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Foreign direct investment, the transfer and diffusion of technology, and sustainable development

Note by the UNCTAD secretariat

Executive summary

Some developing countries have made significant technological progress during the past two decades, but the technology gap between rich and poor countries remains wide in general. Being major creators of new and advanced technologies, transnational corporations (TNCs) have the potential to play an important role in narrowing this gap. Although TNCs are not the only source of technology, they are very important in high-technology activities and in providing an entire package of knowledge, and their research and development (R&D) activities are expanding to the developing world.

TNCs can transfer and diffuse technologies of many kinds, including a wide range of hard and soft elements. They do so through both foreign direct investment (FDI) and various non-equity forms of foreign operation. The bulk of technology dissemination is still undertaken through internalized channels within the networks of TNCs, but externalized channels by non-equity forms have become increasingly important. In addition, foreign affiliates can diffuse technology and skills to local firms, particularly through backward linkages. These will be illustrated with concrete examples at the firm, industry and country levels. Nevertheless, acquisition of technology from TNCs is not automatic and still largely confined to higher-income developing countries. Most of the least developed countries (LDCs) or low-income countries are still not actively participating in global R&D networks for the creation of new technologies, though some are beginning to benefit from the transfer of existing technologies, including from developing country TNCs, as the cases in this note will show.

Making the best use of TNC-mediated technology transfer and diffusion requires proactive policy support. To effectively leverage FDI as a means to achieve technology transfer and diffusion, developing countries need to establish an effective national innovation system (NIS) which provides an interface for technology-related TNC activity, supports the development of the absorptive capacities of domestic enterprises and their linkages with TNCs, and provides a regulatory framework, including a balanced framework for intellectual property that enables the development of a knowledge base and technological capacities. The coherence between FDI policy and other relevant policies (especially innovation and science and technology policy) is important in this regard; and home country policies and international support can also play a role.

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Introduction

1. Technological progress is critical to economic growth and welfare for any country, regardless of level of development. Given fast technological change in the more advanced economies, closing the technological capability gap that separates them from developing countries, and particularly the LDCs, is a necessary condition to put the latter on a path of sustainable development and poverty reduction.[1]

2. Being major creators of new and advanced technologies, (TNCs) have the potential to play an important role in bridging the technology gap between rich and poor countries. This note assesses the contribution of FDI to the transfer and diffusion of technology and know-how for sustainable development in developing countries, taking into account the opportunities and challenges emanating from accelerating technological changes and intensifying competition. Special attention is given to the role of technology transfer and diffusion in building productive, adaptive and technological capacities and enhancing human resources in developing countries, in particular LDCs or low-income countries. The note also discusses policy options, at both national and international levels, and best practices to enhance the technological and innovative capacities in host developing countries contributed by TNCs. The focus is FDI, but other models of TNCs' international expansion, including non-equity modalities, are also considered.

3. For most low-income countries, technological progress is mainly a process of adoption and adaptation of technologies from abroad rather than the creation of new technologies. Therefore, the transfer and diffusion of technology are crucial to building their domestic technological capabilities; and the role of Governments in supporting this process, as well as in building on it to develop and enhance national innovations systems (NIS), is fundamental. Based on various studies undertaken by the UNCTAD secretariat, the note aims at exploring the relationship between FDI and technology transfer and diffusion at the firm, industry and country levels, as well as its broader development implications.

4. The note is structured as follows. Chapter I reviews the technological gap existing between developed and developing countries, and discusses the potential roles of TNCs in narrowing this gap. Chapter II examines the channels through which technologies are transferred and diffused, including both direct means of FDI and non-equity forms of TNC operation and indirect means of linkages and spillovers. The chapter also briefly addresses implications of the internationalization of R&D by TNCs for developing countries. Chapter III presents detailed cases and examples of technology transfer and dissemination at the firm, industry and country levels. The last chapter provides policy recommendations, followed by a list of issues suggested for discussion.

[1] See UNCTAD's *Information Economy Report* for global and regional trends in the diffusion of information and communication technologies.

I. Bridging the technological gap: the potential roles of TNCs

A. The technological gaps between developed and developing countries

5. Some developing countries have made significant technological progress in the past two decades or so, even outpacing that in developed countries (World Bank, 2008).[2] However, the technology gap between rich and poor countries remains wide, with developing countries employing only a quarter of the level of technology in developed countries, measured by the extent to which specific technologies have permeated economic activities (World Bank, 2008). The differences in R&D spending between the two groups of countries remain huge (table 1). In addition, technological achievement varies widely among developing countries and within a country.

Table 1
R&D Expenditures, most recent year
(billions of dollars and percentages)

Country	Year	Total	Business enterprise sector	Share of business enterprise sector in total
Australia	2006	16.2	..	..
Brazil	2006	10.9	..	..
Canada	2008	27.6	15.0	54.2
China	2007	48.8	35.3	72.3
European Union	2007	313.4	198.5	63.3
France	2008	57.7	36.4	63.0
Germany	2007	84.1	58.9	70.0
United Kingdom	2008	50.0	32.1	64.2
India	2007	9.1	..	..
Indonesia	2005	0.1	..	..
Japan	2008	181.9	131.9	72.5
Korea, Republic of	2007	33.7	25.7	76.2
Malaysia	2006	1.0	..	..
Mexico	2007	3.8	..	..
New Zealand	2007	1.6	..	..
Norway	2008	7.3	..	..
Russian Federation	2008	17.3	10.9	62.9
Singapore	2007	4.2	..	..
South Africa	2006	2.4	..	..
Taiwan Province of China	2007	10.1	..	..
Thailand	2006	0.5	..	..
Turkey	2007	4.7	..	..
United States	2008	398.1	289.1	72.6

Source: UNCTAD, based on data in individual countries.

[2] Based on the direct measurement of technology (the extent to which specific technologies have permeated economic activities), a report (World Bank, 2008) estimates that, during the 1990s and 2000s, technological progress in developing countries has been strong, outpacing that in developed countries by 40 to 60 per cent. It should be recognized that the initial level of technology in low-income countries was lower.

6. The technological gap between developed and developing countries is more pronounced for new and advanced technologies. Nevertheless, many developing countries are acquiring new technologies, including information and communication technology (ICT) equipment such as mobile phones and computers, at a more rapid pace than older technologies (UNCTAD, 2010a). More recently, the diffusion of new technologies in such areas as renewable energies and organic agriculture holds promise for a substantial, widespread advance in technological achievement in the developing world. In agriculture, for example, organic production offers a wide range of technological, economic, environmental and social benefits (UNCTAD, 2010b). A study of 114 cases in Africa shows that a conversion of farms to organic or near-organic production methods increased agricultural productivity of 116 per cent (UNCTAD and UNEP, 2008).

7. In many developing and transition economies, enterprises generally perform little R&D; the bulk of it is done in universities and government research institutes and is often de-linked from the productive sector. In the Russian Federation, this sector accounts for 63 per cent of total R&D, lower than most of developed countries. Enterprises should be a core component of an NIS. In developing countries, particularly in LDCs, the limited role of the private sector in their NIS weakens the economic impact of R&D on efficiency, growth and competitiveness. Given the fact that business enterprises account for the bulk of R&D expenditures in the major innovation countries (table 1), attracting FDI can be a useful means for developing countries to promote technological progress. Indeed, globalization of R&D is marked by increased funding of industrial R&D activities by TNCs outside the borders of their home countries; and there has been a considerable shift in high-technology manufacturing and exports to the developing world (UNCTAD, 2005; United States National Science Board, 2010).[3]

B. TNCs as major players in technology creation and diffusion

8. The generation of new and advanced technologies is concentrated in the developed world, and takes place mainly in large corporations (UNCTAD, 2005; United States National Science Board, 2010). TNCs play a major role in global innovation. In most developed countries, they play a key role in the implementers of new technologies in production. TNCs account for about half of the world’s total R&D expenditure and more than two thirds of the world’s business R&D (UNCTAD, 2005). The world’s largest R&D spenders are concentrated in a few industries, notably IT hardware, the automotive industry, pharmaceuticals and biotechnology.

9. Currently, the R&D spending of some large TNCs is higher than that of many developing countries (table 2). Twenty TNCs – with Toyota, Roche, Microsoft, Volkswagen and Pfizer being the top five – spent more than $5 billion on R&D in 2009 (annex table). In comparison, among developing economies, total R&D spending exceeded $5 billion only in Brazil, China, the Republic of Korea and Taiwan Province of China. There were five companies from developing countries listed on the largest 100 R&D spenders: three Republic of Korea TNCs and two Chinese ones – Samsung Electronics (the 10th largest), LG (66th), Hyundai Motor (69th), Huawei Technologies (79th) and PetroChina (80th).

[3] Between 1995 and 2008, the combined share of the European Union, the United States and Japan in worldwide high technology exports declined from 55 per cent to 40 per cent (United States National Science Board, 2010).

Table 2
Largest R&D expenditure by developing and transition economies and TNCs, 2009
(millions of dollars)

Rank	Economy/company	R&D expenditure
1	**China**	**48 771** [a]
2	**Korea, Republic of**	**33 684** [a]
3	**Russian Federation**	**17 345** [b]
4	**Brazil**	**10 926** [c]
5	**Taiwan Province of China**	**10 090** [a]
6	Toyota Motor	9 403
7	**India**	**9 136** [a]
8	Roche	8 893
9	Microsoft	8 437
10	Volkswagen	8 043
11	Pfizer	7 507
12	Novartis	7 163
13	Nokia	6 942
14	Johnson & Johnson	6 764
15	Sanofi-Aventis	6 347
16	Samsung Electronics	6 265
17	Siemens	5 949
18	General Motors	5 875
19	Honda Motor	5 857
20	Daimler	5 785
21	GlaxoSmithKline	5 674
22	Merck	5 659
23	Intel	5 473
24	Panasonic	5 386
25	Sony	5 172
26	Cisco Systems	5 042
27	Robert Bosch	4 971
28	IBM	4 787
29	Ford Motor	4 744
30	Nissan Motor	4 737
31	Takeda Pharmaceutical	4 712
32	**Turkey**	**4 675** [a]
33	Hitachi	4 332
34	AstraZeneca	4 293
35	**Singapore**	**4 206** [a]
36	Eli Lilly	4 189
37	Bayer	4 118
38	EADS	3 998
39	Toshiba	3 934
40	**Mexico**	**3 835** [a]

Source: UNCTAD.

[a] 2007.
[b] 2008.
[c] 2006.

10. Based on data on the 2,000 largest TNCs in R&D expenditures, the following features stand out (table 3):

(a) Most of them are located in developed countries, and more than 90 per cent of total R&D expenditures by these 2,000 TNCs are spent by developed country TNCs;

(b) On average, developed country TNCs spent 1.8 times more on R&D than developing country TNCs in 2009 in terms of the ratio of R&D expenditures to net sales. But, based on these 2,000 TNCs, average R&D expenditures per company between developed and developing countries are not much different;

(c) Some developing country TNCs spend more in R&D than average developed country TNCs. TNCs from the Republic of Korean and Singapore spent more than the average value of R&D expenditures by developed country TNCs in terms of R&D expenditures per employee.

Table 3
R&D expenditures, R&D/net sales ratio and R&D per employee of the 2,000 largest TNCs in the world, 2009

Region/economy	Number of TNCs	R&D expenditures ($ billion)	Average R&D expenditures per company ($ million)	R&D/net sales ratio (%)	R&D per employee [a] ($)
World	2 000	568.6	284	3.3	12 150
Developed countries	1 849	529.4	286	3.4	13 061
European Union	1 000	180.6	181	2.4	8 314
United States	504	191.6	380	4.8	20 170
Japan	259	123.1	475	3.8	17 070
Developing and transition economies	151	39.2	259	1.9	4 298
Bermuda	3	0.9	316	8.4	26 093
Brazil	8	2.1	261	1.4	9 487
Cayman Islands	6	1.4	233	9.4	17 154
China	21	7.5	355	1.2	2 948
Hong Kong, China	8	1.0	126	1.7	4 374
India	17	1.9	112	2.0	4 685
Korea, Republic of	26	14.3	550	2.7	14 058
Malaysia	1	0.1	65	3.6	5 692
Russian Federation	3	1.1	356	0.6	1 687
Saudi Arabia	1	0.1	137	0.5	..
Singapore	7	0.7	102	5.9	17 509
South Africa	1	0.1	121	0.7	3 614
Taiwan Province of China	45	7.5	168	2.6	5 026
Thailand	1	0.0	45	5.7	..
Turkey	3	0.4	126	1.1	4 341

Source: UNCTAD, based on European Commission, 2010.

[a] Based on the number of TNCs which have available data on both the number of employees and R&D. For example, there are only six in the case of the Republic of Korea.

II. TNCs and the transfer and diffusion of technology

11. The interaction between TNCs and domestic firms in developing countries can result in higher rates of knowledge and technology diffusion, thanks to a number of mechanisms, such as imitation, increased competition, backwards and forwards linkages, training and human resources mobility. The knowledge and technology involved takes many forms, including a wide range of hard and soft elements – e.g. technologies embodied in capital

goods – and production, organizational, managerial and other skills. However, the extent to which such mechanisms can be operative in reality depends on a complex set of conditions, including the sectors in which the TNCs operate, the way they are integrated into the national economy, the absorptive capacities of local firms and the extent to which the set of actors, institutions, relationships and enabling environment (including explicit and implicit policies) that constitute the NIS of the host country are supportive of such knowledge flows. Because of such complexity, it is difficult to assume that TNC presence will necessarily result in technological learning in the host country. To this it must be added that firms that possess knowledge often face incentives to create barriers to easy dissemination.

12. Technology transfer and diffusion involves the cross-border flows of both physical goods and knowledge, be it tacit or formal. The latter is becoming more important and involves acquiring new skills and managerial expertise. In the short term, the immediate recipients of new and advanced technologies can benefit from higher productivity, new products and/or lower costs. While in the longer term, the benefits depend on how much the recipients are able to deepen and develop their own capabilities. For an economy as a whole, the benefits also include many externalities, e.g. the diffusion of the technology and its spillovers to other entities.

13. In technology transfer proxied by receipts and payments of royalties and license fees, developed economies continue to be the main home and host countries (table 4). However, the importance of developing and transition economies is rising in both host and home countries: their share in the world total of payments doubled between 1990 and 2009 to 26 per cent, while on the receipts side it quadrupled during the same period. Asia accounted for the bulk, though. Approximating technology transfer through royalties and license fees overlooks the vast majority of technological upgrading of developing host country productive systems through the introduction of superior technology, processes and managements stills which are not necessarily subject to patents or licenses and are not the latest technology available.

Table 4
Royalties and license fees, 1990, 2000 and 2009
(millions of dollars)

Region	1990	2000	2009	1990	2000	2009
	Receipt			**Payment**		
World	27 323	79 383	179 688	24 267	83 242	184 674
Developed countries	27 037	77 482	172 055	21 360	66 254	136 987
European Union	10 039	20 686	55 779	17 172	32 734	85 231
United States	16 640	43 233	89 791	3 140	16 468	25 230
Japan	2 866	10 227	21 698	6 051	11 007	16 835
Developing countries	278	1 733	6 879	2 859	16 164	42 346
Africa	38	193	106	230	840	2 279
Latin America and the Caribbean	195	457	1 627	984	3 371	5 305
Asia	41	1 080	5 146	1 646	11 953	34 761
West Asia	0	0	0	0	173	649
South, East and South-East Asia	41	1 080	5 146	1 646	11 780	34 112
Oceania	3	3	0	0	1	1
Transition economies	8	168	754	48	824	5 341
Memorandum:						
Share of developing and transition economies in the world total	1.0	2.4	4.2	12.0	20.4	25.8

Source: UNCTAD, based on IMF Balance of payments database.

A. Direct technology transfer

14. TNCs can transfer technologies through both FDI and non-equity forms of TNC involvement. Several economic, strategic and policy factors determine the mode of technology transfer: the nature and speed of change of technology, transfer costs and risks, corporate perceptions of benefits and risks and government policies all play a role (UNCTAD, 1999).

1. Through FDI

15. The bulk of technology dissemination is undertaken through internalized channels within the networks of TNCs. Today, FDI has become an important source of new technology to the developing world, as illustrated by the amount of royalties and licensee fee receipts by developed-country TNCs from their foreign affiliates in developing countries (table 5). However, the extent to which new, valuable technologies are transferred to host economies varies significantly between regions and countries. Some developing countries (e.g. China) have established certain technological capabilities with the help of FDI. However, there is little evidence of a significant contribution by FDI to technological capability accumulation in LDCs (UNCTAD, 2007a).

16. Japan provides an interesting example on the level of technology transferred and used by their affiliates abroad, compared with that of their parent firms. In host developing regions, the level of technology at affiliates is lower or at par with that at parent firms. However, when it comes to affiliates in newly industrializing economies in Asia, the technology level used there is not much different from that used in affiliates located in developed countries and four fifths of affiliates use the same level of technology at their parent firms in Japan (table 6).

Table 5
Royalties and licensee fee receipts by TNCs based in selected developed countries from their foreign affiliates, various years
(millions of dollars)

Host region	Germany (2006)	Japan (2007)	United States (2009)
Total world	1 281	9 001	55 430
Developed countries	1 244	5 037	42 656
European Union	437	1 091	34 753
United States	652	3 400	-
Japan	70	-	3 276
Developing economies	30	3 965	12 774
Africa	3	15	522
Latin America and the Caribbean	6	148	5 011
West Asia	..	0	387
South, East and South-East Asia	9	3 354	6 854
South-East Europe and CIS	..	..	..

Source: UNCTAD, FDI/TNC database (www.unctad.org/fdistatistics).

Table 6

Technological levels of Japanese manufacturing affiliates abroad: comparison with those of parent firms, 2008

(distribution share)

Host region/country	Level of technology: Higher than in Japan	At par with Japan	Lower than in Japan
World	1.4	73.6	25.1
Developed countries			
European Union	3.9	86.7	9.4
United States	3.9	83.9	12.3
Developing countries			
Africa	-	33.3	66.7
Latin America and the Caribbean	1.9	68.5	29.6
West Asia	-	100.0	-
South, East and South-East Asia	0.7	71.1	28.2
China	0.9	69.7	29.4
Hong Kong, China	-	80.0	20.0
Memorandum:			
ASEAN4	0.5	70.6	28.8
NIEs3	-	79.5	20.5

Source: Japan, Ministry of Economy, Trade and Industry, 2010.

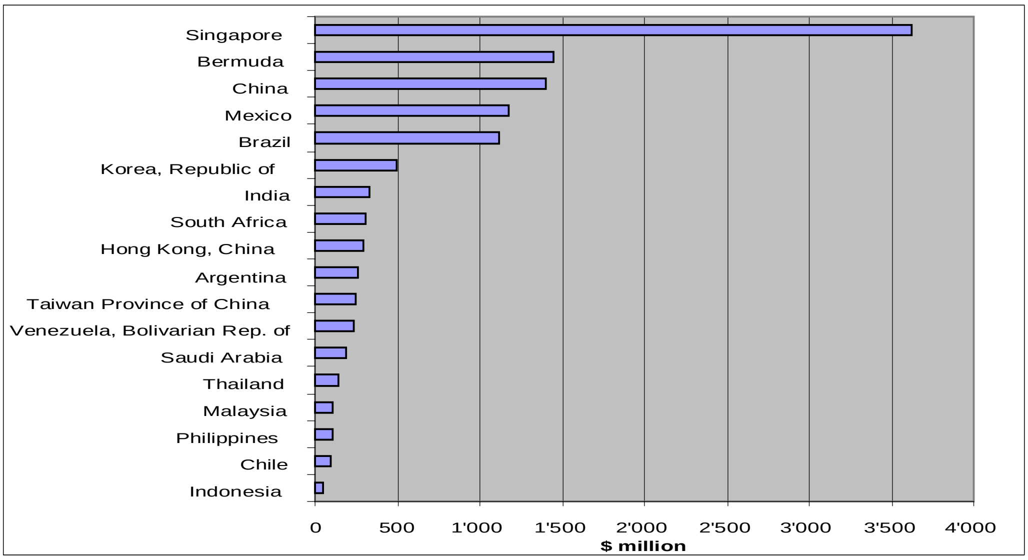
Note: Based on 2,502 Japanese TNCs. The question is to ask the level of technology used by their affiliates abroad which are engaged in division of labour between them and parent firms in manufacturing activities. ASEAN4 refers to Indonesia, Malaysia, Philippines and Thailand. NIEs3 refers to the Republic of Korea, Singapore and Taiwan Province of China.

17. Acquisition of technology from parent firms is largely limited to some developing countries only. A few emerging economies (China, Mexico, Brazil, Republic of Korea, India and South Africa, in that order) were main technology recipients from United States TNCs, judging by data on payments of royalties and license fees (figure 1).

Figure 1

Largest developing country payers to United Sates parent firms in royalties and license fees, 2009

(millions of dollars)



Source: UNCTAD, FDI/TNC database (www.unctad.org/fdistatistics).

2. Through non-equity forms of TNC involvement

18. TNCs can also transfer technology through externalized channels by non-equity forms of activities, such as franchising, licensing and subcontracting. TNCs are not the only source of externalized technology, of course. But they are very important in high-technology activities and in providing an entire package of knowledge, i.e. technology together with management know-how.

19. Indeed, a number of economies that succeeded most in building up domestic technological capabilities – such as the Republic of Korea and Taiwan Province of China – did so by relying mainly on externalized channels of technology transfer. However, local firms often have long-term relations with foreign TNCs in the form of subcontracting or original equipment manufacture contracts (UNCTAD, 1999). They often encouraged the absorption of imported technologies in a strongly export-oriented setting, thus forcing local firms to develop and deepen their own technological capabilities (Lall, 1995). As firms became internationally competitive they had to import technology either by going into other arrangements (franchising or original equipment manufacture) and/or by investing in their own R&D. Indeed, some of these firms from China, the Republic of Korea and Taiwan Province of China have become important corporate innovators (section I) and outward investors to take over innovative firms abroad or to establish observing posts in major innovation hubs in developed countries (UNCTAD, 2005 and 2006).

20. In agriculture, for example, through contract farming arrangements, TNCs have provided local farmers with technical assistance, seeds, fertilizers, as well as other inputs in which technology and know-how are embedded; they have a strong interest in providing effective extension services in order to obtain high-quality, low-cost products (UNCTAD, 1999). A field study conducted by UNCTAD in 2001 revealed that leading foreign affiliates in India's food industry had contributed significantly in this regard. In China, TNC involvement has helped introduce more than 100,000 copies of animal and plant germplasm resources, and a large number of advanced and practical technologies, such as plastic film mulching technology, dry rice planting technology, agricultural remote sensing technology, straw ammoniation technology, and fresh fruit and vegetable processing technology.[4]

B. Technology diffusion: linkages and spillovers

21. Foreign affiliates can diffuse technology and skills to domestic suppliers, customers and entities with which they have direct and indirect dealings. In particular, backward linkages between foreign affiliates and domestic firms are important for enhancing technology dissemination. To ensure that local inputs meet their stringent technical requirements, foreign affiliates often provide the local suppliers not just with specifications but sometimes also with assistance in raising their technological capabilities. Such assistance tends to be more prominent in developing countries, and the knowledge transfer has had a positive impact on the suppliers' competitiveness (UNCTAD, 2001).

22. In LDCs, direct technology transfer by TNCs has been constrained by the limited size of FDI inflows and their bias towards activities focusing on natural resources. Indeed, a common feature of the extractive industries, especially when TNCs are involved in a low-income country, is the relatively limited incidence of linkages with domestic suppliers, particularly as compared with manufacturing and services sectors (UNCTAD, 2007b). More importantly, lack of local capabilities and deficiencies in technological learning in

[4] UNCTAD, based on information from the Ministry of Agriculture and the Ministry of Commerce of China.

these countries hinder the market dynamism necessary for continuous technological upgrading and prevent the indirect effects through linkages and spillovers from happening.

C. Internationalization of R&D by TNCs: opportunities in the making

23. R&D is perhaps among the least internationalized segments of the TNCs' value chain; production, marketing and other functions have moved abroad much more quickly. Responses to UNCTAD's *World Investment Prospects Survey* confirm that the least internationalized functions are headquarters, finance and R&D (UNCTAD, 2009b). For example, United States data show that only 14 per cent of R&D undertaken by United States businesses were performed by their affiliates abroad in 2008, almost no change from one decade ago (13 per cent in 1998) (Anderson, 2010: 53).

24. TNCs have been increasingly shifting their R&D activities to the developing world, though developed countries remain the main host locations of foreign R&D activities by TNCs. Japanese and United States data point to this (table 7): Japanese TNCs allocated 38 per cent of R&D activities abroad in developing countries in 2007, compared with only 6 per cent in 1993. The United States did not use much developing country affiliates in their foreign R&D activities, but their share also rose from 12 per cent to 15 per cent during the same period (table 7). In particular, a number of developing economies in Asia, such as China and India, have emerged as key nodes in the global R&D systems of TNCs.[5]

Table 7
R&D expenditures by Japanese and United States affiliates abroad, 1993, 1998 and 2007
(millions of dollars)

	1993		1999		2007	
Destination region/economy	United States	Japan	United States	Japan	United States	Japan
Total world	10 951.0	1 838.8	18 144.0	3 648.9	35 019.0	4 371.2
Developed countries	9 626.0	1 721.7	16 107.0	3 250.8	29 780.0	2 704.1
European Union	7 392.0	690.7	11 953.0	807.1	21 779.0	931.6
United States	-	974.7	-	2 231.1	-	1 686.5
Developing economies	1 315.0	117.1	2 038.0	398.1	5 138.0	1 667.1
Africa	18.0	0.1	18.0	0.2	65.0	1.4
Nigeria	1.0	..	-	..	3.0	..
South Africa	14.0	..	14.0	..	53.0	..
Latin America and the Caribbean	383.0	8.1	612.0	8.2	1 149.0	761.1
Argentina	26.0	..	26.0	..	64.0	..
Brazil	220.0	..	288.0	..	629.0	..
Chile	4.0	..	4.0	..	48.0	..
Colombia	6.0	..	6.0	..	16.0	..
Peru	1.0	..	2.0	..	-	..
Venezuela	19.0	..	40.0	..	20.0	..
Asia	914.0	108.9	1 408.0	389.6	3 926.0	904.6
West Asia	11.0	..	6.0	..	56.0	8.8
Turkey	7.0	..	6.0	..	54.0	..
South, East and South-East Asia	903.0	1.9	1 402.0	60.3	3 870.0	619.6
China	5.0	1.9	319.0	60.3	1 141.0	314.2
Hong Kong, China	74.0	..	214.0	..	96.0	34.0
India	3.0	..	20.0	..	449.0	..
Korea, Republic of	16.0	..	101.0	..	995.0	..
Malaysia	18.0	..	161.0	..	396.0	..
Philippines	13.0	..	31.0	..	45.0	..
Singapore	312.0	..	426.0	..	578.0	..
Thailand	7.0	..	7.0	..	55.0	..
South-East Europe and CIS	-	..	1.0	..	100.0	..
Russian Federation	-	..	1.0	..	100.0	..

Source: UNCTAD, FDI/TNC database.

Note: Data for the United States refer to majority-owned affiliates only.

[5] For instance, the total number of foreign-invested R&D centres in China had reached 1,400 by mid-2010 (*Source*: Ministry of Commerce of China).

25. Indeed, developing Asia has hosted a large number of R&D centres or facilities established through greenfield investment. In particular, China and India alone accounted for nearly half of all R&D centres and facilities established in developing and transition economies by TNCs in 2009 (table 8). However, large parts of the developing world remain de-linked from TNC R&D systems (UNCTAD, 2005). For example, among LDCs, during the past five years (2005–2009) only three countries – Angola, Bangladesh and Nepal[6] – hosted only one each of greenfield R&D project out of a total of 649 such projects established in developing and transition economies (table 8). All of these three R&D centres in LDCs were established by developing country TNCs. In fact, not only in LDCs, but also in other developing countries, TNCs from developing and transition economies are beginning to establish R&D projects. They are emerging R&D players, accounting for one tenth of the total of 649 projects. South TNCs are set to play an important role in the South–South cooperation in R&D.

Table 8

Greenfield FDI projects in research and development, by host region/economy, 2005–2009

(Number)

Host region/economy	2005	2006	2007	2008	2009
World	330	369	188	224	198
Developed countries	149	187	97	125	102
Developing economies	171	179	87	97	91
Africa	5	2	2	7	3
Latin America and the Caribbean	3	10	3	9	13
Brazil	2	4	2	3	6
Mexico	1	2	1	4	1
West Asia	3	8	8	7	5
South, East and South-East Asia	160	159	74	74	70
China	72	63	25	23	21
India	57	56	24	20	23
Korea, Republic of	7	10	1	2	4
Singapore	10	17	15	15	14
Transition economies	10	3	4	2	5
Russian Federation	9	1	3	2	2
Memorandum					
Share of developing and transition economies in the total	55	49	48	44	48

Source: UNCTAD, based on information from the Financial Times Ltd, fDi Markets (www.fDimarkets.com).

26. The internationalization of R&D by TNCs opens up new opportunities for developing countries to enhance the development of their own innovative capabilities. FDI in R&D can bring various benefits to host countries. While the empirical evidence is limited, what exists suggests that when supported and complemented by proactive policies, such benefits – promoting human resource development, creating knowledge spillovers, upgrading industrial competitiveness – may have significant potential for technological learning in for developing countries (UNCTAD, 2005). For example, in Brazil, the R&D

[6] These R&D activities relate to the following: ZTE (China) is investing in Angola to create a laboratory for researching activities. In Bangladesh, Huawei (China) set up a wireless communication laboratory at a cost of $3 million at Bangladesh University of Engineering and Technology. Dabur India (India) is investing in Nepal to set up a collection centre laboratory.

intensity in foreign affiliates is greater than in domestic firms and that they have a higher propensity to innovate and introduce new products and processes into the market (Franco and Carvalho, 2004). There is some evidence, however, that the R&D centres with a global role and located in developing countries do not necessarily establish significant knowledge links with local firms and may become "islands of excellence" that do not contribute to the host country innovation system. The extent to which such links are missing may reflect the lack of a rich tissue of technologically able counterparts in the host country's NIS (Boehe, 2004). For example, in the manufacturing sector in the United Republic of Tanzania, innovation and knowledge diffusion among local firms is based on internal learning and links with other domestic firms, rather than with foreign affiliates (Goedhuys, 2007).

27. Knowledge spillovers can take place through the mobility of labour, enterprise spin-offs and demonstration effects. There are many examples in which local researchers and engineers leaving foreign-invested R&D centres moved to local firms or established their own companies in Asian economies, such as China, India and Malaysia.

28. Until recently, only a limited number of developing countries have attracted FDI in R&D on a significant scale. Most LDCs are not participating in global research and development networks, and consequently do not reap the benefits that they can generate. These countries lack the right kinds of scientific and engineering skills and a large pool of low-cost research manpower, which are crucial for attracting innovative R&D, as well as a big production base, to which adaptive R&D is closely related. For LDCs, therefore, strengthening the basic institutional framework for innovation and human resource development is the crucial first step.

III. Factors affecting technology transfer and dissemination: lessons from successful cases

29. This chapter identifies existing successful examples from developing countries at different levels (firm, industry and country).

A. At the firm level

30. TNCs potentially have much to offer in developing local technological capacities. However, in many case they do not have an interest in transferring knowledge to and supporting innovation in foreign affiliates beyond what is needed for their production process or product. In the case of joint ventures or other arrangements with foreign firms, transfer of knowledge to local firms and dissemination in local economy would be even more limited unless local firms have a long history of using the foreign technology and accumulating such technology through license agreements or other technology use arrangements. Government support to facilitate the acquisition or use of such technology and process of learning foreign technology is critical. An example is found in the case of a joint venture in the pharmaceutical industry – one of the most technology-intensive industries – and in Ethiopia, an LDC.

31. In 2007, Cadila Pharmaceuticals Ltd (India) and Almeta Impex PLC (Ethiopia) established a joint venture, Cadila Pharmaceuticals (Ethiopia) Ltd (CPEL) for the production of pharmaceutical products in Ethiopia. CPEL imported its equipment from India under a technology transfer agreement (license agreement) with Cadila Pharmaceuticals India, by which this joint venture could use the formulation technology and the brand name of the Indian company. Because of this, the lead-time to register the products to be produced by CPEL was very short and CPEL could start production immediately after the setting up of the production facility whereas normally the time

required for drug approval may exceed even ten years for new chemical entities (Pugatch, 2006, p. 115), and between three and six years for generic versions.[7] The two partners enjoyed prior relationships, which was a major factor in the choice of a partner for Cadila Pharmaceuticals to set up a joint venture in Ethiopia. (UNCTAD, 2010, forthcoming a).

32. Part of the success of transfer of technology at the firm level depends on the existence of the support from domestic institutes in adapting to new situations faced by local firms. In this case, Ethiopia has implemented a plan that lowered import tariffs for raw materials, improved public procurement, and made available advance payment for local producers. The Development Bank of Ethiopia is the principal source of preferential finance. The Engineering and Capacity Building Programme of the Government of Ethiopia, supported by the German Government, provides a capacity-building programme for the pharmaceutical sector, in particular to upgrade manufacturing facilities and processes to obtain good manufacturing practice (GMP) certification.[8]

B. At the industry level

33. Two cases are examined here: (a) one on the pharmaceutical industry, considered a representative of high-technology industries; and (b) one on garment manufacturing, a typical low-technology industry.

34. Many domestic Colombian pharmaceutical firms acquired initial technological capacity in pharmaceutical production through licensing agreements with these foreign pharmaceutical companies. In the 1990s, a process of divestment on the part of international pharmaceutical companies began. Illustrative of this are the decrease in the number of operating plants owned by foreign laboratories (from 100 in 1995 to 10 in 2010) and the consequent increase in the number of those owned by domestic laboratories (from 32 in 1995 to 133 in 2010).[9] These domestic laboratories built up their strength through the purchase of some of the plants that belonged to the foreign TNCs undergoing the process of divestment.

35. The divestment took place despite the introduction of an intellectual property regime whose standards of protection are among the highest in the world, and the provision of important incentives for the establishment of FDI and for the exportation of pharmaceuticals through bilateral trade agreements.[10] This is partly because local firms could develop technologically to be viable producers themselves. These firms have used their initially acquired expertise to develop other avenues of technological learning after the termination of most of the licensing agreements with TNCs. Some companies now receive know-how and technology transfer from foreign suppliers of active pharmaceutical ingredients (APIs), consultants, former employees of TNCs. API and equipment suppliers also provide advice on plant design, processes and drug formulations. As regards

[7] See *Canada – Patent Protection of Pharmaceutical Products*, Report of the Panel, WTO document WT/DS114/R of 17 March 2000, para. 7.48, where the panel states "[…] approximately three to six-and-a-half years are required for generic drug producers to develop and obtain regulatory approval for their products. […]".

[8] Rainer Engels, "Examples for GTZ experience in promoting pharmaceutical manufacturing: Ethiopia and BE center". Presentation during the IPC Informal Subgroup Meeting on the local production of essential generic medicines, 30 September 2009, World Health Organization, Geneva.

[9] See Instituto Nacional de Vigilancia de Medicamentos y Alimentos (INVIMA), 2010, "Establecimientos Nacionales Fabricantes de Medicamentos Autorizados a 15 de Julio 2010"; Gallo and Jairo, 2010: 32.

[10] UNCTAD, field interviews in Colombia.

improvements that allow meeting GMP and other quality standards, the local industry resorts to foreign consultants available on contract basis.

36. The garment industry in the free zones in the Dominican Republic stands out as another industry case where FDI has contributed to the introduction of new production processes and to the transfer of technology and know-how to local companies. The emulation effect and the opening of new markets to local investors may indeed be the most significant channel for the transfer of know-how in terms of its implications for the development of domestic capacities and of the local private sector. While this effect is generally difficult to measure, there are concrete examples within the Dominican Republic of local employees of foreign companies in the free zones who have acquired skills by working for TNCs before setting up their own business (UNCTAD, 2008a).

37. A first example in this industry is the case of Fernando Capellan, a Dominican entrepreneur who, after a career in a United States clothing company, created his own company, Grupo M. The group is now the largest private sector employer in the Dominican Republic and the largest apparel producer in the Caribbean/Central American region. Another example of transfer of know-how to the local workers is that of La Romana. Former employees from free zones' textile companies in the 1990s have specialized in the production of underwear for the local market. They eventually transformed their operations into small factories. Today, their products are sold in several major Dominican clothing stores and 240 direct jobs and about 100 indirect jobs have been created.

38. These two industry cases highlight the transfer of technology and knowledge arising from initial exposure to FDI and the ability of the country workforce to learn and successfully reproduce products or business activities to service the local (in the case of the pharmaceutical industry in Colombia) and both the local and the export markets (in the case of the garment industry in the Dominican Republic). The high technology and the simple technology are required by the pharmaceutical and textile and garments sectors, respectively, where local industry absorptive capacities are generally low.

C. At the country level

39. The experience gained by developing countries that have tapped into TNCs' knowledge networks illustrates that FDI can help enhance skills, transfer competencies and strengthen manpower. For example, FDI inflows have played a central role in the transformation of the Vietnamese economy. In addition to higher economic growth and reduced poverty, this transformation has also led to increased demand for skilled labour. To address the labour market challenges associated with more technologically advanced and skills-intensive sectors, some foreign companies have instituted their own training programmes. Indeed, 58 per cent of foreign-invested enterprises provide formal training programmes to their employees, compared to 41 per cent of domestic firms.[11]

40. In the electronics industry, Intel has been sending Vietnamese employees to other facilities in Asia as part of their hiring strategy, in order to give them training in a fully operational facility from experienced managers. The company has also begun to proactively address the issue of availability of skilled graduates by engaging in talks with United States universities about plans to establish campuses in Viet Nam. Foxconn recruited 500 university graduates in Viet Nam and sent them to China to prepare them for key staff positions.[12] The foreign investors involved in the Phu My 3 power plant have put in place a

[11] World Bank's Investment Climate Assessment Survey of 2009 (www.enterprisesurveys.org).
[12] *Source*: UNCTAD interview conducted in 2007.

"localization plan" in which most positions in the company are turned over to local staff. In addition to being trained to use the computer system to run the plant, nationals are trained to address environmental issues, safety awareness and health issues affecting people working at the plant and also living in the surrounding community areas. In agro-processing, Nestlé, one of the largest foreign investors in agriculture in Viet Nam, with the support of experts has developed a programme to work with Vietnamese coffee organizations and growers to improve coffee quality, with a focus on processing.

41. While these enterprise-driven programmes are an important channel to build skills and generate transfers of competencies, they are not sufficient to generate the amount and levels of skills needed by the rapidly growing Vietnamese economy. Another important channel to operate this transfer on a larger scale is through the formal education sector (UNCTAD, 2008b). An example where FDI in the education sector plays a role is with the Royal Melbourne Institute of Technology, which established a fully foreign-owned university in Viet Nam with campuses in Hanoi and Ho Chi Minh City. The university offers undergraduate programmes in English in commerce, business, design and applied sciences and a Masters in Business and Management. This university has about 3,800 students, including foreigners from Australia, neighbouring countries and Europe. The degrees are recognized nationally and are audited by the Australian Universities Quality Audit Agency.

42. All of these cases and examples illustrated in this section demonstrate that a key determinant of the development impact on a host economy which acquires technologies is its absorptive capacity. Indeed, technological capabilities in the domestic enterprise sector and technology institutions are necessary not only to attract R&D-intensive FDI but also to benefit from its spillovers. Local firms in the host country need to have some minimum level of skills (or absorptive capacity) in order to gain knowledge benefits from technology transfer associated with FDI (UNCTAD, 2010c).

IV. Promoting technology transfer and dissemination: coherent policies matter

43. As illustrated in the above cases, making the best use of TNC-mediated technology transfer and dissemination requires policy support in both host and home countries, at both national and international levels. In host developing countries, a clearly-defined strategy and the right mix of policy instruments and business conditions are needed. Drawing on lessons from the successful cases discussed in the preceding section, this chapter sets up a policy framework for enhancing technological and innovative contributions of TNCs in the context of host developing countries. It also considers the potential effects of home country policies and international regulatory frameworks.

A. Host country policies

44. Technology transfer and dissemination is a complex process and many developing countries experience difficulties in establishing effective policies. Therefore, simply opening up to foreign investment is not likely to transform the technological base of developing countries, and the technologies and functions which TNCs actually transfer depend largely on government strategies and local capabilities. In particular, government policies need to encourage both domestic and foreign investments in building productive and adaptive capacities and fostering business linkages, enhancing spillover effects and promoting technological advances.

45. Developing country strategies with regard to the transfer and dissemination of technologies have over time shifted from a more restrictive (autonomous) approach to FDI to a more TNC-dependent strategy. Under the latter, governments may actively seek to attract FDI through selective targeting – together with skill creation and institution-building – to encourage TNCs' affiliates to move into higher value added activities. They may also take a more passive stance, with only few government interventions and mainly focusing on creating the right domestic conditions for attracting FDI. In practice, most developing countries use a combination of these strategies. Whatever particular strategy a government chooses, it will come with its own set of benefits and risks. Government policies therefore need to aim at maximizing the benefits and minimizing the risks.

46. The basic building blocks for the establishment of a conducive framework for technology transfer and dissemination include the following:

(a) Developing innovation systems at various levels: The innovation systems of most developing countries tend to be weak and fragmented. Policies in this area may aim at correcting systemic weaknesses that hamper knowledge acquisition, dissemination and use in the productive sector. They may address commercial and non-commercial operators and have the general aim of removing failures that result in innovative activity that is sub-optimal from the social point of view, although consistent with the incentives faced by the economic actors. Policy goals may include lowering the inherent risks associated with innovative activity, removing obstacles to coordination among innovation actors and addressing the issue of innovation externalities. Achieving such goals requires, among other things, well-calibrated incentives and benchmarks, consistent monitoring and evaluation, and the existence of accountable innovation governance structures with competent staff and visible political support. Creating technological capabilities at the firm and industry levels is equally critical for an effective innovation system, including actions to promote the establishment of knowledge links among firms and between them and the education and research subsystem, and the emergence of technology intermediaries. Finally, adequate framework conditions (financial environment, entrepreneurship, efficient factors markets, incentives), and material and immaterial infrastructure (venture capital, intellectual property framework, extension services, norms and standards, laboratories, Internet connectivity, physical infrastructure) are also essential;

(b) Boosting absorptive capacities of domestic enterprises: All cases and examples examined in the previous chapter show that, in order to maximize technology dissemination, it is imperative for governments to establish and implement policies that help enhance the absorptive and adaptive capacities of local firms. This involves the creation of a skilled workforce, not only for TNCs to tap into, but also to promote high quality, competitive domestic enterprises. To accelerate skills formation in relevant areas, governments need to be informed about the skills in demand. Education policies also need to evolve over time as the demands from industry change and countries develop. Governments can strengthen the capabilities of small and medium-sized enterprises by including improvement of extension and training services. Governments can also provide venture capital to encourage local entrepreneurs and TNC employees to establish enterprises that take advantage of the skills and technologies developed by TNCs;

(c) Targeting specific technologies and companies: Governments need to target the promotion of specific technologies relevant to priority areas in their development strategies. Governments can seek to attract TNCs into specific (high) technology industries, by using fiscal or financial incentives. Also, the establishment of science and technology parks can be used to create a more conducive environment for innovation and R&D in enterprises, often in close proximity to universities and other public research institutions. Developing industrial parks with high-quality infrastructure may attract high-technology investors. Likewise, public–private partnerships in R&D can play an important role.

Targeting TNCs that are already present in the host country can also be part of this strategy, for instance by offering incentives to move into more complex technologies and to increase or upgrade the technological R&D undertaken locally. This may involve both improving all factor inputs that TNCs need (infrastructure, skills, information and so on) and giving targeted incentives to launch new functions by existing affiliates or to attract technology-intensive sequential investment. Finally, governments can collect, organize and disseminate information to TNCs about the technical, research and training facilities in the host country and improve technology access for local enterprises, by providing information on foreign and local sources of technology. Investment promotion agencies can play a central role in targeting TNCs that are technology leaders and in providing after-care;

(d) Promoting technology dissemination through linkages: Technology alliances and linkages between TNCs and domestic firms are among the key modes of transmission of know-how and technology. Whether domestic companies acquire technology from TNCs, to what degree and at what speed, depends on the type, scale and quality of the interface that exists between them. The type of interface may involve joint venture partners, competitors, suppliers or public-private partnerships (PPPs). For instance, joint ventures can result in effective transfer of technologies provided there is mutual trust between partners and absorption capabilities. PPPs with TNCs, for example build-operate-transfer (BOT) arrangements may include technology disseminated to local partners through training and transfer of the facility or plant to the local enterprise(s) after an agreed period. Backward linkage programmes between TNCs and domestic suppliers could involve intensive consultation, training and technology transfer between TNCs and potential domestic suppliers. Linkages could be promoted by offering fiscal benefits for R&D or the exploitation of its results, or by offering other incentives, such as inexpensive infrastructure. Also, the establishment of local technological and industrial clusters with the participation of both domestic firms and foreign affiliates can enhance the exchange of know how and expertise;

(e) Protecting intellectual property rights (IPRs): The establishment of a well-defined, balanced and enforceable system of IPRs creates incentives for knowledge generation and facilitates cross-border flows of technology. Especially in countries which have fairly well-developed innovative capabilities, this can promote technology transfer and dissemination by TNCs and protect the interests of a host country's firms and institutions in making sure that they are adequately rewarded in R&D collaborations with TNCs. On the other hand, unnecessarily broad exclusive rights, coupled with unbalanced intellectual property enforcement, may impede efforts for technological changes, an avenue for technology generation in many developing countries. The intellectual property regime also needs to be shaped and enforced in a manner that guarantees wide access to appropriate technologies. The World Trade Organization (WTO) Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) establishes international minimum standards of protection and enforcement for R&D-relevant IPRs, such as patents. The agreement recognizes as an objective of IPR protection and enforcement to "contribute to the promotion of technological innovation and to the transfer and dissemination of technology, […] in a manner conducive to social and economic welfare, and to a balance of rights and obligations".

47. The coherence between FDI policy and other relevant policies (especially innovation and science and technology policy) is important for enhancing the contribution of FDI and non-equity forms of TNC participation to the effectiveness and efficiency of the NIS. An open innovation system, along with a business-friendly investment climate, is essential to speeding up the transfer and diffusion of technology. However, openness alone is not sufficient. Governments need to build an institutional framework that encourages and rewards innovation, attracts FDI in high technology and knowledge-intensive activities, and encourages interaction between foreign affiliates and domestic enterprises and research

institutions. Coordination between FDI and other policies is critical in this sense. While mainstreaming FDI into the NIS, host country governments need to emphasize the major policy objective of strengthening domestic technological and innovative capabilities.

B. Home country policies and international support

48. Developing countries alone are often not in a position to build domestic capacities to foster effective transfer and dissemination of technology. Especially in the case of LDCs, international support is needed. Developed countries can help secure benefits from the internationalization of R&D to developing countries in different ways, including through the promotion of R&D internationalization by TNCs and measures aimed at supporting the above framework for technology transfer in developing countries. This could, for instance, include assistance in establishing technical standards and certification systems through access to and provision of testing equipment for standard-setting and quality assessment. They could also support developing country efforts through the development of IPRs and through R&D collaboration between institutions in developed and developing countries.

49. R&D activities are also given attention in a number of international treaties, ranging from international investment agreements, particularly free trade agreements, to international IPR regimes and to international cooperation agreements in the field of science and technology. These agreements can contribute to promoting technology transfer, not the least by establishing cooperation among the parties to the agreements, thereby providing an enabling framework for private-sector R&D projects and FDI in R&D. However, these agreements may also impose obligations that affect the ability of countries to devise their own policies in this regard and to develop their innovative capabilities, including through the internationalization of R&D.

50. Finally, developing countries could draw on official development assistance and directing it into skill development in general, and activities related to high technology production and R&D in particular.

C. Issues suggested for discussion

51. The following issues are suggested for discussion:

(a) What lessons can be learned from the experiences of countries that have succeeded in leveraging FDI for technological development?

(b) How to promote technology transfer through FDI and through non-equity forms of TNC involvement? What are the policy options?

(c) How to attract R&D-related FDI and become part of TNCs’ knowledge networks?

(d) How to enhance the technological contribution of foreign affiliates? What absorptive capacities need to be developed and what are the policy options to achieve this?

(e) What role can FDI and FDI policy play in the establishment and development of national innovation systems in developing countries?

(f) What can be the role of home country policies in promoting technology transfer and dissemination to low-income host countries?

(g) What practical steps can be taken to strengthen international support in promoting technology transfer and dissemination through FDI to developing countries, particularly the LDCs?

Annex

Top 50 TNCs, based on R&D expenditures, 2009

Rank	Company	Country	Industry	R&D expenditures ($ million)	Net Sales ($ million)	Employees (number)
1	Toyota Motor	Japan	Automobiles & parts	9 403	213 515	320 808
2	Roche	Switzerland	Pharmaceuticals	8 893	45 943	81 507
3	Microsoft	United States	Software	8 437	60 497	89 000
4	Volkswagen	Germany	Automobiles & parts	8 043	142 250	338 499
5	Pfizer	United States	Pharmaceuticals	7 507	48 418	116 500
6	Novartis	Switzerland	Pharmaceuticals	7 163	42 859	99 834
7	Nokia	Finland	Telecommunications equipment	6 942	56 935	123 171
8	Johnson & Johnson	United States	Pharmaceuticals	6 764	59 928	115 500
9	Sanofi-Aventis	France	Pharmaceuticals	6 347	41 377	104 867
10	Samsung Electronics	Republic of Korea	Electronic equipment	6 265	115 569	..
11	Siemens	Germany	Electrical components & equipment	5 949	106 504	413 650
12	General Motors	United States	Automobiles & parts	5 875	111 292	217 000
13	Honda Motor	Japan	Automobiles & parts	5 857	104 120	181 876
14	Daimler	Germany	Automobiles & parts	5 785	109 641	258 628
15	GlaxoSmithKline	United Kingdom	Pharmaceuticals	5 674	44 354	98 854
16	Merck	United States	Pharmaceuticals	5 659	26 556	100 000
17	Intel	United States	Semiconductors	5 473	34 010	79 800
18	Panasonic	Japan	Leisure goods	5 386	80 764	292 250
19	Sony	Japan	Leisure goods	5 172	79 390	171 300
20	Cisco Systems	United States	Telecommunications equipment	5 042	34 968	65 550
21	Robert Bosch	Germany	Automobiles & parts	4 971	53 031	274 530
22	IBM	United States	Computer services	4 787	92 712	399 409
23	Ford Motor	United States	Automobiles & parts	4 744	114 545	198 000
24	Nissan Motor	Japan	Automobiles & parts	4 737	87 747	175 766
25	Takeda Pharmaceutical	Japan	Pharmaceuticals	4 712	15 999	19 362
26	Hitachi	Japan	Computer hardware	4 332	104 007	400 129
27	AstraZeneca	United Kingdom	Pharmaceuticals	4 293	31 761	63 900
28	Eli Lilly	United States	Pharmaceuticals	4 189	21 141	40 360
29	Bayer	Germany	Chemicals	4 118	43 298	108 595
30	EADS	Netherlands	Aerospace & defence	3 998	59 488	119 506
31	Toshiba	Japan	General industrials	3 934	69 209	199 000
32	Alcatel-Lucent	France	Telecommunications equipment	3 770	21 056	78 373
33	NEC	Japan	Computer hardware	3 604	43 844	143 327
34	Bristol-Myers Squibb	United States	Pharmaceuticals	3 531	20 946	28 000
35	BMW	Germany	Automobiles & parts	3 401	66 406	96 207
36	Boeing	United States	Aerospace & defence	3 360	66 109	157 100
37	Ericsson	Sweden	Telecommunications equipment	3 336	27 999	86 360
38	General Electric	United States	General industrials	3 218	150 003	304 000
39	Peugeot (PSA)	France	Automobiles & parts	3 215	67 260	186 220
40	Canon	Japan	Electronic office equipment	3 168	33 377	168 879
41	Oracle	United States	Software	3 151	25 967	105 000
42	Denso	Japan	Automobiles & parts	3 090	32 685	119 919
43	Motorola	United States	Telecommunications equipment	3 082	21 361	53 000
44	Boehringer Ingelheim	Germany	Pharmaceuticals	3 077	17 672	41 534
45	NTT	Japan	Fixed line telecommunications	2 789	108 333	196 296
46	Amgen	United States	Biotechnology	2 773	14 176	17 200
47	Google	United States	Internet	2 753	22 898	19 835
48	Hewlett-Packard	United States	Computer hardware	2 729	110 908	304 000
49	Finmeccanica	Italy	Aerospace & defence	2 676	22 923	72 537
50	Abbott Laboratories	United States	Pharmaceuticals	2 656	29 786	73 000

Source: UNCTAD, based on European Commission, 2010.

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