curriculum at higher levels. These investments in skills were part of an export-led development strategy, which provided demand signals for the skills required for improving competitiveness.

Public education spending had been fairly low in East Asia, around 2.5% of GNP in 1960 for most countries. In 1997 the regional average was still only 2.9%, far less than the 3.9% average for all developing countries and the 5.1% average for Sub-Saharan African. But as the region's countries grew rapidly, so did the absolute level of spending on education. And education spending has also expanded as a share of national income, partly through increased private spending.

Evolving priorities in education strategies

At an early stage of development East Asia gave priority to basic education, achieving universal primary schooling in the late 1970s. That made it easier to concentrate on improving quality and increasing resources in upper secondary and tertiary education. At the tertiary level enrolment ratios remained below 10% until 1975, contrasting unfavourably with those in Latin America. But as countries advanced, they needed more skilled and educated workers—and higher education expanded rapidly, especially after 1980. In Korea the tertiary enrolment ratio soared from 16% in 1980 to 39% in 1990 and then to 68% in 1996.

Private funding for post-basic education

East Asia has taken a unique approach to financing education, relying on private sources for a relatively large share of spending, especially at the upper secondary and tertiary levels. And some countries have depended largely on the private sector to provide higher education. In Korea in 1993 private institutions accounted for 61% of enrolments in upper secondary education and 81% in tertiary education.

A large private role in providing education raises important questions about equity in access. Countries have used different approaches to address this issue. Korea targets public resources to basic education and is more selective about the mix of private and public resources at higher levels. Singapore maintains relatively strong government involvement in the operation and financing of education at all levels.

Evidence shows that privately financed institutions have lower unit operating costs. Not all developing countries can rely on private funding, but combining private and public funding at higher levels of education with public spending for primary and lower secondary levels is an option—as long as adequate access to higher education is assured for poor children. Here, grants, loans and subsidies can play a useful role.

High pupil-teacher ratios but attractive salaries for teachers

Both small class sizes and high teacher quality have been shown to enhance student achievement. East Asian governments opted for a strategy in which highly qualified, well-paid teachers work with more students. In Korea in 1975 pupil-teacher ratios exceeded 55 at the primary level and 35 at the secondary level, compared with developing country averages of 36 and 22. But Korea also pays teachers starting and mid-career salaries that are higher relative to per capita GNP than those in any other OECD country.

Lifelong learning

Continuous training was considered a key to developing human skills in the context of rapid technological change. As East Asian countries became more sophisticated, pressures emerged for governments and firms to provide effective education and training systems. In Korea, following enactment of the Vocational Training Law in 1967, the government established well-equipped public vocational training institutes and subsidized in-plant training programmes. In the 1970s, when the government was seeking to develop the heavy and chemical industries, it promoted vocational high schools and junior technical colleges to satisfy the rising demand for technicians. The government also established public education and research institutions to supply high-quality scientists and engineers, such as the Korea Institute of Science and Technology in 1967 and the Korea Advanced Institute of Science and Technology in 1971.

The government of Singapore took similar initiatives, launching a series of training programmes—Basic Education for Skill Training in 1983, Modular Skills Training in 1987 and Core Skills for Effectiveness and Changes in 1987. In the 1990s the government also led the development of the information and communications technology industry by supporting study in this area in tertiary institutions and building specialized training institutes as well as joint-venture institutes with private companies.

Source: World Bank 1993; Lee 2001; Lall 2001.

has been selected, CDI serves as a partner and consultant but does not manage the programme. CDI has adapted its method to reach such diverse communities as street children and indigenous groups. As a result of its work in partnership with community associations, more than 35,000 children and young people, in 208 schools in 30 cities, have been trained in basic computer literacy. Most schools charge the students a symbolic fee of $4 a month, equivalent to the cost of five roundtrip metro rides in Rio de Janeiro, to ensure their commitment.[20]

An interesting approach to improving Internet access and use relies on school networking initiatives, or "schoolnets". A few developing countries have established broad Internet access for schools through nationwide networks, among them Chile, Thailand and South Africa.

- The Enlaces project in Chile has linked 5,000 basic and secondary schools to its network. Schools receive equipment, training, educational software and ongoing support from a technical assistance network of 35 Chilean universities organized by the Ministry of Education. The aim is to connect all secondary schools and half the basic education institutions. The Enlaces network provides access to email and educational resources through the public telephone network, taking advantage of low overnight call charges. And La Plaza, a customized software interface developed locally, provides a virtual "meeting place" for teachers and students.[21]
- Thailand has developed the first nationwide, free-access network for education in South-East Asia, SchoolNet@1509. With only 120 dial-in telephone lines, the network was obliged to establish a system to optimize the use of the lines: it gave each school one account for Web browsing and no more than two for Web development, limiting total access to 40 hours a month. It also created a Website to increase schools' awareness of the network and make Thai content available on the Internet.[22]
- The South African School Net (SchoolNetSA) is an interesting example for its structure and partnerships. SchoolNetSA, which is spread across several provinces, provides Internet services to local schools: connectivity, domain administration, email and technical support. SchoolNetSA has also developed on-line educational content, and many schools have developed their own Web pages.[23]

Technologies such as CD-ROM, radio and cable television—or a mix of technologies—can be combined with the Internet to extend its reach. The Kothmale Community Radio in Sri Lanka uses radio as a gateway to the Internet for its listeners in remote rural communities. Children or their teachers send requests for information about school topics for which no local resources exist; other listeners may also submit requests. The broadcasters search for the information on the Internet, download it and make it available by constructing a broadcast around the information, mailing it to the school or placing it in the radio station's open-access resource centre. The resource centre provides free Internet access and a library with computer databases, CD-ROMs, downloaded literature and print materials. This mediated access brings the Internet's resources to rural and underserved communities. And community rebroadcasting can relay the information in local languages rather than English, the dominant language of the Internet.[24]

Regional and global cooperation can reduce the cost of access to the Internet. Indeed, the development of information and communications technology provides the tools for learning through a global network. And wireless technologies enable developing countries with little telecommunications infrastructure to connect to the network. A pan-African satellite system, to be launched later in 2001, is expected to provide cheaper and better network service to African countries. Satellite-based distance education systems can provide poor nations access to higher-quality education and training in advanced countries. Such initiatives can be part of cost-effective solutions for bridging the "digital divide" between countries.

Many universities in developing countries are testing or implementing Web-based education systems

Many universities in developing countries are testing or implementing Web-based education systems.

- The University of Botswana evaluated two distance education methods: an Internet-based course, free of charge, that ran three months, and a video-based course that ran one week. The Internet course boosted test results by 49%, and the video technology by a similar amount, suggesting to the evaluators that both technologies have potential for distance learning.[25]

- The Indira Gandhi National University, established in 1985, has extended its communications capabilities to impart lifelong education and training, particularly to those living in rural and remote areas. Its sophisticated media centre has a satellite-based communications system, and all its education centres are equipped with computers and email access. Its Website provides general information and course material for all programmes. The Internet is serving a growing number of learners, though it is still only a small part of a system using a wide range of communications technologies, including radio, television, cable television and teleconferencing.[26]

When technology is changing, enterprises have to invest in worker training to remain competitive

Other communities have developed the concept of the "virtual university", using the Internet as a place for students, teachers and researchers to "meet". Working with universities in developing countries, the Francophone Virtual University supports distance education through advice, assistance and educational materials. A first call for proposals in 1998 resulted in the funding of 26 projects, mostly based on the Internet, and 132 more proposals from 16 countries are under consideration.[27]

Providing on-the-job training for lifelong learning

Formal education is only part of the skill creation system. Vocational and on-the-job training are just as important. When technology is changing, enterprises have to invest in worker training to remain competitive. They are more likely to do so when their workers are better educated to start with, since that lowers the cost of acquiring new skills.

Several studies—in Colombia, Indonesia, Malaysia and Mexico—have shown the high impact of enterprise training on firm productivity. Such training can be an effective and economical way to develop the skills of a workforce, particularly where employers are well informed about the skills needed. Some may also have the expertise and resources to provide training in both traditional and emerging skills. The costs of enterprise training tend to be low compared with those of formal training, though employers lose part of the benefit if employees leave. Studies suggest that enterprise-based training yields higher private returns than other post-school training, in both developing and industrial countries.[28]

Enterprise training is also an essential complement to new investment in technology, plants and equipment. Many studies in industrial countries suggest that the shortage of appropriate worker skills is a major constraint to the adoption of new technologies, while well-trained workers accelerate their adoption.[29]

Despite the demonstrated gains in productivity from training, not all employers provide it. Training involves costs—in materials, time and forgone production. In Colombia, Indonesia, Malaysia and Mexico a sizable share of enterprises provide no worker training (table 4.2). Among small and medium-size enterprises, more than half provide no formal, structured training, and more than a third no informal training. Weak management, high training costs, inability to exploit scale economies in training, poor information about the benefits of training, market imperfections and the absence of competitive pressures—all are reasons that firms provide too little training.

TABLE 4.2
Enterprises providing training in selected developing countries
Percent

Country, year	Informal training	Formal training
Colombia, 1992	76	50
Indonesia, 1992	19	19
Malaysia, 1994	83	35
Mexico, 1994	11	11

Source: Tan and Batra 1995, cited in Lall 2001.

Choosing policies for better quality training

Skill development requires policy intervention —in many forms. Governments can establish training centres that involve the private sector. Or they can use fiscal incentives or matching grants to encourage industry associations to establish and manage such centres. In East Asia industry associations provide many valuable training and technical services. Also worth considering are generous tax allowances to smaller firms for investing in training (Malaysia and Thailand give a 200% tax deduction).[30] And governments can sponsor coordination units to support interaction, with majority representation by the private sector to ensure that industry needs are addressed in the design of the training curriculum.

A comprehensive strategy for skill creation needs to address the entire range of market failures through a mix of institutional and other policies. Examples of such failures include a lack of information on education needs in industry and on student demands, inadequate incentives for trainers, low educational qualifications among employers and managers, low absorptive capacity among poorly educated workers and an inability to form efficient training programmes in line with changing skill and technology needs. Consider Singapore's public funding and incentives for lifelong skill development, which try to overcome market deficiencies (box 4.6).

What are some of the key policies developing countries should consider for upgrading skills?

- Conduct comprehensive audits of skill provision and needs, not just once but on a regular basis. International benchmarking can be used to assess skill needs. And there may be a case for targeted development of new skills likely to be critical for future competitiveness, in such areas as food processing, capital-intensive process industries and electrical and electronics engineering. Such exercises can be undertaken by industry associations, academic institutions and government, working together.
- Target special information and incentive programmes to small and medium-size enterprises to encourage them to invest in training. Governments can build on apprenticeship systems, in which craftspeople teach young workers traditional methods, upgrading the systems by setting up training centres and subsidizing training by small and medium-size enterprises.
- Provide recent secondary school graduates with partially financed training in accredited private centres, both encouraging skill acquisition and helping to create a market for private training.
- While most of these examples relate to training in the urban, industrial and service sectors, similar lessons apply in agriculture, where extension workers, researchers and others involved in technological upgrading also need training.

Financing education—tough choices

Skill development requires policy intervention in many forms

Public investments in learning yield high returns to society as a whole. But where should each country direct its investments? Have today's technological transformations made the returns to secondary and tertiary education as high as those to primary education—or even higher? If so, how should spending be distributed across primary, secondary and tertiary systems? And are there ways to increase resource flows to education, beyond simply expanding public spending?

BOX 4.6

Providing incentives for high-quality training in Singapore

The Singapore government has invested heavily in developing high-level skills. It expanded the country's university system and directed it towards the needs of its industrial policy, changing the specialization from social studies to technology and science. In the process the government exercised tight control over the content and quality of curriculum, ensuring its relevance for the industrial activities being promoted. The government also devoted considerable efforts to developing the industrial training system, now considered one of the world's best for high-technology production.

The Skill Development Fund, established in 1979, collected a levy of 1 percent of payroll from employers to subsidize training for low-paid workers. Singapore's four polytechnics, which meet the need for mid-level technical and managerial skills, work closely with business in designing courses and providing practical training. In addition, with government assistance under the Industry-Based Training Programme, employers conduct training courses matched to their needs. And the Economic Development Board continuously assesses emerging skill needs in consultation with leading enterprises and mounts specialized courses. National investment in training reached 3.6 percent of annual payroll in 1995, and the government plans to raise it to 4 percent. Compare this with an average of 1.8 percent in the United Kingdom.

The programme's initial impact was felt mostly in large firms. But efforts to increase small firms' awareness of the training courses and to support industry associations have increased the impact on smaller organizations. To expand the benefit, a development consultancy scheme has been introduced to provide small and medium-size enterprises with grants for short-term consultancies in management, technical know-how, business development and staff training.

As a result of all these efforts the workforce has shifted significantly towards more highly skilled jobs, with the share of professional and technical workers rising from 15.7% in 1990 to 23.1% in 1995.

Source: Lall 2001.

Financing education calls for a mix of public and private responsibility

The social benefits of primary education—such as lower fertility and improved health for mothers and children—have made universal primary education a worldwide goal. But developing countries cannot ignore secondary and post-secondary education, though the social benefits from investments at these levels are less well documented. Getting the balance right is difficult. What indicators can countries use to help them choose the best policy?

The share of national income spent on education relative to, say, defence and health, is only a start. This indicator needs to be supplemented with others, such as teachers' salaries relative to average incomes. Countries differ enormously in what they pay teachers. In Uruguay, for example, the statutory salary of an experienced teacher at a public lower secondary school is just 80% ($7,458 PPP US$) of average income. In Jordan a teacher with the same experience would earn almost 3.5 times ($11,594 PPP US$) the country's average income.[31] Offering starting salaries that are around the average income, or even lower, makes it difficult to attract enough qualified teachers.

An important indicator for higher education is the rate of enrolment in technical subjects such as science, engineering, mathematics and computing. Some developing countries have had great success in raising such enrolments. For example, of the 3 million students enrolled in college in the four East Asian "tigers"—Hong Kong (China, SAR), Republic of Korea, Singapore and Taiwan (province of China)—in 1995, more than 1 million were in technical fields. China and India both have more than a million students enrolled in technical subjects.[32] These large enrolments generate a critical mass of skilled personnel. But there are stark disparities between nations. While gross tertiary enrolment in science and technical subjects was 23.2% in Korea in 1997, it was only 1.6% in Botswana and 0.2% in Burkina Faso in 1996 (see annex table A2.1 in chapter 2).

Tertiary education is expensive—too expensive for many poor countries. That leads to some difficult policy questions. Which skills should countries acquire by sending students abroad? Which subjects require public resources, and which can be privately financed?

The logic of government financing for secondary education is indisputable. Nor can governments neglect the post-secondary level. But public financing does need to be targeted to science, public health, agriculture and other fields in which technological innovation and adaptation will generate large spillover benefits for society as a whole. For some developing countries, participating in regional and global networks of universities will make sense for several decades. But in the long run most will want to establish their own universities and research centres.

Most developing countries already devote substantial public resources to education (table 4.3). But countries around the world find that they need to finance skill development through a mix of public resources, private finance and the direct contributions of individuals. Some policy choices:

- Retain public responsibility for funding basic education, with mandatory primary education the responsibility of government. Out of 196 countries, 172 have passed laws making primary education compulsory.[33] These laws have not always been fully implemented.
- Reconsider the extent to which individuals should pay for some courses at the tertiary level. For courses that generate high private returns, there may be a case for cost recovery. Courses in business and law, for example, could be priced to reflect the market value of these degrees.
- Encourage private supply of some education services, particularly at the post-secondary level. The extent of private spending on education varies enormously across countries. In Korea, for example, private spending is equivalent to 2.5% of GDP.[34]
- Rely more on private funding for vocational and on-the-job training, through private firms or trade associations. Use subsidies and tax allowances for training to encourage individuals and firms to invest in skills.

Public policy in developing countries thus has to focus on increasing resources and, in many, on changing the orientation of education systems. Financing education calls for a mix of public and private responsibility. The public sector must retain responsibility for universal primary education and for secondary and some tertiary education. But countries should consider allowing greater scope for private supply of some education services—and rely more on payments from individuals for advanced professional courses with strong market rewards.

Mobilizing diasporas

Rich countries are opening their doors to developing country professionals—at a high cost to the home countries. About 100,000 Indian professionals a year are expected to take new visas recently issued by the United States. The cost of providing university educations to these professionals represents a resource loss for India of $2 billion a year (box 4.7).

This "brain drain" makes it more difficult for developing countries to retain the very people critical for technological development, people whose wages are increasingly set in the global marketplace. How can a diaspora contribute to the home country? What can supplier countries do to get some "compensation" for generating skills that have an international market? Can countries sustain and improve their domestic education institutions? What can they do to persuade talented people to return? Many countries have adopted strategies to encourage links between the diaspora and the home country.

India's dynamic diaspora network

Diasporas can enhance the reputation of the home country. The success of the Indian diaspora in Silicon Valley, for example, appears to be influencing how the world views India, by creating a sort of "branding". Indian nationality for a software programmer sends a signal of quality just as a "made in Japan" label signals first-class consumer electronics. India's information technology talent is now being courted not just by companies in the United States but by those in other countries.

The worldwide network of Indian professionals has been investing in skill development at home. The network has worked to raise the endowments and bolster the finances of some of India's institutions of higher education. And an effort is under way to establish five global institutes of science and technology.

The Indian diaspora is also having important effects in the information technology sector. Firms increasingly have operations in both the United States—the "front office"—and India—the "manufacturing facility". At a time that talent in information technology has been scarce, Indian-launched firms in the United States have had a competitive advantage stemming from an unusual factor: they are up and running faster than their rivals simply because they can hire technical people faster, drawing as they do from a large transnational network. This has led to rapidly growing demand for information technology specialists from India and thus to a rapid expansion of information technology training, increasingly by the private sector.[35]

Many countries have adopted strategies to encourage links between the diaspora and the home country

TABLE 4.3
Average public education spending per pupil by region, 1997
(estimated)

	Average		Primary and secondary[a]		Tertiary	
	US$	Percentage of GNP per capita	US$	Percentage of GNP per capita	US$	Percentage of GNP per capita
World	1,224	22	999	18	3,655	66
Advanced countries	5,360	21	4,992	20	6,437	25
Developing countries	194	16	150	12	852	68
Sub-Saharan Africa	252	11	190	8	1,611	68
Middle East	584	22	494	19	1,726	66
Latin America	465	14	392	12	1,169	35
East Asia	182	14	136	11	817	64
South Asia	64	15	44	11	305	73
Transition countries	544	26	397	19	603	33

a. Includes pre-primary.
Source: Lee 2001 using UNESCO 2000b.

Efforts in the Republic of Korea and Taiwan (province of China) to reverse the brain drain

Korea and Taiwan (province of China) have focused more on encouraging their diasporas to return than on encouraging them to invest at home. Taiwan (province of China) set up a government agency—the National Youth Commission—to coordinate efforts to encourage return. The commission acts as an information clearinghouse for returning scholars seeking employment and for potential employers. Korea has focused on upgrading its research institutions, such as the Korea Institute for Science and Technology (KIST), as a way to attract returnees. Those who join KIST are given a great deal of research and managerial autonomy.

Both Korea and Taiwan (province of China) have tried hard to attract scholars and researchers. Intensive recruiting programmes search out older professionals and scholars and offer them salaries competitive with overseas incomes, better working conditions and help with housing and children's schooling. Visiting professor programmes allow the countries to tap the expertise of those uncertain about returning home for good.

In the 1960s just 16% of Korean scientists and engineers with doctorates from the United States returned to Korea. In the 1980s that share jumped about two-thirds.[36] A large part of the difference was due to Korea's improved economic prospects.

Today, rather than focusing only on the physical return of their pools of technological talent living abroad, the two countries are working to plug their diasporas into cross-national networks. They are organizing networks of professionals overseas and linking them with the source country.

BOX 4.7

Taxing lost skills

The brain drain from skill-poor countries to skill-rich countries is likely to continue in the foreseeable future. What are the resources at stake for the skill-supplying countries? And how might these countries recover some of the resources they lose through the brain drain?

Consider the drain of software professionals from India to the United States. Under new legislation introduced in October 2000, the United States will issue about 200,000 H-1B visas a year over the next three years. These visas are issued to import specific skills, primarily in the computer industry. Almost half are expected to be issued to Indian software professionals. What resource loss will this represent for India?

Consider just the public spending on students graduating from India's elite institutes of technology. Operating costs per student run about $2,000 a year, or about $8,000 for a four-year programme. Adding in spending on fixed capital, based on the replacement costs of physical facilities, brings the total cost of training each student to $15,000–20,000. Multiply that by 100,000, the number of professionals expected to leave India each year for the next three years. At the high end, it brings the resource loss to $2 billion a year.

How might India begin to recover this loss? The simplest administrative mechanism would be to impose a flat tax—an exit fee paid by the employee or the firm at the time the visa is granted. The tax could be equivalent to the fees charged by headhunters, which generally run about two months' salary. Assuming annual earnings of $60,000, this would amount to a flat exit tax of $10,000, or about $1 billion annually (and $3 billion over three years).

Public spending on education by India's central and state governments amounts to about 3.6% of GDP. The share going to higher education (including technical education) is 16.4%, or 0.6% of GDP—around $2.7 billion in 1999. Exit tax revenues—whether collected through unilateral or bilateral mechanisms—could easily raise public spending in higher education by a fifth to a third.

But estimates of the revenue potential of an exit tax need to take into account behavioural responses: people might try to evade the tax by leaving as students at an early age and then staying on. How would one tax this group of (potential) immigrants, who are likely to be the "cream of the crop" for a developing country? Moreover, if the children of the elite do not enrol in a country's education institutions, the political support for ensuring that the institutions are run well will wither.

Beyond the exit tax, there are several alternatives for taxing flows of human capital:

- A requirement for loan repayment, where each student in tertiary education is given a loan (equivalent to the subsidy provided by the state) that would have to be repaid if the student leaves the country.
- A flat tax, where overseas nationals pay a small fraction of their income, say, 1%.
- The US model, where individuals are taxed on the basis of nationality, not residence. This would require negotiating bilateral tax treaties.
- The cooperative model, where a multilateral regime would allow automatic intergovernmental transfers of payroll taxes or income taxes paid by nationals of other countries.

As with all taxes, each of these involves trade-offs between administrative and political feasibility and revenue potential.

Source: Kapur 2001; Bhagwati and Partington 1976.

Africa's attempts to reverse its brain drain under adverse conditions

Many African countries have suffered from internal conflicts and stagnant economies. Many skilled people have left this hostile environment. The Return of Qualified African Nationals Programme, run by the International Organization for Migration, has tried to encourage qualified nationals to return and helped them reintegrate. It reintegrated 1,857 nationals in 1983–99, slightly more than 100 a year.[37] Given the high level of brain drain from Africa, this effort is unlikely to make much of a difference.

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Can countries do anything to get compensation for the skills lost through brain drain? One possibility is to use tax policy to generate resources for institutions that create skills relevant for both international and domestic markets . Various tax proposals—from a one-time exit tax to longer-term bilateral tax arrangements—have been around for some time (see box 4.7). In light of the increased migration of skills in recent years, such proposals deserve serious consideration.

The contrasting experiences noted above point to an obvious reality: countries with substantial diasporas have a potential resource. A diaspora's expertise and resources can be invaluable, but effectiveness depends on the state of affairs in the home country. That means that it must have an environment conducive to economic development, with political stability and sound economic policies. The diaspora's attitude towards returning to the home country is likely to change as the country develops and its prospects improve. Both the Indian and Korean diasporas responded to improving domestic conditions. Timing and chance play a part in this, but in the end diaspora networks can be effective only when countries get their houses in order.