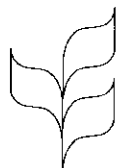




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**FACTORS AFFECTING TRANSFER OF ENVIRONMENTALLY-SOUND TECHNOLOGY  
(NOTE BY THE SECRETARIAT OF THE WTO)**

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Committee on Trade and Environment

FACTORS AFFECTING TRANSFER OF ENVIRONMENTALLY-SOUND TECHNOLOGY

Note by the Secretariat

1. This paper is prepared in response to a request by the Committee on Trade and Environment for a background document on factors affecting transfer of environmentally-sound technology. That request included addressing "the issue in a more analytical framework which would complement WT/CTE/W/8" (WT/CTE/M/4, page 28).
2. Document WT/CTE/W/8 covers a number of issues relating to the environment and the Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS Agreement"), including the links between intellectual property rights (IPRs) and environmentally-sound technologies (EST). It mentioned that IPRs could have two types of links with EST, i.e. promotion or generation of technology, and access to and transfer of technology. Regarding the former, document WT/CTE/W/8 states that "[a] fundamental feature of IPR systems and of the TRIPS Agreement, particularly in the area of patents, is to provide incentives for the generation of new technology, by giving the inventor an exclusive right (subject to certain exceptions) over the use of his invention for a finite period of time .... The IPR system provides protection to the results of investment in the development of new environmentally-friendly technology, thus giving the incentive and the means to finance such research and development. A combination of a well-functioning IPR system and appropriate price signals in the market, which direct research and development effort to environmentally-sound technologies, can play a major role in developing the technologies that will respond to environmental problems" (page 16) .
3. This paper focuses mainly on the issue transfer of technology. However, an important point to bear in mind is that the existence of any technology is a prerequisite to a possibility of access to that technology, i.e. if certain technologies have not been generated then their transfer is by definition not possible. Thus, the role of IPRs in providing an incentive for their generation should not be forgotten in discussions about their transfer.
4. Section I of this paper summarises the main factors that affect the transfer of EST. Since the request for this paper was made in the context of Item eight of the Committee's work programme, Section II of the paper focuses on the effects of IPRs, in particular patents, on the transfer of EST. Section II first clarifies the scope of the issue, and then summarises the different aspects of patents in the context of transfer of technology. Based on this discussion, it provides a simplified analytical framework to consider the link between IPRs and transfer of EST. Finally, Section II summarizes the empirical evidence on the importance of IPRs for technology transfer. Section III provides the conclusions.
5. The main points mentioned in this paper can be summarized as follows. There are a number of different ways in which technology transfer takes place, and IPRs are only one of the factors, and usually not the most important or dominant factor, which affect the transfer of technology. For those seeking technologies, information about the technologies, access to finance

and technological capability have been mentioned much more often than IPRs as the crucial factors determining acquisition of technologies. For those supplying the technology, an IPR regime in the host country improves the willingness of technology suppliers to provide the technology but the importance of IPRs varies across different activities and industries. In certain cases such as joint ventures or technology licensing, IPRs in the home market might also increase the willingness of those demanding the technology to acquire it. Thus, IPRs contribute positively to technology transfer in these situations both from the perspective of the technology supplier and those demanding it. However, in cases where technology can be easily copied, its protection by IPRs will mean that the authorization of the IPR owner has to be obtained to use it when in the absence of such protection it could be used without such authorization. If a voluntary transfer of such technologies is not forthcoming on reasonable terms within a reasonable period, they could be acquired under compulsory licensing, subject to the provisions of Article 31 of the TRIPS Agreement. An important point to bear in mind is that if technologies cannot be easily copied (there are a large number of such technologies), the cooperation of the technology supplier becomes essential for transferring technologies. In such cases, even compulsory licensing will not result in technology transfer unless the cooperation of the technology supplier is obtained.

1. FACTORS AFFECTING TRANSFER OF ENVIRONMENTALLY-SOUND TECHNOLOGY

6. The importance of transfer of environmentally sound technologies ("EST") has been recognized in several fora; for example, Agenda 21 (chapter 34, paragraph 34.7) states that "... access to and transfer of environmentally sound technology are essential requirements for sustainable development". Like other technology that is required to be used pursuant to technical regulations or standards, the need for the use of EST might arise due to requirements imposed by legislation, other standards or multilateral agreements. However, it is not easy to arrive at a definition of EST since most technologies produce some kind of environmental impact, and several technologies might qualify as ESTs, ranging from end-of-pipe technologies to preventive technologies of a more systemic nature such as cleaner and efficient processes of production. Thus, it is often difficult to distinguish between EST and other technologies. This, however, does not pose special problems in assessing which factors affect transfer of EST because the factors which affect transfer of EST are essentially the same as those affecting transfer of technology in general.

7. To develop a conceptual framework to identify the various factors affecting transfer of technology, it is useful to consider the different ways in which technology is transferred. Technology could be transferred through foreign direct investment, which might take the form of a wholly owned subsidiary or might involve a joint venture with host country investors. Alternatively, a person could acquire certain technologies by copying them, including through a process of reverse engineering which may not require any assistance from the supplier of the technology. Technology transfer could also take place through different contractual arrangements such as licensing, management contracts, or subcontracting, or technology could be obtained by purchasing off-the-shelf the machinery that embodies it.

8. Conceptually, the different methods of technology transfer could be considered as:

- (i) a transaction involving only the supplier of the technology, e.g. foreign direct investment in a wholly owned subsidiary;
- (ii) a transaction involving only those in the host country who use the technology, e.g. the situation where the host country national copies the technology, including through reverse engineering;

(iii) a transaction involving both the supplier and user of technology, where specific commercial conditions are stipulated with regard to the use of the technology, and/or the sales or distribution of profits by the enterprise in the host country, e.g. technology licensing or a joint venture involving foreign direct investment;

(iv) a transaction involving both the supplier and user of technology, but without any commercial conditions stipulated regarding the operations, sale or distribution of profits by the enterprise using the technology (e.g. purchase of a machine in the market, which embodies the technology).

In the different situations mentioned above, the factors which affect technology transfer could be considered from the perspectives of the supplier or the user of the technology. The perspective of the technology supplier affects its transfer in situation (i). In situation (ii), the transfer of technology depends on the possibility of technology acquisition by those demanding it in the host country. In situations (iii) and (iv), technology transfer is based on an interaction between the perspectives of the supplier and the user of the technology.

9. Technology transferred through foreign direct investment depends on several factors which affect the perceptions regarding risk and reward to foreign investors. Factors especially important for foreign direct investment are the host country's economic and political stability, well developed labour skills and technological and infrastructural base, and a well functioning regulatory framework. These factors positively affect investment decisions by improving the possibility of assessing the medium to long term economic situation in a country, and increasing the likelihood for efficiently installing and utilizing the technology.

10. Other factors which affect the profitability of investment and thus the likelihood of foreign direct investment are the availability of natural resources, market structure in the host country, access to finance, and in certain cases the extent of intellectual property protection provided in the host country. From the perspective of the supplier of technology, adequate IPRs in another country provide an incentive to transfer technology to that country by preventing unauthorized duplication in that territory (see below for more detail on this point).

11. The likelihood of licensing a technology depends on the profitability of providing a license to other investors, which in turn depends on the possibility of excluding competitors from the existing markets of the licensor. Thus, IPRs provide an incentive for licensors to supply the technology. In addition, the cost of licensing a technology is lowered if the licensor and licensee have adequate technological skills and experience, and the host country has appropriate infrastructural facilities.<sup>1</sup>

12. For host country investors, information about the technology is a particularly important factor. Such information is required on the existence of the technology as well as on the various operational aspects of the technology. This is especially so for developing countries because transfer of technologies to these countries is usually accompanied by certain modifications to suit the different infrastructural and technical environment. Other important factors for investors in the host country include access to finance, knowledge of what to negotiate in a technology transfer package, domestic technological capability and the available infrastructure for acquiring and

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<sup>1</sup>For example, in the case of licensing and joint venture, the manufacturing experience of partners, their size of operation and R&D intensity have been mentioned as aspects which reduce the cost of technology transfer. See, for instance, D.J. Teece (1977), "Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How", *The Economic Journal*, Volume 87, pages 242-261.

utilizing the technology.<sup>2</sup> Factors which affect the possibility of acquiring a technology by copying it include information about the particular technology, technological capability to efficiently install and utilize it, access to finance and whether or not the technology is protected by IPRs.

13. When both the foreign and host country investors are involved in the transfer of any technology, e.g. either through licensing or purchase of machinery such as in situations (iii) and (iv) above, the volume, price and type of transfer of technology will depend on an interaction between the concerns of both these types of investors. However, intellectual property rights ("IPRs") are unlikely to be a important factor affecting the acquisition of technology in situation (iv), because the machinery embodying the relevant technology is available off-the-shelf.

## II. IPRs AND TRANSFER OF ENVIRONMENTALLY-SOUND TECHNOLOGY

14. As mentioned above, IPRs are among the factors affecting transfer of technology. IPRs cover copyright and related rights, trademarks, geographical indications, industrial designs, patents, breeders' rights, layout-designs related rights, trademarks, geographical indications, industrial designs, patents, layout-designs (topographies) of integrated circuits, and undisclosed information. Though it has been noted that a number of different types of IPRs could affect transfer of technology<sup>3</sup>, those referred to most often in the context of transfer of technology are patents and protection of undisclosed information. This section will therefore focus mainly on patents and undisclosed information or trade secrets.<sup>4</sup>

15. This section begins with a clarification of the scope of the issue, and then summarizes the various aspects to be considered in any assessment of the effects of IPRs on technology transfer. This provides a basis for a simplified conceptual framework to identify the main effects of IPRs on technology transfer, which is followed by a summary of the empirical evidence on the effects of IPRs on transfer of technology.

### (a) Scope of the issue

16. An important aspect to be borne in mind regarding the effect of IPRs on transfer of technology is that generation of the technology has to precede the possibility of its transfer. A fundamental feature of IPR systems and of the TRIPS Agreement<sup>5</sup>, particularly in the area of patents, is to provide incentives for the generation of new technology by giving the inventor an exclusive right (subject to certain exceptions) over the use of his invention for a finite period of time. Such an exclusive right protects the results of investment in the development of new EST

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<sup>2</sup>Thus, it is contended that small and medium enterprises, particularly in developing countries, are likely to face greater problems regarding technology transfer in view of their shortcomings with regard to information, expertise and finance.

<sup>3</sup>For example, the importance of copyright has been noted for technology transfer for software, integrated circuits are considered important for the microelectronics industry, breeders' rights for the food industry, industrial designs for industries such as clothing, automobiles, and electronics, and trademarks could have important implications for technology transfer in several industries. See United Nations Transnational Corporations and Management Division (1993), *Intellectual Property Rights and Foreign Direct Investment*, United Nations, New York.

<sup>4</sup>A patent provides the right to exclude others from the use of a technology for a limited time period. Protection of undisclosed information does not establish such an exclusive right, but only operates against disclosure, acquisition and use "in a manner contrary to honest commercial practices".

<sup>5</sup>The objectives of the TRIPS Agreement include promoting technological innovation and "the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge in a manner conducive to social and economic welfare, and to a balance of rights and obligations." (Article 7). Moreover, the TRIPS Agreement contains some specific requirements on developed country Members to provide incentives for technology transfer to least-developed country Members.

technology, and provides an incentive to conduct, and the means to finance, such research and development. This paper does not discuss the issue of the effects of IPR on technology generation, but focuses only on transfer of technology.

17. Further, the effects of IPRs on technology transfer are by definition limited to technologies subject to such rights. Most technology is in the public domain, either because protection was never sought in the first place or because any term of protection granted has expired. It should be recalled that in order to benefit from patent protection, it is necessary to obtain a separate patent in each jurisdiction and that patent is only valid in that jurisdiction. The extent to which patents are sought and granted varies greatly from country to country.<sup>6</sup>

18. In addition, different commercial considerations apply to technology subject to IPRs depending on whether it is under private control or under the control of a government. When an EST is under the control of a government, the government is of course free to transfer the technology on concessional terms. Even where IPRs in EST are privately-owned, such IPRs do not stand in the way of public financial assistance to enable their voluntary transfer on concessional terms.

(b) Effects of IPRs on technology transfer

19. The public policy rationale for IPR systems lies in striking an appropriate balance between the interests of producers and users of technology, which provides incentives for the generation of new technology. This means that there will be instances where the result of an IPR regime is that payment has to be made to use technology that would otherwise be available at no or little cost. This will be the case particularly where technology is easily copiable, including through reverse engineering, without the assistance of those who developed it. Where such technology is protected by IPRs, users will have to seek authorization of the IPR owner, usually in return for a consideration, when in the absence of IPR protection the technology could be used even against the will of the person who developed it. An example of such readily copiable technology would be various types of computer software.

20. However, much technology is not capable of being readily copied or reverse engineered since its effective use requires access to secret know-how in the hands of the enterprise which has developed the technology. In these circumstances, transfer of technology requires cooperation between the source of the technology and the enterprise which wishes to receive it, even in the absence of IPR protection. The likelihood of such technology being made available on reasonable terms or being made available at all is greater where adequate and effective intellectual property protection is provided. The enterprise that is the source of the technology will be concerned that the legal regime in the host country provides safeguards against the dissemination of secret know-how beyond the terms of contract into the hands of third parties<sup>7</sup>, since such know-how, which may be critical for its competitive position worldwide, only remains protectable anywhere to the extent that it remains secret. In the absence of such guarantees the enterprise may refuse to transfer its technology (or its most recent technology) or only do so on terms which discount the risk (i.e. at a higher price). By the same token, an enterprise that wishes to receive technology will be more reluctant to enter into a commitment to pay royalties for the use of the technology in an environment where the legal regime will not provide guarantees against its local competitors gaining access to the same technology for free. Thus, in the absence of intellectual property

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<sup>6</sup> See WT/CTE/W/8 for more details on this aspect.

<sup>7</sup> For example through technical staff that have been trained in the secret know-how selling the information, or moving and making it available to a competitor.

protection, both the enterprise which possesses the technology and the enterprise which seeks it may be more reluctant to enter into a contract for its transfer.

21. In addition, there are other reasons why a functioning intellectual property regime will facilitate transactions for the transfer of technology.

(i) The possibility of transferring any technology depends, *inter alia*, on information about the technology and access to the technology. One of the purposes of the patent system is to encourage inventors to disclose new technology rather than attempt to keep it secret. The requirement that new technology becomes part of the common pool of knowledge of mankind has two important positive implications for the technology transfer process. First, in combination with the exception to patent rights for use for experimental purposes<sup>8</sup>, it ensures that the technology becomes immediately available as a basis for further technological development. Secondly, it ensures that on the expiry of the patent term, the technology falls into the public domain and its use is freely available to all.

(ii) The disclosure requirement also has a number of important consequences for the transfer of and access to technology because the resulting information, which is stored and classified in patent documentation, is accessible to anyone, including to those in countries where a patent has not been sought, and "constitutes the single most valuable and comprehensive source of technology available in the world today".<sup>9</sup>

(iii) Another advantage of the patent system is that, because the technology that may be the subject of a transfer agreement has already been described in an officially approved document, it obviates the need for a special detailed description in the transfer agreement and thus reduces transaction costs. Also, because the patented technology has been recognized by a patent office as technology which is new and truly inventive, it gives security to the recipient that the technology that is being transferred has these characteristics.

(iv) In the absence of effective protection for intellectual property, an enterprise which possesses technology will be reluctant to give detailed secret information about its technology to an enterprise which is considering purchasing it before that enterprise has committed itself to pay for it, since the recipient enterprise will not need to buy what it has already been told. Yet the enterprise which seeks the technology will not be prepared to make a commitment to pay for it until it has adequate information about the technology. An environment protecting intellectual property will facilitate the necessary exchanges of information required for the conclusion of a transfer of technology contract.

22. Another factor which should not be underrated is the psychological importance of IPR protection both for transfers through licensing and foreign investment. A number of empirical surveys of business attitudes have confirmed this (see below).

23. In the event that there is tension between the objectives of promoting technological innovation and the transfer of technology, patent regimes include a possibility of providing compulsory licensing (or non-voluntary licensing) and control of anti-competitive practice under specified circumstances.<sup>10</sup>

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<sup>8</sup>See, for example, Article 29.1 of the TRIPS Agreement.

<sup>9</sup>WIPO, Background Reading Material on Intellectual Property, WIPO, 1988.

<sup>10</sup>For more detail on this matter, see WT/CTE/W/8.

(c) A simplified conceptual framework

24. The discussion above has highlighted the various effects of IPRs on technology transfer and that the effects of IPRs on transfer of technology differs depending on whether or not it can be copied easily. The conceptual framework in this section, based on the perspectives of the supplier and user of a technology, shows that this distinction (i.e. possibility of easily copying the technology) is crucial for determining the effect of IPRs on technology transfer. This framework emphasises only the main likely effects of IPRs on technology transfer in different situations.

25. An IPR regime in any territory is likely to enhance the willingness of a supplier of a technology to transfer it to that territory. Thus, with an IPR regime in the host country, the supplier would be more willing to transfer his technology in situations (i) and (iii) mentioned in Section I above, e.g. when there is foreign direct investment, joint venture or technology licensing.<sup>11</sup>

26. Since technology transfer in situation (iii) depends on an interaction between the supplier and the user of the technology, the response of the user of the technology is also important in such situations. Those acquiring the technology through contracts with the technology supplier would prefer to have a larger market share by excluding others from using the technology in their market, especially if some investment in development work has to be made to adopt the technology to local conditions and its results could be easily copied by competitors. Thus, in situation (iii), the user of the technology might also be more willing to acquire it if he could benefit from an IPR regime in the host country, under which he could enjoy an exclusive licence.

27. If it is not possible readily to copy a technology because of aspects such as technical complexity or trade secrets, situation (ii) above, i.e. when technology can be copied, would by definition not be possible irrespective of whether or not a technology is subject to a patent. Any constraint on the user in the host country acquiring the technology in such a situation would not be due to patents because, even without any patents, the assent of technology owners would be needed to obtain the relevant technology, i.e. we are situation (iii) where technology transfer would involve a joint venture or some form of technology license. In situation (iii), the host country enterprise using the technology is likely to benefit if some form of IPR provides it with exclusive benefits of using the technology in its home market. Therefore, the user of the technology may be more willing to acquire the technology if IPRs are protected in the host country.

28. The perspective of the user of a technology is important also in situations (ii) and (iv), i.e. when a technology can be easily copied or can be obtained by purchasing machinery off-the-shelf. A significant difference between these two situations and others is that the perspective of the supplier of the technology will not be relevant in both situations (ii) and (iv). However, these two situations are themselves different because the effects of IPRs will not be the same in them. IPRs are unlikely to be important in situation (iv), and the main considerations for acquiring technology in that situation are likely to be information about the technology, its price, and the capability of operating it efficiently. In contrast, patents assume an important role in situation (ii), i.e. where the technology can be readily copied in the host country. The ease of copying would imply that the technology could be acquired at a lower cost than if it were subject

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<sup>11</sup>Since there are a number of factors which determine technology transfer, this effect of IPRs might be dominated by the effects of other factors. For example, if the economic and political situation in a country is not stable, foreign direct investment may not be attracted whatever the nature of the IPR regime. This aspect should be kept in mind in all considerations of the effect of IPRs on technology transfer.



to an IPR such as a patent. The existence of a patent on the relevant technology would imply the need to negotiate commercial conditions for the use of patented technology.

29. In the case of abusive anti-competitive practices or if access to technologies needed to meet some important national or international objective is not being provided on reasonable commercial terms within a reasonable period by IPR owners, it is possible to provide access to such technologies under compulsory licensing. The conditions mentioned in Article 31 of the TRIPS Agreement become relevant in that context. However, if a technology cannot be easily copied, then the co-operation of the technology supplier becomes essential for a proper transfer of technology even with compulsory licensing, i.e. without the support of the technology supplier, compulsory licensing would be sufficient to transfer only those technologies which are easy to copy.

(d) Empirical evidence

30. There is not much empirical evidence on the effect of IPRs on transfer of EST, particularly for developing countries. A summary of the main results of the empirical literature on the effect of IPRs on technology transfer is given below.<sup>12</sup> This section first provides some evidence on the effects of IPRs on supply of technology and then addresses the factors relevant to those demanding the technology, such as information, access to finance, and technological capability.

31. Empirical evidence shows that there is no strict relationship between the volume of direct foreign investment and IPR regime. The amount of foreign direct investment depends much more on the host country's economic and political stability, and skill and infrastructural base. However, there is some evidence that compared to decisions affecting the volume of foreign direct investment, firms tend to regard IPRs as more important for decisions regarding the type of technology to transfer through such investment. Increased technology flows of knowledge-intensive technologies are more likely with IPR protection in the host country.

32. Furthermore, evidence from some developed countries shows that foreign investors consider IPRs in the host country as an important element in their decision to invest there, but the emphasis on IPRs varies for investments in different industries or in different types of activity. IPRs are considered important for investment in research and development facilities, or in manufacturing components and complete products, but not for investment in activities such as sales and distribution, or rudimentary production and assembly facilities. Similarly, surveys of firms in the United States have revealed that IPRs are regarded as an important determinant of foreign investment in industries such as chemicals (including pharmaceuticals) and scientific instruments, somewhat less important for investment in electrical equipment, metals and

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<sup>12</sup>For empirical evidence, see the following studies and the references cited therein: D.J. Teece (1977), "Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How", *The Economic Journal*, Volume 87, pages 242-261; E. Mansfield, M. Schwartz and S. Wagner (1981), "Imitation Costs and Patents", *The Economic Journal*, Volume 91, pages 907-918; R. Levin, A. Klevorick, R. Nelson and S. Winter (1987), "Appropriating the Returns from Industrial R&D", *Brookings Papers on Economic Activity*, Number 3; W. Siebeck, ed. (1990), *Strengthening Protection of Intellectual Property in Developing Countries. A Survey of the Literature*, World Bank Discussion Paper No. 112, The World Bank, Washington, D.C.; United Nations Transnational Corporations and Management Division (1993), *Intellectual Property Rights and Foreign Direct Investment*, United Nations, New York; J.J. Noguez (1993), "Social Costs and Benefits of Introducing Patent Protection for Pharmaceutical Drugs in Developing Countries", *The Developing Economies*, March, pages 24 to 53; E. Mansfield (1994), *Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer*, International Finance Corporation Discussion Paper Number 19, The World Bank, Washington, D.C.; UNEP (1994), "Report on the Review Under Paragraph 8 of Article 5 of the Montreal Protocol", *UNEP/OzL.Pro/WG.1/11/4*, dated 19 December 1994; UNEP (1995), *Study on the Financial Mechanism of the Montreal Protocol*, a study by COWIconsult and Goss Gilroy Inc., March 1995; UNCTAD (1995), *Compendium of Documents and Reports Relating to the Work of the UNCTAD Ad Hoc Working Group on the Interrelationship Between Investment and Technology Transfer*, United Nations, New York and Geneva.

machinery industries, and little emphasis is given to IPRs when investing in certain food and transportation industries.<sup>13</sup>

33. A consideration of this evidence suggests that industries which rely on technological complexity to protect their technologies tend to emphasise patents much less in their investment decisions. Patents are only one form of retaining exclusive control over the technology and evidence suggests that in a number of industries, patents are rated as being less effective than trade secrets and effective sales and service as a mechanism for securing the return from R&D.<sup>14</sup> There is also some evidence to show that several patented technologies could be imitated by working around the patent on the basis of, *inter alia*, the information disclosed in the patent about the technology.<sup>15</sup>

34. For technologies required under the Montreal Protocol, it has been found that there was no evidence of impediments in the international flow of technology, although in specific cases it was difficult to obtain production licenses for alternative substances.<sup>16</sup> A few cases were found where technology was not available due to the unwillingness of some private sector technology owners to supply it because they wanted to avoid creating competition for their own products, and in some cases the technology suppliers withheld their technology for fear that their intellectual property rights will not be protected and their technologies will therefore be replicated without permission in the countries concerned.<sup>17</sup>

35. Information about the availability of technologies and access to finance have been shown as very important factors for acquiring technologies, especially by investors in developing countries or by small scale firms. For example, factors cited by several countries as impediments to acquiring technologies to implement the Montreal Protocol included, *inter alia*, lack of information about alternative technologies, lack of funding/capital for conversion to alternative technologies and non-availability of alternative technologies. In the context of implementation of the Montreal Protocol, UNEP (1995) noted that with project preparation gaining momentum in all implementing agencies, a serious funding shortfall was encountered for projects planned to be submitted for approval. On the other hand, factors cited as facilitating the phase-out were, *inter alia*, availability of cheaper substitutes, foreign ownership of local users of ozone-depleting substances, the presence of multinational corporations, awareness programmes, and multilateral fund support.<sup>18</sup>

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<sup>13</sup>See for example Mansfield (1984), *op. cit.*, and Levin, et. al. (1987), *op. cit.* Also, evidence from Levin, et. al. (1987) shows that patents and trademarks are important for pharmaceuticals, protection of "know-how" is important for the chemical industry, and industrial design for the textiles and clothing industry.

<sup>14</sup>For example, a sample surveyed by Levin, et. al. (1987), *op. cit.* shows the following average score given by the sample of firms for judging the effectiveness of different means of protecting competitive advantage of new or improved processes and products, for a scale ranging from 1 (= not effective) to seven (= very effective): patents to prevent duplication 3.52 for processes and 4.33 for products; patents to secure royalty income 3.31 for processes and 3.75 for products; secrecy 4.31 for processes and 3.57 for products; lead time 5.11 for processes and 5.41 for products; moving quickly on the learning curve 5.02 for processes and 5.09 for products; and, scale or service efforts 4.55 for processes and 5.59 for products.

<sup>15</sup>Mansfield (1981), *op. cit.*, found for his sample of patented innovations that more than four years were required to imitate the patented and profitable innovations only in the case of 15 per cent of the innovations.

<sup>16</sup>UNEP (1995), *op. cit.* This study also noted that while some enterprises indicated that license fee for technology transfer were high and that production licenses for alternative substances were difficult to obtain, the Study Team found no evidence of substantive impediments in international flow of technologies supported by the Multilateral Fund.

<sup>17</sup>UNEP (1994), *op. cit.*

<sup>18</sup>UNEP (1994), *op. cit.*, notes that it was unclear whether the factors mentioned by firms were actually important or whether they were considered to be of potential importance.

36. Firms have obtained information about technologies in a number of ways, including patent disclosures<sup>19</sup>, licensing of technology, technical personnel, reverse engineering, employees of innovating firms, publications or technical meetings, links with technology suppliers (including through the foreign owners of the firm) and through information provided by foreign partners in joint ventures. A number of enterprises in developing countries have received their new technologies through joint ventures with a foreign partner or by simple procurement of the new technology. There is considerable evidence that the process of identifying, evaluating, selecting, installing and maintaining new technologies often requires significant resources and skills. This has made it relatively easier for large firms to acquire the necessary technologies, and has placed small scale firms at a disadvantage.<sup>20</sup> Moreover, sometimes the available technologies were too large in scale for small enterprises in some countries to use it cost-effectively, and required complicated resources or facilities to operate.<sup>21</sup>

### III. CONCLUSIONS

37. The factors determining transfer of EST are essentially the same as those determining transfer of technology in general. Technology transfer takes place in several ways including foreign direct investment, joint ventures, licensing of technologies, reverse engineering, and off-the-shelf purchase of machinery. A number of factors determine the transfer of technology through these different means, such as the economic and political stability of the host country, its technological and infrastructural facilities, information about the technology, access to finance, labour skills, and the IPR regime. Empirical evidence shows that an IPR regime creates a psychological sense of security for those transferring technologies. However, the role of IPRs in technology transfer varies across different activities and industries. A large amount of technology is not subject to IPRs, i.e. these technologies are in the public domain. Among the technologies subject to IPRs, patents are not the most important form of protection in many cases, especially for those technologies which are not easy to replicate. Patents are more important for technology transfer in industries whose technologies can be easily copied. For other industries, trade secrecy protection may be more important.

38. Information about technologies, access to finance, and technological capability are important factors determining the acquisition of technologies. Disclosure under patents and links with joint venture partners or foreign technology suppliers have been shown as important means of acquiring information about the technology.

39. In analysing the effects of IPRs on technology transfer, a distinction has been made between technologies that are readily copiable, including through reverse engineering, and technologies whose transfer requires access to secret know-how which can only be obtained in cooperation with the technology supplier. In the former case, IPRs mean that access, at least for commercial purposes, to technology that could otherwise be easily replicated depends on the agreement of the IPR owner, or if that is not forthcoming, on meeting the conditions necessary for obtaining a compulsory licence. The public policy rationale for imposing on the user a cost which it would not have to bear in the absence of IPR protection is that of striking a balance between the

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<sup>19</sup>For example, the sample surveyed by Levin, et. al. (1987), *op. cit.* shows the following score for effectiveness of different methods of learning about new processes and products, for a scale ranging from 1 (= not effective) to seven (= very effective): licensing technology 4.58 for processes and 4.62 for products; patent disclosures 3.88 for processes and 4.01 for products; publications or technical meetings 4.07 for process and 4.07 for products; conversations with employees of innovating firm 3.64 for processes and 3.64 for products; hiring R&D employees from innovating firm 4.02 for processes and 4.08 for products; reverse engineering of product 4.07 for processes and 4.83 for products; and independent R&D 4.76 for processes and 5 for products.

<sup>20</sup>For smaller firms, information about the technology, financial requirements and technological capability tend to be more important factors than IPRs in determining access to technologies.

<sup>21</sup>UNEP (1994), *op. cit.*

interests of the creators and users of intellectual property, that provides incentives for the generation of new technology. In the latter case, i.e. technology which is not easy to copy and requires the cooperation of the supplier to be properly transferred, there are reasons that suggest that a functioning IPR system will not only make suppliers more willing to make technology available but also that, in some circumstances, even those demanding the technology might be more willing to acquire the technology.

