United Nations Conference on Trade and Development

World Investment Report

2005 Transnational Corporations and the Internationalization of R&D

The work is published for
and on behalf of the
United Nations

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This Report is dedicated to the memory of Sanjaya Lall

PREFACE

The globalization of production is reshaping the international economic landscape. With that, the conventional wisdom of developed countries as capital and technology exporters and developing countries as importers is gradually giving way to a more complex set of relationships. The geography of international investment flows is changing. Developing countries are emerging as outward investors, and their importance as recipients of foreign direct investment in more knowledge-intensive activities is increasing. The *World Investment Report 2005,* focusing on the internationalization of research and development by transnational corporations, illustrates some of these changes.

As global competition intensifies, transnational corporations are internationalizing even the most knowledge-intensive corporate functions, such as research and development. Until recently, this trend was limited almost exclusively to developed countries. Today, corporations in industries such as automobiles, electronics, biotechnology and pharmaceuticals are establishing research and development facilities in selected developing countries. They do this to enhance their efficiency, to access expanding pools of scientists and engineers, and to meet the demands of increasingly sophisticated markets in these countries.

These recent trends have important implications for the international division of labour. The traditional view, of more complex production activities being undertaken in the North and simpler ones in the South, is less and less a true reflection of the reality. Firms now view parts of the developing world as key sources not only of cheap labour, but also of growth, skills and even new technologies. As transnational corporations are the dominant players in the creation of new technologies, it matters where they undertake their research and development. Currently, only a few developing countries attract such activities on a significant scale. Most low-income countries are not participating in global research and development networks, and consequently do not reap the benefits that they can generate.

The internationalization of research and development by transnational corporations has important implications for policy-making. The *World Investment Report 2005* stresses the need for coherent national policies – particularly in the areas of science, technology and innovation, education and investment – to ensure greater benefits from this evolution. For many countries, however, this is a daunting task, which will necessitate the full support of the international community.

Kofi A. Annan
Secretary-General of the United Nations

New York, July 2005

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ABBREVIATIONS

AGOA	African Growth and Opportunity Act (of the United States)
ASEAN	Association of South-East Asian Nations
BERD	business enterprise research and development
BIT	bilateral investment treaty
CARICOM	Caribbean Community
CEMAC	Communauté économique et monétaire d'Afrique centrale (Economic and Monetary Community of Central Africa)
CIS	Commonwealth of Independent States
COMESA	Common Market for Eastern and Southern Africa
DTT	double taxation treaty
ECOWAS	Economic Community of West African States
EFTA	European Free Trade Association
EIU	Economist Intelligence Unit
EPA	economic partnership agreement
ESCWA	Economic and Social Commission for Western Asia
EU	European Union
FDI	foreign direct investment
FTA	free trade agreement
FTAA	Free Trade Area of the Americas
GATS	General Agreement on Trade in Services (WTO Agreement)
GDP	gross domestic product
GERD	gross expenditure on research and development
ICSID	International Centre for Settlement of Investment Disputes
ICT	information and communications technology
IIA	international investment agreement
IPA	investment promotion agency
IPR	intellectual property right
ISDS	investor-State dispute settlement
LDC	least developed country
M&A	merger and acquisition
MERCOSUR	Mercado Común del Sur (Southern Common Market)
MFN	most favoured nation
MSTQ	metrology, standards, testing and quality (system)
NAFTA	North American Free Trade Agreement
NAICS	North American Industry Classification System
NEPAD	New Partnership for Africa's Development
NIE	newly industrializing economy
NIS	national innovation system
NSB	National Science Board (United States)
OBM	own brand manufacture
ODM	own design manufacture
OEM	original equipment manufacture
R&D	research and development
RTA	regional trade agreement
SACU	Southern African Customs Union
SADC	Southern African Development Community
SAARC	South Asian Association for Regional Cooperation
SCM	subsidies and countervailing measures (also a Uruguay Round Agreement)
SEE	South-East Europe
SIC	Standard Industrial Classification
TNC	transnational corporation
TRIPS	Trade-related Aspects of Intellectual Property Rights (WTO Agreement)
UNDP	United Nations Development Programme
UNICI	UNCTAD Innovation Capability Index
UNIDO	United Nations Industrial Development Organization
USPTO	United States Patent and Trademark Office
WTO	World Trade Organization

OVERVIEW

END OF THE DOWNTURN

Led by developing countries, global FDI flows resumed growth in 2004...

On account of a strong increase in foreign direct investment (FDI) flows to developing countries, 2004 saw a slight rebound in global FDI after three years of declining flows. At $648 billion, world FDI *inflows* were 2% higher in 2004 than in 2003. Inflows to developing countries surged by 40%, to $233 billion, but developed countries as a group experienced a 14% drop in their inward FDI. As a result, the share of developing countries in world FDI inflows was 36%, the highest level since 1997. The United States retained its position as the number one recipient of FDI, followed by the United Kingdom and China.

Many factors help to explain why the growth of FDI was particularly pronounced in developing countries in 2004. Intense competitive pressures in many industries are leading firms to explore new ways of improving their competitiveness. Some of these ways are by expanding operations in the fast-growing markets of emerging economies to boost sales, and by rationalizing production activities with a view to reaping economies of scale and lowering production costs. Higher prices for many commodities have further stimulated FDI to countries that are rich in natural resources such as oil and minerals. In some developed as well as developing countries, increased inflows in 2004 were linked to an upturn in cross-border merger and acquisition (M&A) activity. Greenfield FDI continued to rise for the third consecutive year in 2004. Provided economic growth is maintained, the prospects for a further increase in global FDI flows in 2005 are promising.

FDI *outflows* increased in 2004 by 18%, to $730 billion, with firms based in developed countries accounting for the bulk ($637 billion). In fact, almost half of all outward FDI originated from three sources: the United States, the United Kingdom and Luxembourg in that order. Developed countries as a group remained significant net capital exporters through FDI; net outflows exceeded net inflows by $260 billion. While FDI outflows from the European Union (EU) declined by 25%, to $280 billion (a seven-year low), most other developed countries increased their investment abroad. In the case of the United States, outflows increased by over 90%, to $229 billion, a record high.

The stock of FDI in 2004 is estimated at $9 trillion. It is attributed to some 70,000 transnational corporations (TNCs) and their 690,000 affiliates abroad, with total sales by foreign affiliates amounting to almost $19 trillion. Ranked by foreign assets, General Electric (United States) remained the largest non-financial TNC worldwide, followed by Vodafone (United Kingdom) and Ford Motor (United States). Among the top 100 TNCs worldwide, four companies, led by Hutchison Whampoa (Hong Kong, China), are based in developing economies.

The pace at which the top 100 TNCs are expanding internationally appears to have slowed down. Although their sales, employment and assets abroad all rose in absolute terms in 2003, their relative importance declined somewhat as activities in the home countries expanded faster. Japanese and United States TNCs are generally

less transnationalized than their European counterparts. The top 50 TNCs based in developing economies, with a shorter history of outward expansion, are even less transnationalized, but the gap between TNCs from developed and developing countries is shrinking in this respect.

International investment in services, particularly financial services, continued to grow steadily, accounting for the bulk of the world FDI stock. The services sector accounted for 63% of the total value of cross-border M&As in 2004, with financial services responsible for one-third of the value of cross-border M&As in this sector. For the first time, this year's *WIR* ranks the top 50 financial TNCs. Large TNCs dominate world financial services, not only in terms of total assets but also in terms of the number of countries in which they operate. Citigroup (United States) tops the list, followed by UBS (Switzerland) and Allianz (Germany). Financial TNCs from France, Germany, Japan, the United Kingdom and the United States accounted for 74% of the total assets of the top 50 financial TNCs in 2003.

Low interest rates, higher profits and the recovery of asset prices, principally in developed countries, contributed to an upturn in M&As, including cross-border M&As; their value shot up by 28% to $381 billion. These transactions played an important part in the continued restructuring and consolidation process of many industries, especially in the developed world. The largest M&A deal in 2004 was the acquisition of Abbey National (United Kingdom) by Santander Central Hispano (Spain), valued at $16 billion. In developing countries, cross-border M&As accounted for a more modest share of overall FDI activity, although firms from these countries were increasingly involved in M&As, including some high-profile cases. The upswing in FDI flows to developing countries was mainly associated with greenfield investments notably in Asia. China and India together accounted for about a half of all new registered greenfield (and expansion) projects in developing countries in 2004.

In terms of the three main forms of FDI financing, equity investment dominates at the global level. During the past decade, it has accounted for about two-thirds of total FDI flows. The shares of the other two forms of FDI – intra-company loans and reinvested earnings – were on average 23% and 12% respectively. These two forms fluctuate widely, reflecting yearly variations in profit and dividend repatriations or the need for loan repayment. There are notable differences in the pattern of FDI financing between developed and developing countries; reinvested earnings are consistently more important in the latter.

FDI continues to surpass other private capital flows to developing countries as well as flows of official development assistance (ODA). In 2004, it accounted for more than half of all resource flows to developing countries and was considerably larger than ODA. However, FDI is concentrated in a handful of developing countries, while ODA remains the most important source of finance in a number of other developing countries. This is particularly the case for most least developed countries (LDCs) even though FDI flows have surpassed ODA for individual countries in that group.

Countries continue to adopt new laws and regulations with a view to making their investment environments more investor friendly. Out of 271 such changes pertaining to FDI introduced in 2004, 235 involved steps to open up new areas to FDI along with new promotional measures. In addition, more than 20 countries lowered their corporate income taxes in their bid to attract more FDI. In Latin America and Africa, however, a number of policy changes tended to make regulations less favourable to foreign investment, especially in the area of natural resources.

At the international level, the number of bilateral investment treaties (BITs) and double taxation treaties (DTTs) reached 2,392 and 2,559 respectively in 2004, with developing countries concluding more such treaties with other developing countries. More international investment agreements were also concluded at the regional and global level, potentially contributing to greater openness towards FDI. The various international agreements are generally becoming more and more sophisticated and complex in content, and investment-related provisions are increasingly introduced into agreements encompassing a broader range of issues. There is also a rise in investor-State disputes, paralleling the proliferation of international investment agreements.

...with the Asia and Oceania region the largest recipient as well as source of FDI among developing countries.

The upturn in global FDI was marked by significant differences between countries and regions. *Asia and Oceania* was again the top destination of FDI flows to developing regions. It attracted $148 billion of FDI, $46 billion more than in 2003, marking the largest increase ever. East Asia saw a 46% increase in inflows, to reach $105 billion, driven largely by a significant increase in flows to Hong Kong (China). In South-East Asia, FDI surged by 48% to $26 billion, while South Asia, with India at the forefront, received $7 billion, corresponding to a 30% rise. FDI inflows to West Asia grew even more, rising from $6.5 billion to $9.8 billion, of which more than half was concentrated in Saudi Arabia, the Syrian Arab Republic and Turkey. China continued to be the largest developing-country recipient with $61 billion in FDI inflows.

The Asia and Oceania region is also emerging as an important source of FDI. In 2004 the region's outward flows quadrupled to $69 billion, due mainly to dramatic growth in FDI from Hong Kong (China) but also to increased investments by TNCs from other parts of East Asia and South-East Asia. Most of these investments are intraregional, taking place especially among the economies of East and South-East Asia. However, interregional investment from Asian economies also increased. For example, a key driver of Chinese outward FDI was the growing demand for natural resources. This has led to significant investment projects in Latin America. Indian TNCs also invested large amounts in natural resources in other regions, primarily in African countries and the Russian Federation. Asian investment in developed countries is on the rise as well: the past year in particular has seen a few sizeable acquisitions of United States and EU firms by Chinese and Indian TNCs – such as the acquisition by Lenovo (China) of the personal computers division of IBM (United States).

The growth of both inward and outward FDI flows in Asia and Oceania is being facilitated by various policy changes at the national and regional levels. For example, the Association of Southeast Asian Nations (ASEAN) and China signed an agreement to establish a free trade area by 2010, and several Asian countries signed free trade agreements with the United States.

FDI rebounded in Latin America following four years of decline ...

Following four years of continuous decline, FDI flows to Latin America and the Caribbean registered a significant upsurge in 2004, reaching $68 billion – 44% above the level attained in 2003. Economic recovery in the region, stronger growth in the world economy and higher commodity prices were contributing factors. Brazil and Mexico were the largest recipients, with inflows of $18 billion and $17 billion respectively. Together with Chile and Argentina they accounted for two-thirds of all FDI flows into the region in 2004. However, FDI inflows did not increase in all the countries of Latin America. There were notable declines in Bolivia and Venezuela, mainly linked to uncertainty regarding legislation related to oil and gas production. In Ecuador the completion of the crude oil pipeline construction explained the decrease in FDI inflows. A number of countries modified their legislation and tax regimes to increase the State's share in revenues from non-renewable natural resources. It is still too early to assess the impact of these changes on the volume of FDI. Significant projects remain under development and additional ones were announced during 2004.

The sectoral composition of inward FDI to parts of Latin America and the Caribbean appears to be changing. For several countries of the region, natural resource and manufacturing industries became more popular FDI destinations than services in 2004. In Argentina, Brazil and Mexico, manufacturing attracted more FDI than services. FDI in Mexico's maquiladora industry surged by 26% in response to growing demand in the United States after three consecutive years of decline. The completion of most privatization programmes, coupled with financial difficulties facing foreign investors in the aftermath of the recent financial crisis and the ensuing economic stagnation in some countries, reduced the attractiveness of the services sector for FDI in Latin America. Firms in that sector suffered the most from the impact of the economic crisis, facing serious problems in reducing their large foreign-currency liabilities while at the same time being unable (owing to the non-tradability of their activities) to shift towards export-oriented production. In Central America and the Caribbean, however, renewed privatization activity made services the largest FDI recipient

sector. In the Andean Community, high oil and mineral prices sustained the position of the primary sector as the main recipient of FDI flows.

... remained stable in Africa ...

FDI flows to Africa remained at almost the same level – $18 billion – as in 2003. FDI in natural resources was particularly strong, reflecting the high prices of minerals and oil and the increased profitability of investment in the primary sector. High and rising prices of petroleum, metals and minerals induced TNCs to maintain relatively high levels of investment in new exploration projects or to escalate existing production. Several large cross-border M&As were concluded in the mining industry last year. Despite these developments Africa's share in FDI flows worldwide remains low, at 3%.

Angola, Equatorial Guinea, Nigeria, Sudan (all rich in natural resources) and Egypt were the top recipients, accounting for a little less than half of all inflows to Africa. While FDI inflows to the last three rose, those to South Africa, another important FDI recipient, fell. LDCs in Africa received small amounts: around $9 billion in total in 2004. Most investment in Africa originated from Europe, led by investors from France, the Netherlands and the United Kingdom, and from South Africa and the United States; together these countries accounted for more than half of the region's inflows. FDI outflows from Africa more than doubled in 2004, to $2.8 billion.

A renewed wave of FDI-friendly measures and initiatives at national and international levels has sought to facilitate and attract more FDI to the African continent. At the national level, many measures focused on liberalizing legal frameworks and improving the overall environment for FDI. However, failure to move rapidly on economic and social policies important for attracting and retaining FDI, and a weak emphasis on capacity building, have hampered the ability of many countries in the region to attract FDI, in particular in manufacturing. Thus far, international market-access measures and initiatives targeting African countries (such as the United States' African Growth and Opportunity Act) overall have not been very successful in increasing FDI. In order to realize the potential for increased FDI and to derive greater benefits from it, African countries generally need to develop stronger industrial and technological capabilities.

The need for international support to Africa's development has been stressed in several recent initiatives. For example, the Commission for Africa (established by the United Kingdom) released a report in March 2005 recommending a substantial increase in aid to Africa: an additional $25 billion per year to be implemented by 2010. It also proposed several measures that could help the continent attract more FDI and enhance its benefits for development. Specifically the report called for donors to double their funding for infrastructure, adopt a 100% external debt cancellation, support an Investment Climate Facility for Africa under the New Economic Partnership for Africa's Development (NEPAD) initiative, and create a fund that would provide insurance to foreign investors in post-conflict countries in Africa.

... and increased in South-East Europe and the CIS for the fourth consecutive year.

FDI inflows to South-East Europe and the CIS, a new group of economies under the United Nations reclassification, recorded a fourth year of growth in 2004, reaching an all-time high of $35 billion. This was the only region to escape the three-year decline (2001-2003) in world FDI flows, and it maintained robust growth in inward FDI in 2004 (more than 40%). Trends in inward FDI to the two subregions have differed somewhat, however, reflecting the influence of various factors. In South-East Europe, FDI inflows started to grow only in 2003. Led by large privatization deals, these inflows nearly tripled, to $11 billion in 2004. In the CIS, inflows grew from $5 billion in 2000 to $24 billion in 2004, benefiting largely from the high prices of petroleum and natural gas. The Russian Federation is the largest recipient of FDI inflows in the region.

By contrast, FDI inflows to developed countries continued to decline.

FDI flows into developed countries, which now include the 10 new EU members, fell to $380 billion in 2004. The decline was less sharp than in 2003, possibly suggesting a bottoming out of the downward trend that started in 2001. The decline pertained to many major host countries in the developed world. However, there were

some significant exceptions; the United States and the United Kingdom recorded substantial increases in inflows mainly as a result of cross-border M&As. Meanwhile, investment outflows from developed countries turned upwards again in 2004 to reach $637 billion.

FDI flows into the EU as a whole fell to $216 billion – the lowest level since 1998. However, the performance of individual EU members varied, with Denmark, Germany, the Netherlands and Sweden registering the most significant declines. To some extent the persistence of the downward FDI trend in the EU reflected large repayments of intra-company loans and repatriation of earnings in a few members. At the same time, FDI inflows into all the 10 new EU countries increased, attracted by high rates of economic growth, the availability of skilled human resources at competitive costs and reduced uncertainty with regard to the regulatory framework for FDI following EU accession. Flows into Japan surged by 24% to $8 billion, while those to other developed countries (Israel, New Zealand, Norway and Switzerland) declined.

Further increases in FDI are expected.

Prospects for FDI worldwide appear to be favourable for 2005. For 2006, global FDI flows can be expected to rise further if economic growth is consolidated and becomes more widespread, corporate restructuring takes hold, profit growth persists and the pursuit of new markets continues. The continued need of firms to improve their competitiveness by expanding into new markets, reducing costs and accessing natural resources and strategic assets abroad provides strong incentives for further FDI in developing countries in particular. Also, the improved profitability of TNCs is likely to trigger greater M&A activity, which should also push up the levels of FDI in developed countries.

Surveys of TNCs, experts and investment promotion agencies (IPAs) undertaken by UNCTAD corroborate this relatively optimistic picture, as do the findings of other recent surveys. In the UNCTAD surveys, more than half of the responding TNCs as well as experts and four-fifths of the IPAs expected short-term (2005-2006) growth in FDI flows; very few predicted a decline of FDI in the near future. The competitive pressure on firms, continued offshoring of services, ongoing liberalization and the growth of TNCs from emerging markets were identified as factors that should lead to more FDI.

At the same time, there are grounds for caution in forecasting FDI flows. The slowdown of growth in some developed countries, along with structural weaknesses and financial and corporate vulnerabilities in some regions, continue to hinder a strong recovery of FDI growth. Continuing external imbalances in many countries and sharp exchange-rate fluctuations, as well as high and volatile commodity prices, pose risks that may hinder global FDI flows.

There is some variation in the FDI prospects of individual regions. In view of the improved economic situation in Asia and Oceania, its important role as a global production centre, its improved policy environment and significant regional integration efforts, the prospects for FDI flows to that region are strongly positive. According to the TNCs, experts and IPAs surveyed by UNCTAD, the region's outlook for FDI is bright. FDI inflows to Latin America and the Caribbean are expected to increase in 2005-2006 as most of the driving forces behind FDI growth in 2004 are set to continue. Prospects are also positive for Africa, partly as a result of higher commodity prices and Africa's natural resource potential. One out of four TNC respondents expected that inflows to Africa would increase in 2005-2006, suggesting more cautious optimism vis-à-vis this region.

FDI inflows into South-East Europe and the CIS are expected to grow further in the near future, based on the expectation that their competitive wages, in particular in South-East Europe, could attract an increasing number of efficiency-seeking or export-oriented projects, while the natural-resource-rich CIS countries could benefit from continued high oil and gas prices.

Despite the decline in 2004, prospects for renewed growth in both inward and outward FDI flows for developed countries in 2005 remain positive, underpinned by forecasts of moderate economic growth and a strong pick-up in corporate profits. Already, during the first six months of 2005, cross border M&As in developed countries increased significantly. For the largest recipient country – the United States – prospects for FDI are good, although the inflows may not reach the high levels recorded in 2004.

R&D INTERNATIONALIZATION AND DEVELOPMENT

TNCs are internationalizing R&D, including in developing countries...

WIR05 focuses on the internationalization of research and development (R&D) by TNCs. This is not a new phenomenon. When expanding internationally, firms have always needed to adapt technologies locally to sell successfully in host countries. In many cases, some internationalization of R&D has been necessary to accomplish this. However, it was traditionally the case that R&D was reserved for the home countries of the TNCs. By contrast, now a number of new features are emerging in the internationalization process. In particular, for the first time, TNCs are setting up R&D facilities outside developed countries that go beyond adaptation for local markets; increasingly, in some developing and South-East European and CIS countries, TNCs' R&D is targeting global markets and is integrated into the core innovation efforts of TNCs.

Consider the following illustrations. Since 1993 when Motorola established the first foreign-owned R&D lab in China, the number of foreign R&D units in that country has reached some 700. The Indian R&D activities of General Electric – the largest TNC in the world – employ 2,400 people in areas as diverse as aircraft engines, consumer durables and medical equipment. Pharmaceutical companies such as Astra-Zeneca, Eli Lilly, GlaxoSmithKline, Novartis, Pfizer and Sanofi-Aventis all run clinical research activities in India. From practically nothing in the mid-1990s, the contribution by South-East and East Asia to global semiconductor design reached almost 30% in 2002. STMicroelectronics has some of its semiconductor design done in Rabat, Morocco. General Motors (GM) in Brazil competes with other GM affiliates in the United States, Europe and Asia for the right to design and build new vehicles and carry out other core activities for the global company. There are many such examples.

In theory, the internationalization of R&D into developing countries is both expected and unexpected. It is expected for two reasons. First, as TNCs increase their production in developing countries, some R&D (of the adaptive kind) can be expected to follow. Second, R&D is a form of service activity and like other services (*WIR04*), it is "fragmenting", with certain segments being located where they can be performed most efficiently. Indeed, according to a survey of Europe's largest firms conducted in 2004 by UNCTAD and Roland Berger, all service functions – including R&D – are now candidates for offshoring. It is unexpected in that R&D is a service activity with very demanding skill, knowledge and support needs, traditionally met only in developed countries with strong national innovation systems. Moreover, R&D is taken to be the least "fragmentable" of economic activities because it involves knowledge that is strategic to firms, and because it often requires dense knowledge exchange (much of it tacit) between users and producers within localized clusters.

It is clear that, to date, only a small number of developing countries and economies in transition are participating in the process of R&D internationalization. However, the fact that some are now perceived as attractive locations for highly complex R&D indicates that it is possible for countries to develop the capabilities that are needed to connect with the global R&D systems of TNCs. From a host-country perspective, R&D internationalization opens the door not only for the transfer of technology created elsewhere, but also for the technology creation process itself. This may enable some host countries to strengthen their technological and innovation capabilities. But it may also widen the gap with those that fail to connect with the global innovation network.

...with important implications for innovation and development.

Innovative activity is essential for economic growth and development. Moreover, sustainable economic development requires more than simply "opening up" and waiting for new technologies to flow in. It demands continuous technological effort by domestic enterprises, along with supportive government policies. With the

increasing knowledge-intensity of production, the need to develop technological capabilities is growing. Greater openness to trade and capital flows does not reduce the imperative of local technological effort. On the contrary, liberalization, and the open market environment associated with it, have made it necessary for firms – be they large or small in developed or developing countries – to acquire the technological and innovative capabilities needed to become or stay competitive.

R&D is only one source of innovation, but it is an important one. It takes various forms: basic research, applied research and product and process development. While basic research is mainly undertaken by the public sector, the other two forms are central to the competitiveness of many firms. In the early stages of technological activity enterprises do not need formal R&D departments. As they mature, however, they find it increasingly important to monitor, import and implement new technologies. The role of formal R&D grows as a firm attempts significant technological improvements and tackles product or process innovation. For complex and fast-moving technologies it is an essential part of the technological learning process.

But the process of acquiring technological capabilities is slow and costly. Technical change and advanced science-based technologies in many industries call for more high-level skills and intense technical effort. These require better infrastructure, not least in information and communication technologies (ICTs). They also require strong supporting institutions, as well as stable and efficient legal and governance systems. Finally, they require access to the international knowledge base, combined with a strategy to leverage this access for the benefit of local innovation systems. The cumulative forces that are increasing the gap between countries with respect to innovation make the role of policy increasingly important at both the national and international levels.

There are large differences in countries' capabilities to innovate and benefit from the R&D internationalization process. According to a new measure of national innovation capabilities – the UNCTAD Innovation Capability Index – the differences appear to be growing over time. Developed countries fall into the high capability group, as do Taiwan Province of China, the Republic of Korea and Singapore, along with some of the economies of South-East Europe and the CIS. The medium capability group comprises the remaining economies in transition, most of the resource-rich and newly industrializing economies and two sub-Saharan African economies (Mauritius and South Africa). The low capability group contains most of the sub-Saharan African countries as well as several countries in North Africa, West Asia and Latin America. Among developing countries, South-East and East Asia are the leaders in innovation capability, while the position of Latin America and the Caribbean has deteriorated over time and has been overtaken by North Africa and West Asia.

The innovative capabilities of a country are directly relevant to its attractiveness as a host country for R&D by TNCs, as well as to its ability to benefit from such R&D. The quality of R&D performed abroad depends on local capabilities of the host country. The same applies to the resulting externalities in terms of how much local firms and institutions are able to absorb and learn from exposure to best practice R&D techniques and skills. Whether or not R&D deepens over time, and how far it spreads over different activities, are the result of an interactive process between the TNCs and local actors in the host economy, and this process is in turn affected by the institutional framework and government policies of the host country.

TNCs are the drivers of global R&D.

Global R&D expenditure has grown rapidly over the past decade to reach some $677 billion in 2002. It is highly concentrated. The top ten countries by such expenditure, led by the United States, account for more than four-fifths of the world total. Only two developing countries (China and the Republic of Korea) feature among the top ten. However, the share of developed countries fell from 97% in 1991 to 91% in 2002, while that of developing Asia rose from 2% to 6%. Similarly, there has been a rise in innovation outputs (as measured by the number of patents issued). For example, between the two time periods of 1991-1993 and 2001-2003, the share of foreign patent applications from developing countries, South-East Europe and the CIS to the United States Patent and Trademark Office, jumped from 7% to 17%.

TNCs are key players in this process. A conservative estimate is that they account for close to half of global R&D expenditures, and at least two-thirds of business R&D expenditures (estimated at $450 billion). These shares are considerably higher in a number of individual economies. In fact, the R&D spending of some large TNCs is higher than that of many countries. Six TNCs (Ford, Pfizer, DaimlerChrysler, Siemens, Toyota and General Motors) spent more than $5 billion on R&D in 2003. In comparison, among the developing economies, total R&D spending came close to, or exceeded, $5 billion only in Brazil, China, the Republic of Korea and Taiwan Province of China. The world's largest R&D spenders are concentrated in a few industries, notably IT hardware, the automotive industry, pharmaceuticals and biotechnology.

The R&D activities of TNCs are becoming increasingly internationalized. This trend is apparent for all home countries, but starts from different levels. In the case of United States TNCs, the share of R&D of their majority-owned foreign affiliates in their total R&D rose from 11% in 1994 to 13% in 2002. German TNCs set up more foreign R&D units in the 1990s than they had done in the preceding 50 years. The share of foreign to total R&D in Swedish TNCs shot up from 22% to 43% between 1995 and 2003.

Reflecting the increased internationalization of R&D, foreign affiliates are assuming more important roles in many host countries' R&D activities. Between 1993 and 2002 the R&D expenditure of foreign affiliates worldwide climbed from an estimated $30 billion to $67 billion (or from 10% to 16% of global business R&D). Whereas the rise was relatively modest in developed host countries, it was quite significant in developing countries: the share of foreign affiliates in business R&D in the developing world increased from 2% to 18% between 1996 and 2002. The share of R&D by foreign affiliates in different countries varies considerably. In 2003 foreign affiliates accounted for more than half of all business R&D in Ireland, Hungary and Singapore and about 40% in Australia, Brazil, the Czech Republic, Sweden and the United Kingdom. Conversely, it remained under 10% in Chile, Greece, India, Japan and the Republic of Korea. Other indicators, such as the rising number of R&D alliances and growing patenting activity, similarly confirm the increased internationalization of R&D activities in developing countries.

Their R&D is growing particularly fast, though unevenly, in developing countries...

The share of host developing countries in the global R&D systems of TNCs is rising, but unevenly. Only a few economies have attracted the bulk of the R&D activity. Developing Asia is the most dynamic recipient. In the case of R&D expenditures by majority-owned foreign affiliates of United States TNCs, for example, the share of developing Asia soared from 3% in 1994 to 10% in 2002. The increase was particularly noticeable for China, Singapore, Hong Kong (China) and Malaysia. In the foreign R&D activities of Swedish TNCs the share of countries outside the Triad more than doubled, from 2.5% in 1995 to 7% in 2003. Survey findings and other data for Germany and Japan support the growing importance of developing countries and some economies in transition as locations for TNCs' R&D.

Official statistics generally suffer from time lags, and may not fully capture the pace of R&D internationalization. More recent data on FDI projects indicate that the expansion of R&D to new locations is gaining momentum. Of 1,773 FDI projects involving R&D worldwide during the period 2002-2004 for which information was available, the majority (1,095) was in fact undertaken in developing countries or in South-East Europe and the CIS. Developing Asia and Oceania alone accounted for close to half of the world total (861 projects). A survey of the world's largest R&D spenders conducted by UNCTAD during 2004-2005 also shows the growing importance of new R&D locations. More than half of the TNCs surveyed already have an R&D presence in China, India or Singapore. In South-East Europe and the CIS, the Russian Federation was the only significant target economy mentioned by the responding firms as hosting R&D activities.

In the same survey, as many as 69% of the firms stated that the share of foreign R&D was set to increase; only 2% indicated the opposite, while the remaining 29% expected the level of

internationalization to remain unchanged. The momentum appears to be particularly strong among companies based in Japan and the Republic of Korea, which until recently, have not been internationalizing their R&D to any large extent. For example, nine out of ten Japanese companies in the sample planned to increase their foreign R&D, while 61% of European firms stated such intentions. A further shift in terms of R&D locations towards some developing, South-East European and CIS markets is also envisaged. China is the destination mentioned by the largest number of respondents for future R&D expansion, followed by the United States. In third place is India, another significant newcomer location for R&D. Other developing economies mentioned as candidates for further R&D by some respondents include the Republic of Korea, Singapore, Taiwan Province of China, Thailand and Viet Nam. Very few respondents indicated any plans to expand R&D to Latin America or Africa. The Russian Federation was also among the top 10 target locations.

Another new and notable trend in the internationalization of R&D is the emergence and fast growth of foreign R&D activities of developing-country TNCs. This trend is driven by the need to access advanced technologies and to adapt products to major export markets. Some of these TNCs are targeting the knowledge base of developed countries, while others are setting up R&D units in other developing economies.

...and the type of R&D undertaken varies by region.

The R&D conducted in different locations varies considerably by region and economy. For example, in 2002, three-quarters of the R&D of United States majority-owned foreign affiliates in developing Asia were related to computers and electronic products, while in India over three-quarters of their R&D expenditure went into services (notably related to software development). In Brazil and Mexico, chemicals and transport equipment together accounted for over half of all R&D by United States foreign affiliates.

Moreover, TNCs carry out different types of R&D abroad. Foreign affiliates of TNCs may undertake *adaptive R&D*, which ranges from basic production support to the modifying and upgrading of imported technologies. *Innovative R&D* involves the development of new products or processes for local, regional or (eventually) global markets. *Technology monitoring* units are established to keep abreast of technological development in foreign markets and to learn from leading innovators and clients there.

While it is difficult to quantify R&D by type, among developing host economies the evidence points to the predominance of Asia in innovative R&D for international markets. R&D activities in selected Asian economies such as China, India, the Republic of Korea and Taiwan Province of China are becoming increasingly important within the global R&D networks of TNCs. Examples include the Toyota Technical Center Asia Pacific in Thailand, Motorola's R&D network in China and Microsoft's sixth global research centre in Bangalore, India. Some of the innovative R&D conducted there is at the cutting edge. The semiconductor industry is an example. One of the earliest to move production into developing countries, it has also been among the first to move advanced design to selected developing economies in Asia. Some of the design is done by foreign affiliates and some by local firms. A few firms from the Republic of Korea and Taiwan Province of China, and to a lesser extent from China and India, for instance, are now at the technology frontier of design work.

TNCs have so far located limited R&D in Latin America and the Caribbean. Relatively little FDI in Latin America and the Caribbean is in R&D-intensive activities; when it is, the R&D conducted is mostly confined to the adaptation of technology or products for local markets, called "tropicalization" in the Latin American context. Some important exceptions exist in Brazil and Mexico in particular. In Africa, the R&D component of FDI is generally very low; with the exception of some countries such as Morocco and, especially, South Africa, R&D by TNCs is virtually non-existent. This is partly because of weak domestic R&D capabilities, and in many cases the absence of institutional mechanisms that create sufficient incentives for investors to devote resources to R&D.

In some of the new EU members, foreign affiliates have emerged as important R&D players. In the Czech Republic, Hungary and

Poland, R&D by foreign affiliates is often linked to manufacturing, mostly in the automotive and electronics industries. Some foreign affiliates also conduct "innovative" R&D for regional or global markets.

The process is driven by new push and pull factors, and is facilitated by enabling technologies and policies...

The need to adapt products and processes to key host-country markets has always been an important motive for TNCs to internationalize R&D. The need to tap into knowledge centres abroad to source new technologies, recruit the best skills and monitor the activities of competitors is also well known in the literature. However, the recent surge of R&D by TNCs in selected developing host economies also reflects the quest for cost reduction and for accessing expanding pools of talent in these locations. It can be seen as a logical next step in the globalization of TNC production networks. It also resembles the international restructuring that has taken place in export-oriented manufacturing and ICT-based services through which TNCs seek to improve their competitiveness by exploiting the strengths of different locations.

R&D internationalization to new locations outside the Triad is driven by a complex interaction of push and pull factors. On the push side, intensifying competition, rising costs of R&D in developed countries and the scarcity of engineering and scientific manpower along with the increasing complexity of R&D, reinforce the imperative to specialize as well as to internationalize R&D work. On the pull side, the growing availability of scientific and engineering skills and manpower at competitive costs, the ongoing globalization of manufacturing processes, and substantial and fast-growing markets in some developing countries increase their attractiveness as new locations.

The expanding pool of talent in selected developing countries and economies in South-East Europe and the CIS is very important in this context – notably in science-based activities – especially for companies that fail to find a sufficient number of skilled people in their home countries. In recent years, there has been a dramatic increase in the number of people enrolled in higher education in developing countries and economies in transition. In 2000-2001 China, India and the Russian Federation together accounted for almost a third of all tertiary technical students in the world. In addition, more scientists and engineers are staying in, or returning to, China and India to perform R&D work for foreign affiliates or local firms or to start their own businesses. In Bangalore, for example, some 35,000 non-resident Indians have lately returned with training and work experience from the United States. Reflecting the growing importance of the human resource factor, both developed and developing countries are now adopting new policy measures to attract skills from abroad.

The internationalization of R&D is also facilitated by improvements in ICT and associated cost decreases, new research techniques that allow greater "fragmentation" of R&D and better information on research capabilities that are available worldwide. At the same time, overall improvements in host-country investment climates have all contributed to creating a more enabling framework. Important policy developments relate, for example, to intellectual property rights (IPR) protection, reform of public research activities, infrastructure development, and investment promotion efforts specifically targeting R&D-related FDI and R&D incentives.

There are some fundamental reasons why the current trend towards R&D internationalization is set to continue. First, the competitive pressure on firms is likely to remain intense, forcing them to innovate more. Second, the need for greater flexibility in R&D in response to rapid technological change requires sizeable numbers of research staff with a range of specializations, and it necessitates locating R&D activities where such pools of researchers are available. Third, ageing populations in many developed countries are likely to result in an insufficient supply of specialized, up-to-date skills, forcing TNCs to look elsewhere for fresh talent. Fourth, through cumulative learning processes involving local enterprises and institutions, the developing countries that take part in the internationalization of R&D will progressively enhance their own ability to conduct more R&D. At present however, it appears that only a few developing countries led by China and India and some economies of South-East Europe and the CIS, can effectively meet the conditions required to participate.