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Technology Transfer in the TRIPS Age:
The Need for New Types of Partnerships between the Least Developed and Most Advanced Economies

By Dominique Foray
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ABBREVIATIONS AND ACRONYMS

FDI: Foreign Direct Investment
GPT: General Purpose Technologies
ICTs: Information and Communication Technologies
IPRs: Intellectual Property Rights
LDCs: Least Developed Countries
MNCs: Multinational Corporations
ODA: Overseas Development Assistance
PPPs: Public-private Partnerships
TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights
TT: Technology Transfer
WIPO: World Intellectual Property Organisation
WTO: World Trade Organisation

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FOREWORD

Technology Transfer in the TRIPS Age: The Need for New Types of Partnerships between the Least Developed and Most Advanced Economies is a recent contribution of the ICTSD Programme on Intellectual Property Rights and Sustainable Development. Technology transfer (TT) to developing countries has been discussed by the international community and policy makers in general for more than three decades and continues to resurface in international deliberations. In recent years, ICTSD has contributed to these discussions by producing some pioneering studies.[1]

This study draws on the empirical literature addressing TT issues in an age where the trend of reinforcing the protection and enforcement of intellectual property rights (IPRs) prevails. It highlights the complexity of the TT process particularly when entities at different development levels are involved and the importance, in these cases, of the absorptive capacity of the recipient firms. The study also examines the arguments advanced to consider intellectual property (IP) protection as both a hindrance and a stimulus to TT. The paper makes practical recommendations, applicable, first, to least developed countries (LDCs), that want to use TTs as an effective growth engine, and, second, to developed countries that have to comply with the provisions of Article 66.2 of the World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

According to the study, many countries are increasing their exposure to foreign technologies by means of trade and foreign direct investment (FDI), while improving absorptive capacities to facilitate the dissemination of technologies and spillovers within the domestic economy. This represents a virtuous path that a number of developing countries – notably middle-income countries – follow. The experience of LDCs, however, is less promising. Firstly, FDI and trade remain at a low level and the poor quality of their absorptive capacities makes it unlikely that the few foreign technologies that are transferred will disseminate throughout the economy. In this respect, the main message is that the number, scale and domains of TTs cannot be left to depend on FDI or trade, nor can they take only the form of market transactions (licences).

With respect to TRIPS Article 66.2 obligations, the study suggests that transfer of technology should be part of a principal economic operation and not be a *joint product* or *by-product*, contingent on other operations. The locus of decision-making regarding modes of learning and areas for focus must shift away from foreign bodies to local agents and authorities. As far as additional incentives by governments are concerned, they should consist of assistance for projects that are socially beneficial but with low expected profitability for technology supplier firms. This should ensure that conditions for TT involve the choice of relevant partners on both the supply and demand sides, selection of the right area related to a clearly expressed local demand for technology and the creation of organisational forms that favour the consolidation of the transfer (absorption, adaptation and subsequent spillover), as well as the related entrepreneurial dynamic.

In this context, the study advances the need for greater use of public-private partnerships (PPPs) as a mechanism for ensuring both the effectiveness of the intervention and the efficiency of the TT operation.

The premise of ICTSD's work in this field is based on the appreciation that IPRs are economically and politically important but controversial, and towards that end a better understanding of IP is indispensable for informed policy making at the national and international level. The relationship between transfer of technology and IP stands high today in the deliberations of the Council for TRIPS, in the discussions of the UN Framework Convention on Climate Change (UNFCCC) and in the implementation of the WIPO Development Agenda recommendations adopted in 2007.

Empirical evidence on the role of IP protection in promoting innovation and dissemination of knowledge remains inconclusive. Diverging views persist on these matters. However, there is a consensus that IP matters and that the right policies and friendly environments are needed to gear the system to achieve its fundamental objectives: namely, to promote innovation and creativity and facilitate the dissemination of knowledge.

A central objective of the ICTSD Programme on Intellectual Property and Sustainable Development has been to facilitate the emergence of a critical mass of well-informed stakeholders in developing countries – including decision makers and negotiators, but also within the private sector and civil society – who will be able to define their own sustainable human development objectives and effectively advance them at the national and international levels.

We hope you will find this study an additional contribution to the debate on IP, innovation and sustainable development, and particularly in responding to the need for increased awareness and better understanding of the complexities of technology transfer and, among others, its interface with IP. An underlying assumption of our work has been the pursuit of a proper balance between the different interests at stake in designing appropriate IP regimes compliant with international commitments and supportive of public policy objectives as well as development efforts.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

This study draws on the abundant empirical literature produced over recent decades that addresses the issues of technology transfer (TT) between countries with very different development levels in an age of stronger intellectual property (IP) regimes.

The key findings of this study are that, in the case of least developed countries (LDCs), the number, scale and domains of TT cannot depend alone on general economic operations, such as foreign direct investment (FDI) or infrastructure construction; neither can they only take the form of market transactions (licences). In all these cases, the particular circumstances and conditions that prevail in LDCs imply a suboptimal level of TT in relation to these countries' needs.

There is therefore an obvious economic rationality for specific projects in which the TT is the primary product (an economic project in itself, not linked with another economic operation) but entails a low expected private profitability for the technology-owning firm. Such a prospect would involve acknowledging the existence of TT operations with far smaller commercial returns or no commercial return at all and finding operational mechanisms to incentivise these firms to sink costs in these operations. Such a strategy requires the provision of additional incentives from governments of developed countries.

Incentivising foreign firms to enter such transactions is a clear opportunity for developed country governments to properly fulfil their obligations contained in Article 66.2 of the World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The following recommendations are applicable to developed countries' TRIPS obligations:

- The transfer of technology should form the subject of a principal economic operation (and not be a *joint product* or *by-product*; i.e. contingent on other operations);
- The locus of decision-making regarding modes of learning and areas for focus must shift away from foreign bodies to local agents and authorities;
- In providing additional incentives to the technology-owning firms, governments should seek effectiveness and efficiency. To achieve this:
  - Governments should provide incentives in an effective way by only assisting projects that are socially beneficial but not very profitable for the firms that own and could transfer the technology; and
  - Conditions for the efficiency of the TT operations involve the choice of relevant partners both on supply and demand sides, selection of the right area for focus (related to a clearly expressed local demand for technology) and the creation of organisational forms that will favour the consolidation of the transfer (absorption, adaptation and subsequent spillovers), as well as the related entrepreneurial dynamic;
- Governments should make as much use as possible of public-private partnerships (PPPs) as a mechanism for ensuring both the effectiveness of the intervention and the efficiency of the TT operation.

Technology transfers have to be operated in many domains (including export-oriented industry). But they must be particularly supported in those domains that correspond to the model of innovation central to economic growth in LDCs: that is, entrepreneurial activities meeting needs in local markets that are likely to generate domestic spillovers. In other words, TTs must offer a positive supply

response to a demand for technology stemming from local entrepreneurs. Two factors are relevant here:

1. These domains are potentially important for growth because the spillovers generated in the course of such projects are likely to be captured by the local economy; and

2. These domains *need* additional incentives so the donor's intervention will be effective and respond fully to the TRIPS provision, which is not necessarily the case of export-oriented sectors in which the market incentives alone are sufficiently strong to motivate firms in rich countries to operate TTs.

The other areas – for instance the export goods-oriented manufacturing and processing sectors – are also important but they will in any case be served through TTs operating as *joint product*s of FDI. As such, they should not be listed as part of the efforts made by the developed countries to comply with Article 66.2 of the TRIPS Agreement.

INTRODUCTION

The broad and rapid diffusion of new and advanced knowledge is positive for social well-being. Efficiency and growth are promoted by the speed with which new knowledge and innovative technologies are disseminated: the greater the proportion of individuals, firms, or countries making swift use of superior products and processes rather than being restricted to inferior substitutes, the more widespread and substantial the growth benefits. If, for instance, only one firm (or one country) uses a new technology that increases productivity while other firms (or countries) are obliged to retain the old, less efficient technique, the benefits are significantly less than if all firms were able to adopt the new technology. This dissemination is important for the efficiency of the economic growth process.

One of the main forms of knowledge dissemination (and probably the most valuable from the point of view of developing productive and innovative capabilities) is technology transfer (TT). Krugman (1979), for instance, considers the pattern of trade and economic growth to be governed primarily by two activities: innovation and TT.

Early literature based on the standard model of economic growth predicted convergence across countries and considered TT as an "easy" mechanism to achieve this process. Once produced, technology can be widely applied. The implicit assumption is that the cost of technology diffusion is lower than that of its production.

However, on the ground, the difficulties and complexity of TT operations, particularly when they involve two countries different levels of development, has been recognised in the growing literature on international technology transfer. Some of the landmarks towards a better understanding of the difficulties and complexity of TT include:

- A more adequate conceptualisation of technology (stressing its tacit dimension);
- A careful appreciation of the transactional difficulties particularly related to problems of contracting tacit knowledge and pricing technologies on markets that remain relatively inefficient in this respect;
- A better understanding of the importance (and non-trivial nature) of diffusion within the country once a technology has been transferred there. This is a process that involves particular barriers and incentives;
- The growing consideration of the fact that innovation and technological progress in LDCs cannot be a mere reproduction of what is happening in developed countries. Innovations must be tailored according to local opportunities, capabilities and needs. Their consequences for economic development are strongly dependent on how such "particularisation" materialises in products, processes and services;
- The recognition that the most important innovations for LDCs are probably not "technical" but reside in the process of discovering a country's strength; and
- An accumulation of evidence concerning the relative advantages and shortcomings of the different channels through which TT occurs.

These landmarks towards a better understanding of TT, the conditions for its success and how to minimise the risks of failure, have not, however, given rise to new policy opportunities and the implementation of new programmes.

In parallel, the knowledge economy has been established slowly in rich countries, strongly affecting the relative importance of the various TT channels. And while the market for technologies as a prominent mechanism has grown over the last two decades, this has possibly come at the expense of non-market based mechanisms, such as imitation.

This study draws on the abundant empirical literature on TT produced over recent decades.

After an overview of the main findings of the paper in chapter 1, chapter 2 expands on the idea of the cognitive complexity of TT based on the distinction between knowledge and information. It then examines the different phases that make up this complexity. It discusses how this complexity becomes even greater when the transfer involves entities of very different development levels and demonstrates the pivotal nature, in this case, of the notion of capabilities. The building of these capabilities is carried out within the framework of suitable organisational forms, such as technology platforms or production centres. This section then elaborates on a concept of incremental innovation oriented towards the development of local applications – a concept that should help to structure the objectives of TTs made to LDCs.

Chapter 2 also raises the question of the choices of specialised domains in which to undertake TTs. It makes reference to the work by Enos in particular to show how choices that are irrelevant, unconsidered and guided by donors can lead to catastrophic results. It suggests the importance of the process of discovering good specialisations, as effectively demonstrated by the works of Hausman and Rodrik; indeed, technologies from industrialised countries very often require complex and costly adaptations, with an uncertain degree of success. Learning what a country is good at producing is therefore a critical issue and requires entrepreneurial commitments. The knowledge that is likely to be generated from these "experiments" is of great social value. Finally, chapter 2 tackles the question of barriers and incentives offered to firms to undertake TT operations and carry them through successfully. These incentives and barriers are examined for different forms of TTs (main product, joint product and by-product).

Chapter 3 deals with the role of intellectual property in TTs. Recently, the number of transfers based on licence purchasing has increased considerably. This must be correlated with the globalization of IP systems and the increasing power of technology markets. This part of the text summarises the arguments that point to a negative role of IP protection and those that, on the contrary, indicate a positive role. In Chapter 3, the question of the effects and general impact of TRIPS on technological innovation in LDCs is also dealt with. The development of a global IP system, corresponding to uniform quality standards has, without a doubt, positive effects on rich countries. It makes extremely uncertain investments more secure, encourages better knowledge dissemination via the market and gives greater visibility to innovation efforts and the accumulation of intellectual assets, especially in small firms. These positive effects indisputably compensate for the social cost imposed by monopoly prices in a system that is functioning "reasonably" well. However, these positive effects can under no circumstances be predicted in the context of international TTs between countries with very different development levels. In this particular case, the new system takes the place of a previous system based on imitation, without replacing it completely. A comparatively important TT channel disappears; others take its place but also stipulate different rules less favourable to LDCs.

Chapter 4 takes stock of the most recent evidence about TT and technology diffusion as compiled by the World Bank (2008). It draws on this data to observe that middle-income countries are increasingly successful in using FDI and trade to operate TTs (TT having clearly the status of a joint product) and that due to the improvement of their absorptive capacities, those TTs generate spillovers to the domestic economy resulting in an increase of its overall efficiency. When things are going well in this way, one may stand back in awe at the unfolding of the process and its ability to sustain high marginal social and private returns on TTs over an extended period of time. But this is occurring far less in LDCs and evidence shows that trade and FDI remain at a low level. Thus the success of TT as joint product is poorly supported in LDCs, while weak absorptive capacities prevent the few TTs that do take place from leading to spillovers into the domestic economy.

Finally, chapter 5 develops a TT model that incorporates the different elements considered to provide general practical recom-mendations, first to LDCs that want to effectively use TTs

as a growth engine, and second to developed countries that have to comply with the provisions of TRIPS Article 66.2. This segment first examines the conditions for implementation of TRIPS Article 66.2, which encourages firms in rich countries to transfer technologies to LDCs. Here, the pertinence of the objective (increasing incentives) is shown and, through the use of recent examples, suggests that under certain conditions private firms can "respond" positively to an increase in incentives – in the case of orphan and neglected diseases, for instance. Success in these areas (expressed as the commitment of private firms to activities considered *a priori* unprofitable) is apparently not carried over to the transfer of technology to LDCs however. Chapter 5 thus attempts to explain this absence and to outline some rudimentary solutions, involving the use of PPPs as a mechanism to increase the efficiency of TT operations, as well as the careful selection of areas to ensure the effectiveness of aid from international donors (incentives should be provided where and when they are really needed).

1. OVERVIEW OF MAIN FINDINGS

1.1 The Economic Fundamentals of Technology Transfer to LDCs

Technology transfer basically consists of a "transfer" of technological knowledge, including a "transfer" of the capacity to assimilate, implement and develop a technology. The acquisition of information concerning the technology is thus only a part – although admittedly an important one – of the transfer. The process of learning how to use and maintain the technology is at least as important as its frequently required adaptation to local conditions. Ultimately, this adaptation may lead to the development of new applications based on the transferred technology. Furthermore, a technology is itself progressive; therefore, the challenge of a TT is to master technologies that are changing continuously. Finally, the perimeter for potential adopters of the transferred technology is never predetermined and the transfer's social returns depend essentially on the extension of this perimeter beyond the initial target – for example, a specific industrial installation. In other words, the transfer process should not stop at the first installation but with the generalisation of the technology in the geographical space considered.

Thus a successful TT goes through the perilous phases of the assimilation and **absorption** of technological knowledge: **adaptation** to local conditions, **absorption of subsequent improvements** and **generalisation** of the transferred knowledge. These phases are described as the *consolidation* of the transfer. This complex cognitive dimension of TT demands an equivalent level of complexity of the organisational forms related to the transfer process. The latter must guarantee not only the acquisition of information but also the learning of the technology, its adaptation and its progression. Favourable organisational conditions can also promote its generalisation. It is in accordance with this logic that the efficiency of the various transfer modes can be evaluated.

The TT context between systems with very different development levels makes the problems of TT consolidation (absorption and learning, adaptation, assimilation of subsequent improvements, generalisation) even more difficult to solve. Such heterogeneities create "capabilities' issues." Weak capabilities on the LDC side impose strong forms of *internal and external* organisation in the LDC to maximise the probability of succeeding in the various phases of TT. Weak capabilities also imply that the various modes of TT are not "equivalent" in terms of their potential to impact the productivity of a wide range of sectors in the local economy.

As far as LDCs are concerned, this study emphasises the centrality of a particular model of innovation for growth and development. Research and development (R&D) and other more informal learning activities undertaken to produce locally oriented innovations, allow the country to develop absorptive capacity, while at the same time the locally generated spillover from this same R&D may end up diffusing away from the local economy. There are vast areas of economic activity where innovation is needed to *serve local needs and local demand*, whereby "local" may mean a large fraction of the world population.

Economically speaking, it makes sense to know whether **the TT constitutes an economic operation in itself or is dependent on an economic operation that exceeds it**. In this respect, a distinction will be made between:

- Transfers dependent on more general economic operations, such as foreign direct investment (FDI), the construction and supply of infrastructure, or the integration of companies from developing countries as exporters in international trade. In any event, the TT is *a joint product or by-product*;[2] the importance and quality of TTs are therefore contingent on a large number of factors resulting from the primary economic operation. It is thus the incentives for the primary economic

operation to succeed that determine whether the TT and its consolidation also succeed (or not);

- Transfers that in themselves constitute the *main operation*. This is carried out either through the medium of the market (licence, joint ventures), or via non-market channels. In these cases, the prime motivation for the operation is the success of the TT and it is the incentives directly linked to the TT (cost and profit) that command the operation.

When TT is a *joint product* of FDI, the locus of decision-making lies in foreign firms. Foreign firms decide the modes of learning, the amount of resources devoted to the TT operation, the potential scope for further dissemination, and the objectives of assimilating subsequent improvements. The choice of the domain where the TT will operate is pre-defined when the TT is a *joint* or a *by-product*. Drawing on Enos et al. (1998), this paper proceeds to argue that when the locus of decision-making for TTs lies with the foreign firms, there is a risk of suboptimal decision processes.

When the TT is the *main operation*, there is more flexibility about who will make the main decisions: i.e., domestic bodies (entrepreneurs, governmental agencies), foreign donors or foreign firms. For instance, when the TT is the *main operation*, the question of the choice of domains (who makes the choice, based on what criteria, how to go about discovering the "best" domains, etc.) **becomes an integral part of the economic issue of TT**. This aspect is crucial – the choice of where TTs will operate matters a great deal. TTs operate in specialised domains that they will strengthen in order to transform them into a growth engine for the relevant country. Enos et al. (1998) made this argument well, stating that: "the main task in advancing science and technology in the developing countries is to identify the most attractive direction in which to proceed. This proper direction is that which best represents the interests of the developing countries and this interest is not congruent with the interests of banks or foreign donors."

It is therefore apparent that the technology holder's commitment may vary considerably depending on the TT's status as an economic operation and the importance attributed to it in the success of the primary operation (if it does itself not constitute the primary operation). When the TT is a *joint product* (occurring as a consequence of a direct investment), and if things are going well, the phases of absorption, adaptation, and assimilation of subsequent improvements are in a sense "embedded" in the investment plan. However, since the TT is a *joint product*, there is the problem of "balancing incentives" between the need to make the direct investment operational and profitable in the short-term, and the need to transfer technologies and capabilities. Indeed, the risk of a strong imbalance arising between these two incentives is considerable in LDCs since the cost of transferring technologies and building capabilities is very high. As a result, the foreign firm is tempted to limit the scope and depth of the transfer of technologies and capabilities in order to increase the short-term profitability of the investment. In such a case, the TT is no longer a *joint product* but becomes a *by-product* – that is, a negligible objective.

When TT is the *main operation*, the problem is that incentives cannot be allowed to depend on another economic operation; the TT must be sufficiently attractive in itself for the technology holder to enter into the transaction. In this case, operational mechanisms must incentivise technology-owning firms to sink costs into these operations. In addition, classes of firms likely to serve as effective partners in such transactions need to be specifically targeted. This includes, for example, independent and specialised developers and suppliers of technological processes and solutions.

The table below summarises the economic characteristics of TTs as main, joint- and *by-product*s.

Table 1. A Typology of TT as an Economic Operation

TT as economic operation	Main operation	Joint product	By-product
Transactional Forms	Licensing Joint ventures	FDI, infrastructure Trade: Import of high tech products and capital goods; export by firms from LDCs; subcontracting	FDI Trade Large scale Infrastructure projects
Incentives	Directly associated to the TT for both technology supplier and technology demand	Need to balance incentives between the FDI operation and the TT	Incentives are imbalanced: the TT is contingent on the way the *main operation* (FDI) is managed
Locus of decision making	Local entrepreneurs	Foreign investors	Foreign investors
Choice of the domain	Part of the TT process	Neutralised; This is the domain of the FDI	Neutralised

Which economic forms are best suited to LDCs? Firstly, they are all important. This is the application of the so-called 'Tinbergen assignment', which says that since there are a number of generic goals and an array of specific sectoral and regional economic concerns that TTs are intended to serve, there will be a need for as many separate instruments as there are targets. Thus all the forms are important provided there are sufficient incentives to consolidate the TT.

Intellectual property (IP) offers a relatively extensive range of solutions to all the problems identified above. It creates a particular institutional framework within which certain transactional forms can be developed, such as the pur-chase of licences. This transactional form offers a specific answer to difficult questions concerning the cognitive complexity of the transfer. Finally, it offers a suitable incentive structure to encourage a technology holder to transfer his technology: he can fix a price that makes it worthwhile for him to transfer his technology. In short, it is rare to see a mechanism offering such a "range of services." However, the efficiency of IP as a facilitating mechanism for TT is by no means always guaranteed, particularly when the TT involves entities of very different development levels. While a market for licences is considered relatively inefficient when it involves firms with the same level of capabilities, it is likely to be super-inefficient when an LDC is concerned. The technology market will not necessarily always constitute the most appropriate institutional form to ensure a TT. It is quite reasonable to think that too many transactions, although essential for the innovation projects of potential purchasers, will in fact never be realised.

1.2 Current Situation and Key Messages

The 2008 World Bank report shows that middle-income countries are increasingly relying on FDI and trade to access foreign technologies and that TTs are likely to spillover into the domestic economy thanks to the progress made in terms of absorptive capacities. This is consistent with the most recent empirical observations showing that the increased multinational activities in these countries leads to a vigorous process of technological transfers and spillover, and that there is a positive relation between IPRs reform and the stimulation of TTs.

However, this is not what is happening in the case of LDCs. These countries are still locked into a low equilibrium between a limited exposure to foreign technologies and a weak absorptive capacity. So not only has exposure to foreign technology not increased significantly, but the extent to which LDCs can benefit from this exposure is severely limited by weak capabilities. Secondly, since the TTs associated with FDI are by definition *joint product*s, the problem of incentives imbalance does arise between the need to make the direct investment operational and profitable in the short-term and the need to transfer technologies and capabilities (see above).

Therefore, one of the main messages of this study is as follows:

> *In the case of LDCs, the number, scale, and domains of TTs cannot be allowed to depend only on general economic operations such as FDI or infrastructure construction; neither can they take the form of market transactions alone (for instance, licences). In all these cases, the particular circumstances and conditions prevailing in LDCs imply a suboptimal level of TT in relation to these countries' needs.*

One logical policy response should be to augment FDI flows towards LDCs. However, this cannot be the only policy response. This is a long-term issue and the risk of incentives imbalance is very high when the country considered exhibits weak capabilities. There is therefore an obvious economic rationality for specific projects in which the TT is the *main operation*: that is, an economic project in itself, not linked with any other economic operation. Thus, beyond attracting more FDI, one response is to provide additional incentives to undertake projects in which TTs are not dependent on another economic operation.

When a TT constitutes a *main operation*, the incentives cannot be allowed to depend on another economic operation. The problem is precisely that such TT in the LDC context entails a very low expected private profitability for the technology holder. Such a prospect would involve acknowledging the existence of TT operations with far smaller commercial returns or no commercial return at all. Indeed, TT as a *main operation* is costly when the recipient has weak capabilities; this is due to the problem of building capabilities and supporting absorption, adaptation, assimilation of subsequent improvements, and generalisation of the technology in a system that exhibits low absorptive capacities. In this perspective, organisational forms are central to ensure the TT will successfully meet the different phases since there is no "superior" economic operation that will provide the organisational structure, such as when the TT is a *joint product* of a direct investment. As a consequence, this sort of TTs requires the provision of additional incentives from the governments of developed countries.

Incentivising foreign firms to enter such transactions is a clear opportunity for governments of developed countries to properly fulfil their obligations as expressed in Article 66.2 of the World Trade Organisation (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).

1.3 Prioritising Areas where Transfer of Technology Should be Operated

Technology transfer as a *main operation* provides opportunities for shifting the locus of decision-making to "local agents" in terms of the modes and quality of learning, TT, and the choice of the area to be concentrated on. In contrast with TT as a *joint product*, TT as a *main operation* offers an opportunity to prioritise some domains.

Domains to be prioritised by governments in their efforts to comply with Article 66.2 obligations involve two criterions:

- **Domains where additional incentives are actually needed,** as opposed to domains where the market incentives are sufficiently

high for motivating foreign firms to commit resources; and

- **Domains where there is a clear demand for technology from local entrepreneurs,** who are then incentivised to develop innovative projects to suit local needs and markets. These projects are likely to generate spillover effects that are more easily captured by the local economy than those generated through FDI and the production of knowledge for global markets.

In summary, prioritisation done as a response to the TRIPS 66.2 provision should emphasise those domains corresponding to a certain model of innovation that is central to LDCs. This includes, for instance, locally oriented innovations that address local needs through local entrepreneurial activities, which allow the country to develop absorptive capacities. These domains are important for growth because the spillover generated in the course of such projects is likely to be captured by the *local* economy. Additionally, in these domains, TTs *need* additional incentives so the donor's intervention will be effective and respond fully to the TRIPS provision, which is not necessarily the case for export-oriented sectors in which the market incentives alone are sufficiently strong to motivate firms in rich countries to operate TTs. Other areas, such as export-oriented goods processing and manufacturing, are also important but do not need additional incentives. Also, TTs in these domains are likely to generate less spillover because of asymmetric capabilities between multinational corporations (MNCs) and the rest of the economy. As such, they should not be listed as part of the efforts made by the developed countries to comply with the 66.2 provision.

1.4 Towards New Types of Partnerships

The complexity and difficulties of TT operations call for new types of public-private partnerships (PPP). The essence of this kind of arrangement resides in the involvement of a third party, which is specialised in linking public donors, private firms, and local entrepreneurial activities to ensure the effectiveness of the TT operation. As such, this process will compensate for the shortcomings of existing mechanisms and which are essential to address problems arising from TT management as a main operation.

As stated above, in the circumstances of TT as a main operation, the locus of decision-making should not be kept in foreign assistance bodies but rather transferred to local government initiatives and entrepreneurs. Shifting the locus of decision-making to local actors and authorities is part of PPPs' menu of tasks.

The PPP has to work on the supply and demand side. In both cases, the incentive issue (i.e. to motivate local entrepreneurs and technology holders) has to be addressed.

On the demand side, the centrality of innovations targeting local needs and potentially generating spillover that is captured by the local economy has been previously emphasised in this text. In addition, the areas in which TTs must be primarily carried out are those of goods and services that address domestic needs through local entrepreneurial activity. Projects in these domains are socially beneficial and extraordinary advances must be achieved mainly in traditional sectors that generate local spillover. Therefore, the PPP has to target the local demand for technologies.

On the supply side, the PPPs must account for the existence of a certain profile of technology holders in developed countries that can be motivated and proceed efficiently when beginning an LDC TT transaction. As a consequence of a certain stage of vertical disintegration in industries, the emergence of specialised segments focusing on the invention and development of technologies, while not competing on the downstream market, is positive for TT to LDCs. This is a favourable context to find capable and motivated suppliers that are likely to undertake TT in an efficient way.

1.5 Responding Properly and Effectively to TRIPS Article 66.2

The role and functions of developed country governments must be examined and evaluated with regard to the different arguments previously developed. In short, TRIPS Article 66.2, which in vague terms calls for the provision of additional incentives to the firms and other organisations of developed countries to undertake TTs to LDCs, should be made more explicit. Practical means to achieve this include:

- Relying on the joint product and by-products logics only to ensure a satisfactory flow of consolidated technologies towards LDCs does not suffice. Above all, TTs as main operations must be developed. According to the new logic, the locus of decision-making regarding modes of learning and areas for focus will likely shift away from foreign bodies to local agents and authorities.

- In providing additional incentives to technology-owning firms, governments are seeking effectiveness. To achieve this, they should:

  - Provide effective incentives by offering assistance to projects that are socially beneficial but not profitable for the firms that own and could transfer the technology;

  - Ensure that conditions for efficient TT operations involve the choice of relevant partners on supply and demand sides, the selection of the right areas for focus (related to a clearly expressed local demand for technology) and the creation of organisational forms that will favour the consolidation of the transfer (absorption, adaptation and subsequent spillover), as well as the related entrepreneurial dynamic;

- Make use, as much as possible, of PPPs as a mechanism for ensuring both the effectiveness of the intervention and the efficiency of the TT operation.

2. THE NATURE OF TECHNOLOGY TRANSFER

Chapter 2 expands on the idea of the conceptual complexity of TT based on the distinction between knowledge and information. It then examines the different phases that make up this complexity. It goes on to discuss the fact that this complexity becomes even greater when the transfer involves entities of very different development levels and demonstrates the pivotal nature, in the case of LDCs, of the notion of capabilities. The building of these capabilities is carried out within the framework of suitable organisational forms, such as technology platforms or production centres. LDCs are also distinctive with regard to the type of innovation that is important to support as an engine for growth. Finally, chapter 2 tackles the question of barriers and incentives offered to firms to undertake TT operations and carry them through successfully.

2.1 Information and Knowledge

Discussion of TT in this paper refers to the transmission of technological knowledge. Of course, not only product or process-related knowledge, but also organisational knowledge can be transferred.

The channels of transmission may involve trade and transfers of materials, designs, blueprints, scientific papers and patents, formulae, manuals, databases, instruments and machinery, as well as the physical relocation of people possessing specialised technical abilities and skills. In all cases, the transferring of knowledge is different, more complex and costlier than the dissemination of information concerning a technology.

Disseminating information is simpler and less costly than the activity of transferring technological capabilities to individuals, organisations and, on a wider scale, social aggregations that were previously lacking them. While a TT can be considered a success if the technology in question has been put into operation and resulted in increased productivity in a certain economic activity, it is only the creation of technological capabilities in the host country that will ensure the long-standing efficient use of that technology in the country considered.

This section elucidates the content and implications of the distinction between knowledge and information. Box 1 below systematically explains all the properties and characteristics of knowledge that make its transfer and management difficult.

As conceived here, knowledge entails something more than information (Foray, 2004). Knowledge, in whatever field, empowers its possessors with the capacity for intellectual or physical action. The meaning of knowledge here is fundamentally as a matter of cognitive capability. Information, on the other hand, assumes the form of structured and formatted data that remains passive and inert until used by those with the necessary knowledge to interpret and process them.

The full meaning of this distinction becomes clear when the conditions governing the reproduction of knowledge and information are examined. While the cost of replicating information amounts for no more than the cost of making copies (next to nothing thanks to modern technology), reproducing knowledge is a far more expensive process since cognitive capabilities are not easy to articulate explicitly or transfer to others: “we can know more than we can tell” (Polanyi, 1966). Knowledge reproduction has therefore long hinged on the “master-apprentice” system (where a young person’s capacity is moulded by watching, listening and imitating) or on interpersonal transactions among members of the same profession or community of practice. These means of reproducing knowledge may remain at the heart of many professions and traditions, but they can easily

fail to operate when social ties unravel, contact is lost between older and younger generations, and professional communities lose their capacity to act in stabilising, preserving and transmitting knowledge. In such cases, reproduction grinds to a halt and the knowledge in question is in imminent danger of being lost and forgotten.

Therefore, the reproduction of knowledge and the reproduction of information are clearly different phenomena. While one occurs through learning, the other occurs simply through duplication. Mobilisation of a cognitive resource is always necessary for the reproduction of knowledge, while information can be reproduced by a photocopy machine.

A further complication is the fact that knowledge can be codified: that is, articulated and clarified in such a way that it can be expressed in a particular language and recorded via a particular medium. Codification involves the exteriorisation of memory. It hinges on a range of increasingly complex actions such as using language to write a cooking recipe, applying industrial design techniques to draft a scale drawing of a piece of machinery, creating an expert system from the formalised rules of inference underlying the sequence of stages geared to problem solving, and so on. As such, knowledge is detached from the individual, and the memory and communication capacity created are made independent of human beings (as long as the medium upon which the knowledge is stored is safeguarded and the language in which it is expressed remembered). Learning programmes are then produced that partially replace the person who possesses and teaches knowledge.

When knowledge is differentiated from information, economic problems relating to the two can be distinguished. Where knowledge is concerned, the main economic problem is its reproduction and transfer (problem of learning), while the reproduction of information poses no real problem (the marginal cost of reproduction is close to zero). The economic problem of information concerns essentially its protection and disclosure: that is, a problem of public goods. However, the codification of knowledge creates an ambiguous good. This good has certain properties of information (public good) but its reproduction, as knowledge requires the mobilisation of cognitive resources.

Box 1. Knowledge as a Commodity

Knowledge is Sticky and Tacit

There is codified technological knowledge that is quite easy to transfer since it mainly involves the "costless travel" of a paper, software, or database. But new knowledge and expertise have a broad tacit dimension, meaning that they are neither articulated nor codified. Tacit knowledge resides in people, institutions, or routines. Tacitness makes knowledge difficult to transport, memorise, recombine and learn – all operations of high importance in TT activities. For instance, the knowledge involved in the effective production of advanced information technology products entails far more than the transfer of a set of blueprints. Given tacitness, knowledge is, therefore, costly to transfer from one site to another in a useable form. As von Hippel (1994) puts it, knowledge is sticky. Knowledge stickiness refers to the incremental expenditure required to transfer a unit of knowledge to a specified locus in a form usable by a given knowledge seeker. When this cost is high, stickiness is high. Stickiness raises a number of issues in terms of the organisation of knowledge production, product design and system integration.

Industrial and technological operations draw crucially upon sets of human skills and techniques that have been acquired experientially and are transferred between people by demonstration, informal personal instruction, advice and consultations, rather than being reduced to explicit and codified methods and procedures. Even in industries where mature technologies are transferred, training costs can be substantial and greater than adaptive R&D costs.

Many production processes that are implemented by people trying to follow the codified instructions without having access to the complementary tacit understanding of experts fail to deliver outputs of the expected quality immediately, and for a long time produce below the rates anticipated.

With regard to TTs, the tacitness and stickiness of knowledge create transactional difficulties. The difficulties created by the complementary role of tacit knowledge in successfully transferring incompletely codified technological knowledge from advanced to developing countries suggests that involving firms from the former countries via cooperative ventures, technology support and training contracts will be in the interests of firms in the latter countries.

Knowledge is Partially Localised

Technological knowledge is often not of general value for the economy because it has been produced in a local context for particular purposes. A large body of literature argues that the production of knowledge is at least partially localised: learning that improves one technology may have little or no effect on other technologies. However the degree of standardisation and maturation of technology and knowledge can mitigate these difficulties.

The other facet of this property is that local environments are subject to strong variations: even stringent requirements for equipment duplication cannot eliminate all significant differences between local environments (Appleyard et al., 1996). As explained by Ho (1997), because a technology is developed for specific conditions, transferring it to an environment different from that for which it is designed often requires adaptation before it can be successfully absorbed. In fact, a technology is rarely introduced into a new environment without some adaptations.

Knowledge is Weakly Persistent

Evidence in psychological literature shows that people forget: if the practice of a task is interrupted, forgetting occurs. Hirsch (1952) found that when performance was resumed after interruption it was at a lower level than that achieved prior to the interruption. Furthermore, knowledge can be depreciated (through deterioration and obsolescence). Communities that are in possession of it can fall apart, resulting in the disintegration of their collective knowledge.

Knowledge is often a Joint product

Knowledge is produced in a context of activities in which other motivations (the manufacturing of a good or provision of a service) are predominant. People learn by doing or by using. There is learning-by-doing because knowledge is not absolute but must be defined in relation to a specific physical context. Such a characteristic gives many activities important potential value in terms of knowledge production and innovation: those activities related, for instance, to the introduction of a novel type of equipment, organisation, or method.

Knowledge is Progressive and Cumulative

In the field of science and technology, knowledge is more often than not cumulative and progressive: technological improvement is therefore a central issue and a critical challenge for workers and engineers who need to recognise and exploit the latest improvement. An organisation must thus be far more technically competent to advance with the times (to advance with the state of the art) than to stand still.

2.2 Consolidation of Technology Transfer

2.2.1 Evidence on Costs

Teece's empirical works about TTs by multinational companies (1977) showed that the transmission and absorption of the know-how required to actually put the technology into operation involved substantial costs. These averaged roughly 20 per cent of the total project costs and were supplementary to the cost of transmitting knowledge in the form of capital goods, blueprints, specifications and special materials. Also included in the cost were pre-engineering technological exchanges, engineering costs associated with transferring process or product design, and the associated process – or product –engineering, as well as R&D necessary for tailoring technology to suit local conditions. They also included pre-start-up training costs and outlays made during the initial 'shakedown' and 'debugging' phases of learning that was required for the plant to achieve its designed performance specifications.

Cost variations are clearly related to the fundamental objective of the TT, whether to acquire the capacity to produce a product according to the design and specifications of others (material transfer), to acquire the capacity to produce a product and make minor design and technical changes (design transfer), or, to lessen dependence on foreign technology (i.e. to acquire the capacity to develop one's own technology).

Evidence regarding costs is a relatively good indication of the fact that a TT involves more than the mere acquisition of information about technology. Not only must the knowledge be successfully transferred for the technology to be put into operation, but persistence and memory have to be ensured and new knowledge generated must adapt the technology to the new environment and application. This new knowledge has, in-turn, to be managed, memorised, adop-ted and shared. Finally, the assimilation of subsequent knowledge improvements is a critical requirement.

Moreover, the skills necessary for putting a technology into operation appear to be organisational, rather than exclusively individual. Recurrent difficulties in absorbing new technologies during the 1960s and 1970s led policymakers to define technology more broadly for it to include organisational and management skills and know-how, rather than just engineering in a narrow sense. This enabled the development of a greater appreciation of the importance of acquiring "software" (disembodied information in the form of codified instructions and directions for use) and above all "wetware" (what is in the memories of individuals), as well as technology embodied in physical capital (Ho, 1997). One firm hiring another firm's most skilled engineers may be necessary but not sufficient to "reverse engineer" and successfully transfer the new technology (Appleyard et al., 1996).

The learning capacity of the recipient is therefore vital: countries that spend relatively large amounts on R&D in the relevant industry tend to be quick to begin producing a new product even if they are not its inventor. Similarly, firms that spend relatively large amounts on R&D tend to quickly adopt new technology developed by others (Mansfield, 1982).

2.2.2 Consolidation

Conceptually, the consolidation of TT involves different phases and steps: absorption and learning, adaptation to the local environment and needs (which is likely to include true innovative work), assimilation of subsequent improvements and, finally, generalisation.

The absorption phase basically corresponds to initial activities dedicated to the learning and application of the imported technological knowledge, plus the maintenance of equipment and its long-term performance.

The phase of adaptation to local conditions may comprise development and innovation tasks, not entailing major discontinuity, but allowing the imported technology to be adjusted to local specificities, on both the supply and demand sides.

The assimilation of subsequent improvements phase signifies that the improvements of the technological knowledge do not of course come to an end once the transfer has been made. Sometimes, these improvements are a pure extrapolation of existing phenomena and therefore their mastery only requires an extension beyond the present boundaries; at other times, the improvements involve the opening up of new areas of knowledge, in which case their mastery confronts the operating personnel with new phenomena.

Finally the **generalisation phase** corresponds to the dynamics of adoption of the transferred technology by all the potential adopters. This generalisation also includes the dissemination of imported technological knowledge.

2.3. TT in the Context of LDCs: Capabilities, Organisational Design and Models of Innovation

Technology transfers between developed economies and LDCs involve very specific issues and must be treated as an entirely different topic, as opposed to TTs occurring between two firms with the same level of technological capacities and management capabilities, for example.

TT between developed economies and LDCs involves the transfer, implementation and absorption of a technology from a mature technological structure to an entirely disarticulated production and knowledge system. Each consolidation phase – absorption of technology, adaptation to local conditions, assimilation of subsequent improvements, and generalisation – causes significant difficulties. As opposed to a TT involving two entities of the same level of development, greater attention must generally be paid to:

- Learning and training services;
- What is imported in terms of equipment (some sources of failure are importation of the wrong equipment, incomplete sets of equipment, or inappropriate equipment);
- The sufficient availability of high quality local raw material and components (a major source of failure is the inadequate supply of local raw material and components (see Ho, 1997));
- The local demand structure (products unsuited to the local market constitute another source of failure).

2.3.1 Capabilities

The term “capabilities” here draws on Enos (1996) to introduce an issue relevant for the least technologically advanced firms. The most technologically advanced firms can profitably absorb new knowledge and subsequent improvements, and undertake development to adapt the technology to specific conditions. They employ the skilled persons needed to appreciate and assimilate advanced technologies, and can draw upon their previous experience in carrying out each successive task. Technology transfer is in fact a decreasing cost activity. The more extensive the experience previously acquired by the transferring organisation in supplying subsidiaries with the technology in question, the narrower the gap between the technical capabilities of the two participating organisations, and the lower the transfer costs in relation to total project size (Mansfield, 1995).

Less advanced firms lack these prerequisites for technological progress: even if they draw upon outside suppliers for the tasks of planning, design, engineering, construction and initial operation, they are likely to find themselves incapable of operating the plant in a way that exploits its full potential, let alone securing the mundane day-to-day improvements that so markedly increase

its performance. It may take all the technical and managerial resources of the less advanced firms to master the transferred technology and implement the necessary adaptations and developments. Mastering improvements as they come along may prove too great a challenge.

Mastering a given state of the art is not enough; what is critical is to master a progressive state of the art (Enos, 1996). In the knowledge economy, these tasks are never-ending. No sooner have workers mastered one state of the art that they must begin to shift their attention to its successor. Improvement can occur so rapidly that workers can never relax thinking they have absorbed the current set of knowledge, as the next phase of improvements is already upon them.

Building capabilities to increase a TT's chances of success is thus a crucial matter. It points towards economic models of development that emphasise the accumulation of skills and learning capacities, rather than fixed assets or capital, in facilitating the TT process. This, in turn, calls for certain proper organisational structures.

2.3.2 Organisational design

Organisational structures are critical for the successful management of the whole TT process. What is at stake here is an idea that goes back to A. Marshall's concept of the internal and external organisation of firms. The internal organisation of the receiving entity is central to the process of technology absorption and its adaptation to local conditions, as well as the assimilation of subsequent improvements. External organisation is critical to the process of broader dissemination and spillover from one particular entry point of the technology into the country.

These two organisational dimensions are likely to be "weak" in the case of LDCs. It is therefore critical to establish organisational structures that are dedicated to improve both internal and external dimensions in order to maximise the probability of TT success.

The terms "technology platform" or "production centre" are used to designate forms of organisation explicitly aimed at facilitating the learning of the technology, its adaptation to local conditions, the assimilation of subsequent improvements and its generalisation. These essentially involve technology development centres devoted to a specific domain and partly financed by public development assistance. These centres provide a certain number of technological services to assure the development of appropriate innovations. They pinpoint and structure demand for technology from local entrepreneurs. They also ensure the updating of technological knowledge and its diffusion. Crucially, they facilitate access to the financing of innovation by local banks, either by simply supporting the project in question, or creating credit lines from developed countries. Box 2 describes this type of project using the example of the Cleaner Production Centers set up as part of collaboration between Switzerland's State Secretariat for Economic Affairs (SECO), the United Nations Industrial Development Organisation (UNIDO) and several developing countries.

Technology platforms constitute an attractive organisational innovation when the TT involves countries with different levels of development. They represent a method of coordinating and adapting resources whose assembly is, by definition, problematic. They provide a better understanding of local technology demands. Finally – and perhaps most importantly – they "anchor" the technological development in the local economy, endeavouring to attach it to an industrial dynamic.

A TT linking entities with very different development levels calls for sophisticated organisational forms if the success of the different consolidation phases is to be guaranteed. However, these organisational forms are themselves heavily dependent on the chosen transaction modes, as discussed further below.

Box 2. Cleaner Production Centres as an Example of a Technology Platform

The Swiss-supported Cleaner Production Centers offer a wide range of services relating to clean technologies (SECO, 2005), such as:

- Information on state-of-the-art technologies;
- On-site consultancies in production companies or the service sector and special services such as eco-audits, project evaluation, introduction of ISO 14000, etc.;
- Support in drafting investment projects to submit to banks during the search for financial resources;
- Training for workers, consultants and students.

The CPCs are autonomous organisational units with their own board of directors representing local industries and services. Each centre receives technical support from a Swiss Reference Centre that are reputed institutions in the relevant area.

The TT may involve training, software (such as environmental control systems), or hardware, or a combination of all three, including supplies, provision of services, licences, documentation, and creation of joint ventures.

The CPCs help local entrepreneurs to find solutions for financing technologies. In addition, Switzerland has established green credit lines that combine a guarantee of credit from a short-listed local bank with a partial reduction of repayment in the event of a successful investment

2.3.3 LDC Innovation Models[3]

The issue of innovation in LDCs involves certain peculiarities. There are local needs and local markets that are not necessarily well served and that may require enhanced government incentives.

In terms of innovation capacities, LDCs are characterised by two features: small countries (small refers here not to the size of GDP but to the relative size of the relevant sectors in the economy; that is, those sectors that could potentially benefit from technological spillover from innovation) and weak absorptive capacity. This constitutes both a challenge and a risk: the challenge to be recipients of spillover affects that originate elsewhere, and the risk that the export-oriented R&D done at home will easily spill out of the country and benefit external firms and consumers rather than the local economy. Therefore, in terms of knowledge and information spill in and spill out, the net result may be negative for the LDC.

The consequence is that even if an LDC could benefit from "plugging" some of its activities into the global market, this should not preclude *the support of locally oriented innovation*, which can be critical for growth and social well-being. The development of capacities to produce locally oriented innovations allows the country to develop absorptive capacity, while at the same time the locally generated spillover from this same R&D may end up diffusing away from the local economy. There are vast areas of economic activity where innovation is needed to *serve local needs and local demands*, whereby "local" may mean a large fraction of the world population.

Finally, it may be that the most important innovations for LDCs are not purely technical but in fact reside in this "discovery process" of what the country should do in terms of specialisation in industry and service.

2.3.3.1 The centrality of local innovation and local spillover

Innovation should be widely distributed over the whole spectrum of economic activities across sectors (not just high tech) and types of innovations (not just formal R&D). In LDCs, this means incremental, cumulative, and mostly informal (without R&D) innovations, developed mainly in "traditional" sectors or in services not qualifying as "high tech." Although mostly dealing with low-tech activities, these innovations are generating local spillover and will ultimately impact the productivity of a wide range of sectors in the local economy.

If we regard information and communication technologies (ICTs) as the major general purpose technology of our time, ever expanding segments of LDC economies should adopt and "invent" new applications for ICTs in ways that increase productivity. General Purpose Technologies (GPT) foster economy-wide growth not simply or principally by innovation in the GPT itself, but rather when a wide and expanding range of other sectors adopt the advancing technology, generating new useful applications of the GPT. Therefore, the key issue for "secondary countries" (countries that are not at the frontier of the GPT) is how to allocate R&D and other innovative inputs so as to level the growth potential of the prevalent GPT. The main point is that it is not ICTs alone that cause growth, but rather that adopting sectors ought to establish innovation complementarities for economy-wide growth to take place. These types of innovation complementarities (adoption, local innovations in traditional sectors) may be less overtly innovative and therefore not be deemed as worthy of support or encouragement. Yet, ultimately, they constitute the key to economic growth.

Any innovation policy in the case of LDCs should, therefore, pay attention to these issues. It should not aim just at increasing total R&D, but do so in a way that incentivises local innovation and spillover rather than global R&D and external leakages. Such a policy should develop absorptive capacity and ultimately impact the productivity of a wide range of sectors in the local economy.

This is the "model" of innovation that TT has to foster in an LDC context. From this perspective, government and donors should pay more attention to local demand for technology. Much of the discussion in TT literature has focused on the supply side – the willingness of technology holders to transfer technology (Arora, 2007). Very little attention has been paid to providing better knowledge of the structure of the demand for technology in a given country, region, or industry.

2.3.3.2 Discovering the next areas for focus

According to Hausman and Rodrick (2002), there is a key role for entrepreneurs in LDCs: to learn what the country is good at producing. For an LDC, there is great social value in discovering the relevant specialisation since this knowledge can orient the investments of other entrepreneurs. It is also a misperception of LDCs' realities to assume that the production functions of all extant goods are common knowledge.

But the entrepreneur who makes the initial "discovery" can capture only a small part of the social value generated by this knowledge; other entrepreneurs can quickly emulate such discovery. Consequently, entrepreneurship of this type – generating learning on what can be produced – will be undersupplied.

If learning what a country is good at producing requires an investment and the return on this investment cannot be fully appropriated, this is a problem that is unlikely to be solved with legal protection. Indeed, entrepreneurs in LDCs are trying out technologies that already exist abroad. The discovery may be that an existing good can be produced profitably in the country. Such discovery does not normally get legal protection no matter how high the social return. There is therefore a role for government policy, probably not fulfilled by the IP protection system.

2.4 The Choice of Technology Transfer Areas in the Case of LDCs

In a note-worthy case study of science and technology policy in four sub-Saharan countries (Ghana, Kenya, Tanzania and Uganda), Enos (1998) clearly demonstrates that the areas of science and technology most vigorously pursued in these countries are increasingly determined by foreigners. Tanzania's Agricultural Master Plan, for example, assigns the first R&D priorities to coffee, tea, rice, animal health, soil and water management, and 'farm system' research, in that order. Of course, setting priorities, planning, and allocating resources to undertake research according to these priorities are highly desirable policy actions. However, the question is: on what bases are the priorities set? Who does the setting? Is there any impact?

2.4.1 Enos' main argument: the process used to determine priorities is dubious

As described in Box 3, Enos has six strong arguments to describe the vicious circle for those economies in which the decision locus has shifted to foreigners and where the re-focus is on scientific and technological progress in the area of export-oriented commodities facing deteriorating terms of trade instead of areas of domestic expansion.

Box 3. Defining the Areas of Focus: Six Arguments

1. Enos argues that there is a shift in the locus of decision-making concerning the future direction of economies from local authorities to foreign assistance bodies. This is likely to continue for a long time since local resources devoted to the pursuit of science and technology are scarce and it may well be decades before the countries will have sufficient resources to finance scientific education and R&D without foreign support.

Let us go back to Tanzania's selection of target areas in science and technology to understand what is going on. Obviously the criterion used to select R&D in coffee, cotton, and tea in that order is based on the country's export specialisations that provide the biggest export earnings for financing national development. The argument is as follows: the countries are short of foreign earnings with which they finance their development. An increase in the capability of these countries to provide the goods and services desired abroad will help grow their foreign earnings. And, the main foreign markets for these goods and services have always been, and will remain, in the developed countries. The argument is thus that these economies will best serve their own members by conforming to the existing pattern of world trade.

2. Decisions made by foreigners regarding the direction taken by science and technology are primarily based on the principle of comparative advantage. A country should invest in activities that can potentially be carried out at a relatively lower cost than in other countries. So some activities, such as production of textiles and processing of tropical foodstuffs, are excluded from the menu of activities appropriate for developing countries (they are reserved for producers in developed countries). As a result, the menu of activities available is very restricted. It essentially includes those commodities that are consumed but not produced in developed countries: primary commodities such as beverages (cocoa, coffee, tea) and, to a lesser extent, fibres (cotton and wood). Scientific research is undertaken to increase the production and lower the costs of producing these commodities. Education is directed towards training people who will orient their careers accordingly.

3. The choice of science and technology areas to be pursued is primarily based upon the effects of such choices on developed countries. This means that among the various areas where Tanzania has a comparative advantage, the commodities accorded highest priorities are those that are not produced by the countries sponsoring the master plan, which includes the EU, Germany, the Netherlands, and the UK. Not only do developed

countries support R&D in those commodities that they import but they also tend to ensure that these are the very commodities that receive the most R&D.

Tanzania certainly has a comparative advantage in coffee or tea. As such, this is a general argument to allocate resources for technological development to these areas. However, Tanzania may also have a comparative advantage in the production of maize, roots and tubers, oil seeds, and etc., which are considered as a medium priority in the master plan. R&D in these areas will thus receive far less attention.

Why is this happening? From the donor point of view, there is the need not to offend powerful groups of producers in the developed countries, the universal aim of export promotion, and the reliance of the country considered on competitive advantage criteria.

4. The implication of arguments one, two, and three above on the shift in decision-makings, comparative advantage rationale, and the dominance of effects on developed countries, is the change in the aim of economic development; the shift is from domestic expansion to export promotion. Export promotion involves focusing on world markets, discovering those products most in demand, and mobilising domestic resources for that purpose. Between domestic expansion and export promotion, there is an obvious clash, at least in the short-term.

5. Focusing on technological progress in a given area of export-oriented commodity is a correct decision for a single country (in the absence of other countries adopting the same decision). But it is likely to be a wrong decision when many countries adopt it. The chain of events is well known for commodities for which demand is price inelastic: the total value of the marketed commodity falls. Second, the country has reallocated resources to an activity that yields fewer returns as time passes. The cost of this reallocation may be high and is sunk. Third, the country is left with a monoculture.

6. It is unfortunate that these countries are allocating most of their resources for science and technology to areas facing deteriorating terms of trade. Devoting scarce R&D to their improvement will merely accelerate this deterioration. R&D and its concomitant activities should therefore be directed elsewhere.

The severe deterioration of terms of trade is thus an emerging property of demand inelasticity and the successful transfer of technologies carried out to improve similar activities in too many LDCs.

2.4.2 The question then is "where else?"

In principle, the answer is quite simple and was provided in the preceding section (2.3.3.1). That is, greater advances should be sought in those activities that provide employment for a rapidly expanding population and generate the production of goods and services for domestic consumption. Thus the aims of advancing science and technology are: modest gains for export commodities characterised by deteriorating terms of trade, and immodest gains for non-traded goods and activities like tourism, which use relatively abundant resources to earn foreign exchange. This last area could be referred to as "stable-terms-of-trade goods" in order to distinguish it from exportable commodities like coffee whose terms of trade will continue to deteriorate in the future.

To summarise, the aims of science and technology policy in LDCs are to make reasonable advances in the area of exportable commodities and extraordinary advances in the areas of goods for domestic consumption and stable-terms-of-trade goods.

Table 2. Mapping the Areas for TT focus

Product type	Examples	Current production potential	R&D contribution	Demand elasticity	Supply elasticity	Terms of trade (trend)
Traditional exportable commodity	Coffee	Excellent	Moderate	Low	High	Deteriorating
Traditional locally consumed primary commodity	Cotton	Excellent	Moderate to substantial with sufficient R&D	Medium	High	Stable
Locally processed perishable goods	Soap (manufactu-ring) cooking oils (refining)	Good	Moderate, only if R&D directed towards appropriate technology	Medium	High	Stable
Simple traditional capital goods and services	Agricultural mechanical	Fair	Substantial only if R&D directed correctly	Medium	High	Stable

Source: Enos, 1998

TTs have to be operated in many domains, including export-oriented industry. But they must be particularly supported in those domains corresponding to the model of innovation that is central to economic growth in LDCs. This includes entrepreneurial activities that meet the needs of local markets likely to generate domestic spillover. In other words, TTs must offer a positive supply response to a demand for technology stemming from local entrepreneurs. Two reasons for this are provided:

- First, these domains are potentially important for growth because the spillover generated in the course of such projects are likely to be captured by the local economy;
- Second, these domains *need* additional incentives so that the donor's intervention will be effective and will respond fully to the TRIPS provision. This is not necessarily the case of export-oriented sectors in which the market incentives alone are sufficiently strong to motivate firms in rich countries to operate TTs (see chapter 5 below).

2.5 Transactional Modes, Barriers and Incentives[4]

The major sources of transfer, as described in the literature (see e.g. Maskus, 2004, World Bank, 2008) include trade, FDI (i.e. MNC), licensing, joint ventures, and the movement of people.

Among these various forms of TTs, there are two logics to distinguish that make sense when organisational issues, as well as incentives and barriers are considered: packaged and unpackaged forms of TT (Enos et al., 1998). The packaged form essentially means that the technology is transferred through FDI, import of goods, or the building of infrastructures by foreign firms. In other words, the transfer of technology is a ***joint product or a by-product*** of another economic operation. The importance and quality of TTs are therefore contingent on a large number of factors resulting from the primary economic operation. It is thus the incentives for success of the primary economic operation that

determine the motivation for success of the TT and its consolidation (or not).

Unpackaged is defined as the transfer of a technology not channelled through direct investment, trade, or infrastructure development. Joint ventures, licensing, and arrangements involving technical assistance, collaboration contracts, informal transfer of know-how, and consultancy are classified as unpackaged modes of TT. The technological knowledge is "disembodied" and transferred through software and wetware, not hardware. In this case, the TT in itself constitutes the ***primary economic operation***. Here, the prime motivation for the operation is the success of the TT and the incentives directly linked to the TT (cost and profit) that control the operation. The main advantage of this mode is that it gives the host country control over technology selection, management decisions, and development of local skills.

Discussion here of TT as a *joint product*, *by-product* or *main operation* refers to the definition of these concepts in accounting. *Joint product*s are two products that are simultaneously yielded from one shared cost and they have comparably high (sales) value. *By-product*s for their part are produced along with a main product. The latter constitutes the major portion of the total (sales) value. *By-product*s have a considerably lower (sales) value than these main products. These concepts can be applied to TTs with the substitution of "perceived value to technology holders" for "sales value."

It is therefore apparent that the technology holder's commitment may vary considerably depending on the TT's economic operation status and the importance attributed to it in the success of the primary operation, if it does itself not constitute the primary operation.

In the case of TT that is a *by-product*, the technology holder is interested in the success of the main economic operation. Here, realising the TT is of secondary importance. In the case of a *joint product*, the issue is to balance incentives between the success of the other economic operation (e.g. a direct investment) and the success of the TT. Finally, in the case of TT as a *main operation*, the economic incentives cannot be allowed to depend on another economic operation. The TT must be sufficiently attractive in itself for the technology holder to enter the transaction.

These three forms of TT (*joint product*, *by-product* and *main operation*) are examined below, along with the various channels implemented for each. The incentive structure, barriers, limitations, and opportunities associated with each type are also examined.

2.5.1 TT as a joint producr or by–product: the need for balancing incentives

This section briefly examines TT mechanisms as related to trade and direct investment. In both cases, TT is a *joint product* and as such creates both opportunities for knowledge transfer and limitations.

2.5.1.1 Trade

Trade as a channel for TT involves imports of goods and services — especially capital goods and high tech products – and export by firms from lesser developed countries. The role of high tech products and capital goods import as a TT mechanism is clear: it directly impacts the domestic economy by improving productivity and it can foster local innovation through reverse engineering of imported high tech products.

Exporting goods creates an indirect mechanism for TT. By participating in the global value supply chain, LDC firms will benefit from numerous training and technological spillover effects from their customers.

One interesting form of trade-related TT is subcontracting, whereby the subcontractor manufactures the final product under the

principal's brand name (Enos et al., 1998). This allows foreign involvement without the transfer of ownership. Such an arrangement often involves the foreign partner in selecting capital equipment, training managers, engineers and technicians, and advising on production, financing, and management. Since the quality, delivery, and price of the final product are critical for the foreign investor, this is likely to generate long-term technical relationships for capacity building in the host country. Here incentives seem to be aligned. Moreover, learning and constructing technological capabilities often occurs (Hobday, 1995). For example, many electronic systems purchased under this form of TT (subcontracting) were designed, specified, and manufactured by the local firm rather than the foreign company (see the case study on the electronics industry from the Asian new industrial economies).

The transfer of technology through this arrangement nevertheless has certain limitations. It is difficult for the company in the developing country to establish international brand images. Dependence on foreign companies for technologies and components can persist for a long time. On the one hand, evidence shows that substantial learning can take place through this mode. Yet, on the other, it seems difficult to overcome the limitations arising from the dependence of firms in developing economies on this mode of technology acquisition.

2.5.1.2 Direct investments

A lot of TT occurs through foreign direct investment. FDI is an efficient transfer mechanism because it provides the necessary incentive and long-term framework to make TT effective. When FDI is involved, the foreign participant has a direct interest in the successful TT (Ho, 1997). Consequently, it is likely to participate actively in the transfer process, supplying not only equipment and capital to its foreign affiliate but also high-quality disembodied knowledge, particularly tacit knowledge such as general technical, business, and managerial know-how. In other words, the foreign investor has an incentive to supply much of the missing technical and managerial expertise and know-how needed to start up the project promptly and help it to rapidly reach its designed production rate. Incentives are aligned.

There is abundant empirical literature that focuses on the dissemination effects or technology spillover from FDI (Blomström and Kokko, 1998). Spillover occurs when local firms benefit from the MNC affiliate's superior knowledge of technologies without incurring a cost that exhausts gains from improvements. They operate via different mechanisms as elaborated on below:

- Backward linkages: This arises from the MNC affiliate's relationships with local suppliers. Complementary activities developed through these linkages are likely to create spillover effects and several case studies highlight such positive outcomes. However, they also stress that the local content of MNC production is a strong determinant of strength of linkages.

- Forward linkages: This stems from contacts with customers. However, there is much less evidence of forward than backward linkages, so that the argument pointing toward the existence of FDI spillover toward customers is suspicious.

- Training of local employees in MNC affiliates: Although it is obvious that FDI involves some supply of training for local employees ranging from on-the-job training to seminars, and more formal schooling to overseas education, perhaps at the parent company, the evidence on spillover from MNC affiliate training of local employees is far from complete. There is certainly an accumulation of human capital skills in the MNC's employee stock. Some of these skills can be appropriated by local firms when employees move to new jobs, but how much is an open question.

- Demonstration effect: A few case studies suggest that demonstration (when affiliates'

technology imports have induced local competitors to imitate their behaviour) may be an important channel for spillovers. However, there are too few studies to reveal how important the simple demonstration effects are.

To summarise this literature, potentials for knowledge and technology dissemination from FDI are obviously significant. But many conditions are necessary to realise it fully. Some of these conditions relate to the host country: market size, local content regulations, and the size and technological capability of local firms are country characteristics that will clearly influence the extent of spillovers.

FDI as a vehicle for TT also exhibits some shortcomings that create challenges for the importing country. First, the decision concerning which technology to transfer and how to organise the production of the knowledge required for development and local adaptation remains in the hands of the foreign investor. The transferred technology could thus conceivably be inappropriate for the host country – for instance, too modern for its needs and too capital intensive given the resource endowments of most developing countries. It is also likely that foreign investors will do most of their research and development in their home countries, preventing the development of core technologies in host countries (Enos et al., 1998). Will the developing economies get the right technologies on the right terms? If the main vehicle for transfer is foreign investments, the main TT aspects will not be decided publicly, via the intervention of government agencies, but privately, by the firm. There is therefore the risk that the shift from external and collective to internal and individual choice of technology may remove the transfer of technology from the public arena (Enos et al., 1998).

2.5.1.3 Balancing incentives: from joint product to by-product

Are incentives really aligned (the advantage most frequently advanced)? Foreign investors primarily want to succeed in putting the plant into operation and keeping it running for a certain period of time. The success of the TT is likely to become of secondary importance.

If incentives are not properly balanced between the need to make the industrial facilities operate efficiently and the need to transfer training and knowledge to the future local workers and engineers, it is likely that the foreign investor will devote insufficient resources and time to the learning process. The whole range of capacities and capabilities (including tacit knowledge) has to be absorbed by the nationals of the importing country. But what matters most for foreign investors is the success of the industrial operation and not the success of the transfer in itself. For example, Choii et al. (1994) argue that foreign investors have little incentive to take the initiative in shifting responsibility for technological adaptations to local suppliers or staff. If the replacement of expatriates is unnecessarily delayed, this prevents the learning process from fully taking place. This is a clear case of unbalanced incentives between the need to make the investment operational in the short-term and the need to transfer the technology. In this case, TT becomes more like a sort of *by-product* (as such a very uneven and unplanned event) rather than a joint product.

2.5.2 Technology Transfer as Main operation

Joint ventures, licensing, and arrangements for TT as technical assistance, such as collaboration contracts and the informal transfer of know-how have been the most popular alternatives to wholly foreign owned MNC subsidiaries as sources of technology (Enos et al., 1998). Joint ventures are contractual arrangements between two (or more) firms in which each provides some advantage that should reduce the costs of joint operations. For instance, the MNC will make the new technology available while the domestic firm provides its knowledge of the market, the regulatory and business environment, and some other local advantages.

In this case, TT is the main operation and therefore the incentives are shaped by the cost and benefits of the TT *only*. In other words, incentives cannot be leaning against another economic operation. The TT must be attractive enough for the technology holder to enter into the transaction. As a *main operation*, the TT provides an opportunity to shift the locus of decision-making away from the foreign bodies to local agents both in terms of the learning process and the areas in which TTs will operate. TTs as a *main operation* give the host country control over management decisions and the development of local skills. This is why many countries have expressed a preference for joint ventures, with the foreign partner in a minority position, over wholly FDI.

2.5.2.1 Licensing

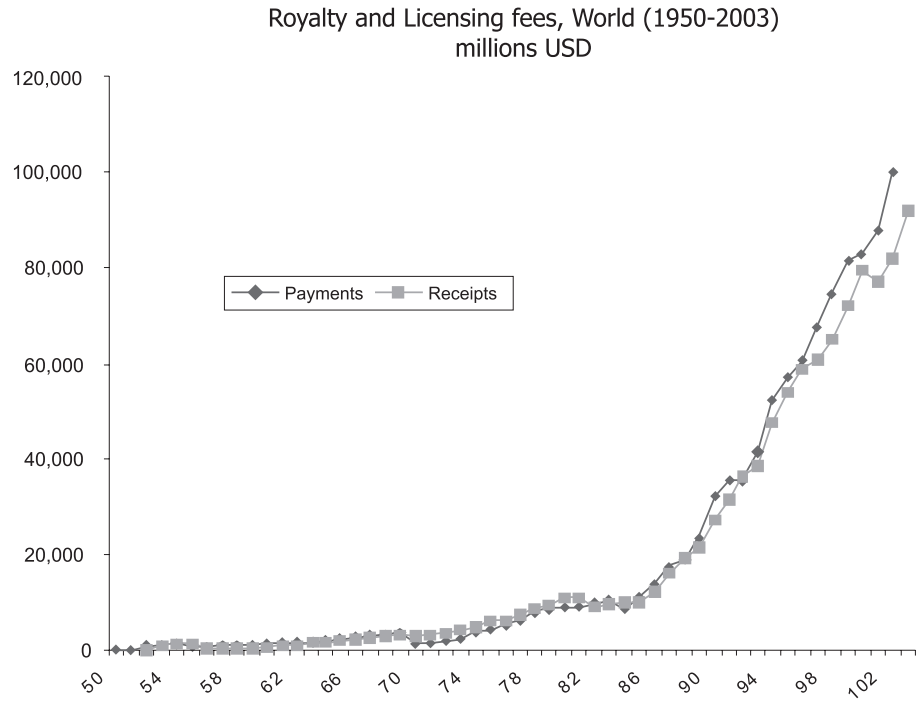
Licensing involves the purchase of production rights, protected by IPRs, and in many cases, the provision of technical assistance and know-how, which are needed to adopt and adapt the technology. The transfer of tacit knowledge and the provision of technical services are central to ensure that the licensor will secure the proper capabilities so as to use the technology in an effective way. For instance, studies of licensing in India suggest that Indian firms importing technology tend not to receive sufficient amounts of technological know-how. As a result, their ability to assimilate, utilise, and improve the technology is limited. (Arora, 1996). Theoretical works (notably by Arora, 1995, 1996) demonstrate the conditions under which know-how can be transferred through contracts. One important condition is to bundle know-how transfer with the provision of complementary inputs.

Licensing is becoming central among the various market-based channels as markets for technology become thicker and more "efficient." Athreye and Cantwell (2007) find that international patent licensing and royalty receipts have surged since the mid-1980s. From around USD 10 billion in 1984, international patent licensing and technology receipts grew to more than USD 80 billion in 2002 (at current prices). Over 120 countries reported receiving such royalties and more than 130 countries reported making such payments in 2002. There has therefore obviously been a significant increase in international TT through licensing operations (see Arora, 2007, for an up-to-date overview). What is more, this appears to coincide with an overall strengthening of IP regimes, first in rich countries but later in poorer countries too.

Some countries have pursued a licensing-based strategy of technology acquisition in the belief that it is more favourable to TT and the development of learning capacities by domestic firms than FDI. Some sparse evidence (Enos et al., 1998) tends to show that joint ventures provide greater training than licensing, while the latter involves greater indigenous technological effort.

However, one should not forget that markets for patents or licenses are not markets for technology. Most firms want to purchase technologies, not mere patents. For this reason, patents are sold or licensed as part of the bundle of goods and services needed to implement a technology (see Arora's argument below). But this sort of transaction is more complicated and costly than a mere patent license or assignment. In addition, in view of tacit knowledge, and the importance of collaborative development, it is unrealistic to expect technology markets for today's complex inventions to function as well as the robust markets during the heyday of the individual inventor (Bessen and Meurer, 2008). Therefore, the various phases of a TT, notably absorption, learning, adaptation, and assimilation of the subsequent improvements are complex to predict and to plan. They are therefore difficult to draft as detailed objectives and milestones in the contractual arrangement.

Figure 1. The Growth of Royalties and Licensing Fees



Source: Athreye and Cantwell, 2007

2.5.2.2 TT as a main operation: cost and benefits

In TT as a main operation, there are no other economic operations to "help" and the prospect of returns on the TT operation must only be sufficiently attractive to incentivise the technology holder to enter the transaction. This means that very often additional incentives provided by governments will be needed (chapter 5, below). But TT as a main operation offers opportunities to shift the locus for decision-making to the local agents and domestic firms.

When TT is a joint product of FDI, the locus of decision-making lies in foreign firms that decide about the domain, the modes of learning, the amount of resources devoted to the TT operation, the potential scope of further dissemination, the objectives of assimilating subsequent improvements, and etc. Clearly, when the locus of decision-making regarding areas for TTs lies with foreign firms, there is a risk of a suboptimal decision process (see the argument above in the case of FDI).[5]

When the TT is the main operation, there is much more flexibility about who will make the main decisions: domestic bodies (entrepreneurs, governmental agencies), foreign donors or foreign firms. The argument is that in the circumstances of TT as the main product, the locus of decision-making should not be kept in foreign assistance bodies but transferred to local government initiatives and entrepreneurs. This is particularly important for decisions that concern:

- The mode of learning and the "quality" of TT. To what extent conditions for effective learning and transfer of capabilities will be organised by the technology holder? and;

- The choice of areas to be concentrated on. TTs address specific knowledge areas and technological trajectories. The issue of selection involving both priority-setting and technology forecasting must be addressed since it is a critical one: a successful TT, if not done in a relevant area for the country considered, will produce very little benefit. It is thus imperative to critically examine the conditions and procedures of priority-setting and technology selection. Section 2.4 above already clarified in what domains TTs should be undertaken first. This argument will be fully developed below (in chapter 5).

2.5.3 Technology transfer without compensation: imitation and reverse engineering

What distinguishes this mode of operation from licensing and joint ventures is that imitation does not entail any compensation to the technology owner. This does not mean that it is a costless process, however. Imitation can be very complex – it takes time and resources, which makes it perfectly tolerable from a competition point of view. The initial inventor can use the "lead time" (the gap between the invention and the entry of imitators) to capture a large fraction of the benefits and thereby cover R&D fixed costs. Being the first is an asset that can command a positive price under competitive conditions. This price reflects the present value of the future flow of marginal utilities that subsequent copies will yield to impatient consumers because the process of imitation takes time.

It is because imitation is time consuming and costly that Samuelson and Scotchmer (2001) argue that reverse engineering has generally been considered a positive element for fostering innovation and the transfer of knowledge. Reverse engineering is fundamentally directed to discovery and innovation. Engineers learn the state of the art not only by reading publications, going to conferences, and working on projects, but also by reverse engineering others' products. Learning what has been done before often leads to new products and advances in know-how. If reverse engineering is costly and takes time, as is usually the case, innovators will be protected long enough to recoup R&D expenses. As such, it is a competitively healthy way for second comers to access and discern the know-how embedded in an innovator's product.

Samuelson and Scotchmer (ibid.) also argue that the very act of reverse engineering rarely (if ever) has destructive effects on the market. Harmful effects are far more likely to result from post-reverse engineering activities, such as selling a competing product made with know-how from an innovator's product. Because of this differentiation, policy has at least to ignore the act of reverse engineering while focusing on regulatory controls on market-destructive post reverse-engineering activities.

2.6 Brief Summary

This section has put a framework in place based on two key taxonomies:

- The phases of TTs: absorption, adaptation, assimilation of subsequent improvements, and dissemination (spillovers); and
- The economic nature of TTs: by-product, joint product, or main operation.

When the TT is a *joint product* (occurring as a consequence of a direct investment), the phases of absorption, adaptation, and assimilation of subsequent improvements are in a sense embedded in the investment project. However, since the TT is a *joint product*, there is the problem of "balancing incentives" between the need to make the direct investment operational and profitable in the short-term, and the need to transfer technologies and capabilities. Indeed, the risk of a strong imbalance arising between these two incentives is considerable in LDCs since the cost of transferring technologies and building capabilities is high. As a result, foreign firms are tempted to limit the scope and depth of the transfer of technologies and capabilities in order to increase the short-term profitability of the investment. In such a case, the TT is no longer a *joint product* but becomes a *by-product* – that is to say a negligible objective.

When TT is the *main operation*, the problem is that incentives cannot be allowed to depend on another economic operation. The TT, in that case, does not offer other benefits to the technology holder than what is generated through the transaction. On the other hand, it provides opportunities to shift the locus of decision-making toward local authorities and agents both in terms of the choice of areas for focus and the mode of learning to be implemented.

In both cases (joint product and main operation), the broad dissemination of the technology and the spillovers stemming from a given TT locus are not guaranteed. The successful achievement

of this final phase of the TT requires particular organisational forms.

This also underlines the peculiar nature of innovation in LDCs that TTs have to serve (*demand side*). The centrality of a particular model of innovation for growth and development has already been emphasised. R&D and other more informal learning activities undertaken to produce locally oriented innovations allow the country to develop absorptive capacity, while at the same time the locally generated spillovers from this same R&D may end up diffusing away from the local economy. TT as a main operation provides the opportunity to target those areas in which such innovative activities can be undertaken.

Chapter 4 uses recent evidence to observe the mechanisms (in particular FDI, trade and licensing) that are effectively operating in the LDC context and their relative importance and impact on economic growth and development in these countries.

3. TECHNOLOGY TRANSFER AND INTELLECTUAL PROPERTY RIGHTS

3.1 The Conditions for Technology Transfer to LDCs under TRIPS

As a new international system of IP protection has slowly been implemented as part of WTO Agreements to guarantee the enforceability of IPRs globally, policy discussions have been reinvigorated. This places significant pressure on countries that decided one or more decades ago to limit the scope of IP protection to facilitate knowledge access for both immediate consumption (drugs) and learning (technological knowledge).

3.1.1 An overview of TRIPS

The TRIPS Agreement establishes global mandatory minimum standards for the granting and protection of IP rights in several areas, particularly copyrights and patents. It also provides for strong enforcement measures and a settlement of disputes mechanism. Countries are free to decide how to implement these provisions according to their own legal system and practices. The application of TRIPS in developing countries has been mandatory since 2000, except for technologies not previously protected by-product patents. However, LDCs are benefiting from a transition period until 2013, with a further extension until 2016 for pharmaceutical products.

Both the US and EU benefit economically from stronger foreign IP rights, as this strengthening will lead to an increased flow of royalties or profits in the entertainment, pharmaceutical, and other industries. The introduction of a global system to enforce IPRs is a positive development for multinational companies as well, which expect an increase in the profitability of their R&D investments. These industries are therefore placing strong pressure on the negotiators of the developed nations. Hence there is a sense that if stronger IPRs cannot be negotiated at the World Intellectual Property Organisation (WIPO) or the WTO, they should be obtained via bilateral agreements. While the TRIPS Agreement established minimum standards of IP protection for WTO Members, substantial efforts are being made, particularly by the United States, to negotiate bilateral arrangements to limit part of the autonomy left to developing countries by TRIPS to go beyond its required levels of IP protection, thereby strengthening IP rights.

On the other hand, the official TRIPS message is that developing countries should consider this legal obligation as a positive arrangement. In a knowledge economy, strong IPRs are presented as beneficial for developing countries themselves since this evolution will create incentives for the endogenous development of domestic entrepreneurial capacities and help these countries to attract more FDI and absorb and acquire more foreign technologies through licensing and other market-based transactions.

It is time to revisit this economic discussion within the new context of a global IPR system under construction. Regarding TTs, the question is how IP protection effects the different transfer modes as described above. There are two related questions here: first, how does patent protection affect TT within a given mode? Second, how does patent protection affect the choice between these modes? Arora (2007) suggests that the relative importance of the different sources may vary over time, and that IP protection may affect these sources differently.

3.1.2 Transformation of the institutional conditions for TTs under TRIPS

Maskus (2004) proposes a distinction between "market-based forms of TT" (including FDI, technologies embodied in imported goods, licensing, exports by firms in the recipient country) and "non-market-based forms of TT" (including imitation and reverse engineering, learning from patents filed by foreign inventors, learning from scientific publications, movement of workers and students, and other types of spillovers). Maskus (2004) shows that certain "market-based" channels have increased in importance over time.

Simple reasoning, plus some sparse empirical studies, would allow the following developments to be identified. The strengthening of IP protection can be expected to result in an increase in the relative importance of licences and direct investments, and in the quasi-disappearance of imitation. It can also be anticipated that within a specific mode – such as, direct investment – the TT will be more successful insofar as a strengthening of IP protection will increase the technology holder's incentives to transfer in an efficient manner.

Some transfer modes would thus practically disappear, while others would be strengthened. The TRIPS philosophy is basically to reduce the range of transfer modes, whilst consolidating institutions that facilitate a small number of modes, at the risk of eliminating others (see Box 4).

Box 4. TRIPS and the Public Domain of Knowledge

TRIPS has considerable potential to increase the "excludability" of R&D results and reduce knowledge diffusion and informational spillovers (Foray, 2004).

By focusing on licensing as the main means of transferring technology, TRIPS is conceptually based on a narrow view of the channels through which knowledge can diffuse. In reality, these channels are multiple and all contribute to the transfer of knowledge, while the incentives created by TRIPS promote only one channel (patenting and licences), entailing the risk of blocking the others. Focusing exclusively on providing better IP protection is likely to cause serious collateral damage to other complementary institutions that support TTs in different ways.

The fact that the diversity of institutional arrangements is threatened constitutes a cause for concern. Traditionally, IPRs are considered as one of the incentive structures society employs to encourage innovative effort. They co-exist with other incentive structures, each of which involves costs and benefits as well as a certain degree of complementarities. The new view is that IPRs are the preferred means of commodifying the intangible capital represented by knowledge, and should therefore be seen as a common currency or "yardstick" for measuring the output of activities devoted to knowledge generation and the foundation for markets in knowledge exchange.

The space for public research and knowledge sharing is shrinking and functions that were assumed by the public domain are no longer assumed at the same level. In short, recent decades have seen the emergence of a pronounced worldwide trend towards the commoditisation of publicly funded research outputs, including underlying data and information resources.

It is also advisable to examine to what extent TT modes are entirely interchangeable from the point of view of their effectiveness, especially for LDCs. If this were the case, then the strengthening of IP protection would not radically affect the capacity of these countries to assimilate and absorb new technologies. If, on the other hand, this is not the case then the strengthening of IP protection could seriously affect the capacity of certain countries to absorb the technologies they need. Countries extensively using imitation as TT mode are less well placed with regard to direct investments or licensing, for example.

3.2 The Impact of TRIPS on Technology Transfer

It has been argued for a long time by developing countries (and many economists) that the international IP system was biased against them. This argument was essentially a distributional or equity argument: poor countries, at their stage of development, ought not to be obliged to pay for knowledge that would ultimately become part of mankind's universal heritage. Along these lines, India and Brazil, among other countries, passed laws restricting the scope of IP protection.[7]

A rather different rationale is based on the idea that since, in most cases, the markets of developing countries were not those for which patent holders had targeted, their innovations and profits deriving from sales represent pure economic rents. So that while it might be debated as a matter of equity that as beneficiaries they should pay, or that being poor they should not be asked to pay, the important fact remains that it would not make much difference from an efficiency standpoint: the world's supply of such innovations would not be much diminished – if at all – by these countries adopting a free riding policy. The more recent growth in consciousness regarding global marketing possibilities has tended to vitiate this line of rationalisation.

The pros and cons of the impact of TRIPS on the capacity of developing countries to perform TTs are systematically discussed below.

3.2.1 TRIPS barriers and obstacles to LDCs performing technology transfers

Many TTs occur through involuntary dissemination via copying and reverse engineering. Such mechanisms are perfectly acceptable from a competition policy point of view when operations are complex and demand resources and time (see below). The technology holder does not participate in this transfer, and in many cases, seeks to restrict it. During the period of no – or moderate – IPR in the LDCs, copying was certainly a major channel for TT. One can argue that it is plausible that today stronger IPRs may retard such transfer while strengthening "market-based" channels.[8]

The fact that copying and reverse engineering require more complex and sophisticated legal conditions might be a significant problem for developing countries; a problem whose magnitude can be realised just by recalling that most rich countries have used this mechanism as a main strategy for technological improvements and growth. For a while Switzerland, for instance, excluded all inventions in the chemical field from patentability. Such a decision was explained by the difficult position of the young Swiss chemical industry, unable to compete with German firms that had a large-scale advantage. The Swiss chemical industry adopted a strategy based on two pillars: innovation and imitation/variation. It focused on products with high-added value, especially medicines. This strategy was backed by a policy of imitation. The absence of regulations concerning patents for the Swiss chemical industry allowed the Basel firms to concentrate their resources on imitating procedures developed abroad. It was only in 1907 that a patent law worthy of the name came into being as a consequence of the industry's changing attitude. The development of the Swiss chemical firms made them increasingly dependent on innovation through their own R&D activities and less on imitation and learning by doing. Under these conditions, a patent law became important for the industry. Within a few decades, the accusation of piracy was forgotten and the Swiss chemical industry became known for the quality of its products.

What kind of catching-up and knowledge access mechanisms does the international governance system leave LDCs when copying is becoming legally more difficult? What is the alternative? And, what are the mechanisms that could replace copying? These are important questions since copying and reverse engineering proved historically to have two virtues for development.

First, it allows immediate and free access to essential knowledge. Second, it facilitates the building of productive capacities and industrial learning, as already explained in the Swiss case. Another example is the Indian Patent Act in 1970 that made pharmaceutical product innovations unpatentable, allowing innovations to be copied and marketed in India. Regarding pharmaceutical process patents, the statutory term was shortened to seven years and automatic licensing was put in place. As a result, Indian industry learned very fast: Indian firms accounted for 70 per cent of the bulk drug market. Of the top ten firms, based on 1996 pharmaceutical sales, six were Indian rather than subsidiaries of foreign multinationals (Lanjouw, 1998). Cassier and Correa (2005) made a careful empirical study of the anti-retroviral copying project in Brazil,

showing evidence of technological learning as a result of copying.

Now that TRIPS makes copying and reverse engineering more difficult, there is still the problem of devising new mechanisms to address these issues: how to preserve free and immediate access to essential knowledge for passive consumption, and how to ensure free access to technological knowledge for active contribution to incremental improvements, local innovations, and capacity building?

New evidence tends to suggest that if stronger IP protection slows down imitation in the South, this is offset by an increase of multinational activities (such as FDI), suggesting an overall enhancement of industrial development in developing countries (Branstetter et al., 2007). But while it might be true for a certain category of developing countries, it is certainly not true for the poorest. It is therefore necessary to review the pros and cons with regard to TRIPS impact on TT and to qualify these arguments for the particular case of LDCs.

3.2.2 Stronger IPRs are needed to support technology transfer

There is a well-known set of arguments based on the theoretical view that IP protection is an incentive mechanism that rewards and motivates innovative activities and as such is an indispensable component of a TT-friendly system. With some nuances, this argument is perfectly plausible and acceptable for the case of developing countries that are clearly catching-up (see Arora, 2007, for the most recent paper on this subject). It is likely, however, that such arguments do not apply to the reality of a number of developing countries and particularly LDCs.

Export and parallel trade issues would also arise with respect to goods produced under suspension of industrial design protection. Because countries protect industrial design with different legal mechanisms and because a wide spectrum of goods may be protected by industrial design, it is difficult to generalise with respect to the specific type of exhaustion issues that would be presented. If exports were to be undertaken, this would in any event be included within the calculation of the level of suspension.

3.2.2.1 Attracting foreign direct investments and promoting domestic entrepreneurial activities

It is claimed that where the IP protection regime is weak, FDI is discouraged, and that when investments do occur, they are more likely to be confined to wholly-owned subsidiaries or the transfer of older technologies. But, again, these arguments need qualifications.

First, many factors influence FDI decisions and there is little empirical evidence to support the assertion that the insecurity of intellectual property exerts powerful adverse effects on them. The fact that the type of R&D undertaken in developing countries, being less innovative, is not sensitive to patent protection must be considered here. There are exceptions, notably the chemical and pharmaceutical industries, in which the host country's IP regime does significantly effect FDI decisions and levels in R&D facilities (Mansfield, 1995). But these industries are not many. They are those where the centrality of patent as a mechanism to reward innovators has been observed for a long time.[9]

Second, as already noted, FDI by multinationals in wholly-owned subsidiaries is considered to be, at best, a somewhat uncertain channel for transferring technological knowledge and empowering the indigenous industries with technological capabilities (see above chapter 2, 2.5.1.2). Therefore, it seems more relevant to consider how the efficacy of other TT modes, such as joint venture and arms-length licensing agreements, are affected by the nature of the prevailing IP regime.

Another possible positive influence of stronger IPRs concerns entrepreneurial initiatives in the LDC itself. Entrepreneurs, like any other economic agents, respond to incentives. They will

start businesses and develop new applications of the technology if the expected private returns associated with these creative activities are sufficiently high, i.e. higher than those promised by other (less productive) kinds of business. Clearly, stronger patent laws contribute positively to private returns on innovation. For instance, securing mechanisms to capture the economic rents created by innovation will change the pay-off structure of the economy to make investments in innovation a highly profitable activity, so that entrepreneurial activities – previously developed in non-productive areas – will be ***reallocated*** to productive areas such as technology development. Alas, while this theory may apply in rich and middle-advanced countries, it will not in the case of LDCs. Many other problems have to be solved before stronger patents will start to have an impact on entrepreneurial incentives in the domestic economy. Without good infrastructure, the rule of law, and well educated people, patents alone will not do the job.

In other words, if an LDC is seeking to attract more FDI and promoting entrepreneurial activities at home, it needs to solve many difficult problems related to investment climate, efficient governance, market size and infrastructure before dealing with the patent issue. Thus, the relevant policy question is to ask at what stage of development economic and market-based incentives (such as patents) become important to incite productive entrepreneurial activities and attract more FDI.

Hall (2005) summarises this discussion as follows:

i) Throughout history, a stronger patent system has tended to be the result of technological development and the creation of firms capable of taking advantage of these systems, and not a precondition.

ii) Stronger patent rights are likely to increase payments from developing to developed countries for technology rights.

iii) International trade flows and FDI respond positively to strengthened patent rights in middle-income and large developing countries, but not in the poorest ones (Branstetter et al., 2005).

Again, the argument here concerns the *least* developed countries. Regarding a few major catching-up economies, the current alignment of national patent and regulatory systems with those of developed countries is based on the belief that such alignment is useful for attracting foreign capital and, to a lesser extent, that it might stimulate local innovation and entrepreneurships (see chapter 4 below and Abbott, 2003).

3.2.2.2 Structuring complex transaction on knowledge

One argument that has attracted attention, initially voiced by Arora (1995) involves the role of IP protection in the creation of technological capabilities associated with a transfer of technologies. The argument goes as follows: to be successful, a TT must take into account the complementary role of tacit knowledge, which is absolutely necessary to "activate" the technology in an economically sustainable way. The association of the transfer of this tacit knowledge (through technology support and training services) with the transfer of the technology itself requires the design of specific contracts. While information asymmetries and monitoring difficulties make it virtually impossible to draft efficient contracts specifying the transfer of tacit knowledge, it is possible to design contracts for the successful implementation of technologies by bundling the provision of assistance together with the licensing of the use of codified information such as patent and copyrights (Arora, 1995).

In such cases, patents play a significant role in helping to structure a complex transaction including unpatented knowledge.

If the protection for such property is weak in the borrowing country however, the originating firm is unlikely to enter into such contracts. The implication of this is clear: the would-be borrowers have an interest in a stronger IP

protection regime. This argument tells us that the South will gain from extending IP protection into its own markets by focusing on the conditions for the successful transfer of codified and tacit knowledge regarding innovations.

The argument developed by Arora (1995) is a sophisticated one. It is based on the transactional difficulties created by the fact that codified information and tacit knowledge are complementary and must be transferred together. However, this argument overlooks the problem of legal and technical capacities of the recipient country that needs, in particular, highly skilled people able to deal with complex contract negotiations.

3.2.2.3 Structuring and providing free technical information, while not impeding access and transfer "to certain countries"

Finally, "copying" as a TT mechanism is not necessarily impeded or prohibited in a strong IP environment but can, on the contrary, be enhanced in certain special circumstances.

First, it is useful to recall that in exchange for patent rights, the inventor must publicly divulge technical details of the new technological knowledge. Technical description is an essential act. It is intended to provide sufficient "instructions" for a specialist in that particular field to be able to reproduce the invention. In this sense, the patent system generates a huge repository of technical information in any technological area that can be freely used by anyone looking for information about a given technology. It may then happen that the patents providing the useful information are not valid in certain countries so that not only can the information be freely used, but also the knowledge can be reproduced and used commercially in these countries.

This is exactly what happened in Ethiopia where certain technologies were needed to develop hearing aids powered by solar energy. A search was carried out for patent documents related to hearing aids, which enabled the retrieval of a number of interesting documents. Detailed analysis revealed that all these documents related to patents that did not protect the disclosed inventions in any African countries. Therefore, the published patent documents contained technical information that could be freely used in Africa for solving technical problems, and the disclosed devices could be freely manufactured and distributed in Africa (Corsi, 2007).

This case exemplifies an ideal situation in which the IP system provides a strong mechanism to structure information and increases the productivity of information search, while not impeding access to the knowledge once retrieved. It is important to know whether this case represents a general pattern – i.e. there are many granted patents for which the applicants have no interest in the African markets and consequently will never apply for corresponding protection – or whether it is quite exceptional.[10]

There is therefore an obvious need for international collaboration to establish IP information systems and clearing houses. Such a system could greatly reduce the cost of patent searches by developing countries. There are already a few examples of internet-based patent databases that enable a user to easily access and analyse published patents and patent applications from many countries (Byerlee and Fischer, 2002). This mechanism, sometimes called "unilateral access" has a number of limitations however, even when it is strictly legal (ibid.).

3.3 Markets For Technology: Are They Really Efficient?

In an ideal world where all entities are at the same level of technological advancement, it can be hypothesised that the technology market, based on a strong and respected IPRs system, offers a very effective mode of TT. This is Baumol's theory, supported by empirical evidence from Arora et al. (2001): IP creates transferable rights and can also help to structure complex market transactions involving technologies.

Baumol (2002) argues that firms are remarkably quick to transfer their technologies, which can

be explained by capitalist incentives as well as the efficiency of markets for technology. Under (theoretically) simple conditions, an equilibrium price will emerge where both firms – buyer and seller – will be better off after having carried out the transfer; markets work, knowledge transfer occurs. The very simple condition is that the buyer is a more efficient user of the technology than the seller. The buyer's superior efficiency means that it can earn more from its use of the technology than the owner. Thus the buyer can still make a higher profit than the owner would be able to earn by using the technology itself, even if the buyer pays a somewhat costlier licence fee. Since TT through market transactions provides a means of obtaining a sufficient reward from innovation, if the price is right, it will pay the firm to permit others to use its technology.

Such conditions are not likely to occur in the case of TTs involving very heterogeneous systems. No equilibrium price will emerge and it is not easy for a profit-seeking organisation to engage in such an operation if the profit potential is very low, or even zero.

And even in a homogeneous world in which all firms are equally technologically advanced, markets for technology as a vehicle for TT do not work that well. In a convincing paper based on recently collected evidence, Cockburn (2007) argues that it is difficult to think of any other market that has as many failures. There are many obstacles to licensing, including that:

- Knowledge-based transactions are costly and complex;
- There are many "missing" markets for specific technologies (difficulty in finding appropriate licensees);
- Reaching agreements regarding price and other conditions is difficult; and
- Operating managers are reluctant to sell technologies.

As a result, a large fraction of the total IP inventory appears to be un-licensable under any circumstances; an average of over one-third of a firm's total IP inventory is considered unlikely to be licensed, despite the firm's willingness to license its technologies. These obstacles impose two major types of disadvantages:

- "Unrealised deals," which mean an underutilisation of IP on the markets; and
- Wrong prices for technologies, leading to poor outcomes.

The markets for technology are therefore inefficient. Such inefficiency is even greater when the market is placed upstream of the innovation value chain (i.e. when transactions involve research tools, scientific information, etc.). Baumol's ideal world (in which markets for technology work well and knowledge disseminates widely and quickly through this mechanism) does yet not exist – and perhaps never will.

3.4 A Fundamental Asymmetry

Stronger IP protection systems create a fundamental asymmetry when a proportion of agents are "IP-users-only." In a rich country or region, this situation is not likely to happen (or only marginally so) and a stronger IPR protection system will not generate asymmetry. Each entity is a potential IP producer and IP consumer so that both will receive some further benefits and bear additional costs. The only exception concerns the final consumers who, by definition, are not IP producers or holders.[11] This non-asymmetric world is not the case, however, when the global world is considered: a large proportion of potential patent users have no capacity to produce IP so that the costs and benefits of the strengthening of the IP system will be unequally distributed.

3.4.1 TRIPS in an asymmetric world

In a multi-country world, the cost to one country of introducing patent protection depends not only on the size of the deadweight loss but also on who is doing the inventing. If the newly available patent rights for drugs in an LDC are entirely assigned to inventors elsewhere, the loss of consumer surplus is a net cost to the LDC. All the profits accrue to foreign nationals in the form of royalties. Thus, static costs to a country introducing patent protection in a multi-country world may be higher than the standard one-country model would suggest (Lanjouw, 1998).

The table below summarises the static and dynamic costs and benefits resulting from a stronger IPR system.

Table 3. Costs and Benefits of a Stronger Patent System

	Static	Dynamic
Cost of stronger IPRs for country X**	Knowledge is bought at monopoly price (above marginal cost) leading to a loss of welfare (which can be dramatic in LDCs)*	Barriers to access modifiable technologies (as base for learning) are increasing
Benefits of stronger IPRs for country X**	Knowledge is sold at monopoly prices and companies in X can capture the economic rents	The pay-off structure (incentives) of the economy changes so that entrepreneurial activities become more profitable. Foreign capital (R&D) is attracted

** The cost of building a legal system is not considered here, although this can be very high in a country where such a system does not yet exist (or is performing badly)*
*** This table applies indifferently to developed and developing countries*

As far as *static* cost and benefit are concerned, an LDC that has "nothing to sell" will not benefit from the strengthening of the IP system, while it will bear the high costs of making certain essential knowledge inaccessible to large fractions of the population.

As far as *dynamic* cost and benefit are concerned, the new system impedes learning by increasing barriers to access technological components and modules for those who cannot afford to buy technological licences. The benefits are clearly significant for catching-up countries that already have a class of entrepreneurs and innovative companies likely to respond positively (in terms of investments) to a stronger IP system. They are negligible for LDCs, however. Indeed, it is an illusion to think that the mere manipulation of incentives (such as creating an IP system) will suffice to motivate the development of entrepreneurship and innovative activities in the poorest countries.

Using a general equilibrium model framework with two regions (the North and South), Angeles (2005) shows that the effect of strengthening IP protection in the South has a positive effect on the increase of world innovation, but this does not come without costs. Higher prices for consumers in the South are the negative side of this policy. The South may suffer a net welfare loss if its productivity is very low in relation to the North, which is clearly the case of the LDCs.

Table 4 below presents absolute numbers of patent applications by residents and non-residents in LDCs and shows that these asymmetric relations are likely to be amplified in the near future.

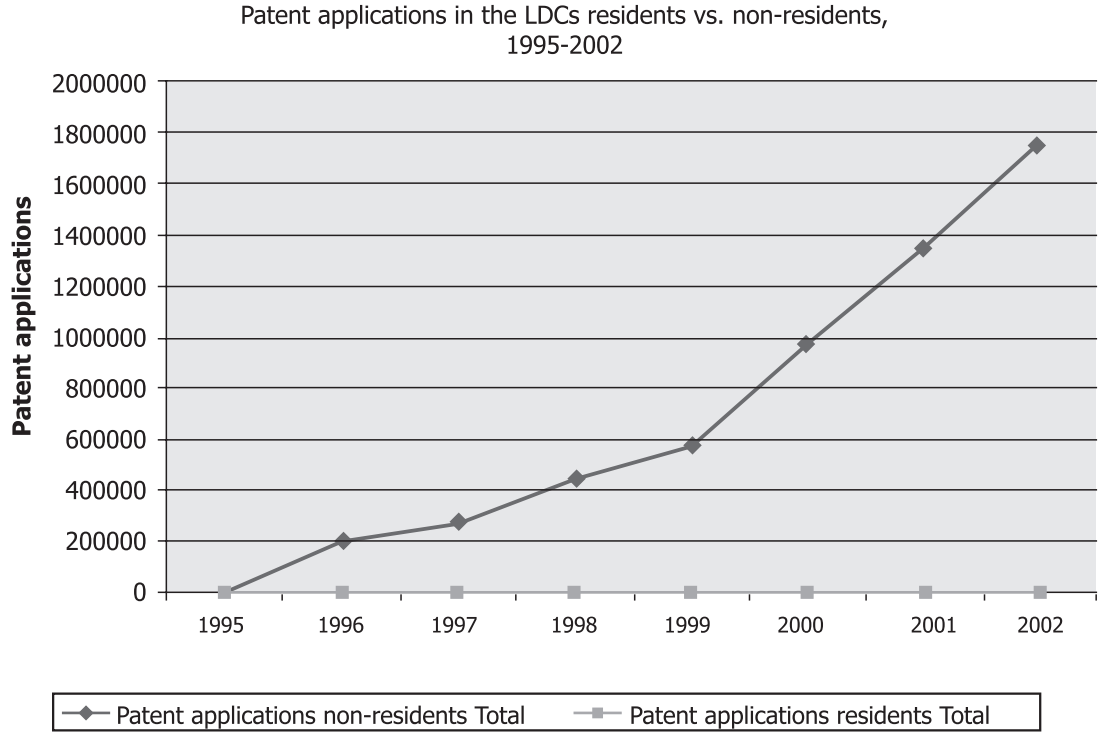
Table 4. Patent Applications by Residents and Non-residents in LDCs

	Patent applications by non- residents	Patent applications by residents
1995	172	73
1996	195 116	27
1997	261 141	6
1998	449 616	70
1999	570 676	18
2000	978 409	18
2001	1 352 635	23
2002	1 753 699	6

Source: WIPO, 2006
Resident applications are those for which the first name applicant or assignee is a resident of the state or region concerned; Non-resident applications are those from applicants outside the relevant state or region.

The table above not only illustrates the strong asymmetric distribution of costs and benefits as produced in a global patent system, but it also shows very worrying trends: while the growth of patent filings by non-residents has been continuous and significant since 1995, patent filings by residents show no such trend. No growth (even at a very low rate) is perceptible, meaning that the impact of TRIPS on incentives and the ability of domestic and local entrepreneurs to patent, are negligible. As a result, the asymmetric distribution of costs and benefits is likely to intensify in the near future.

Figure 2. Patent Applications in the LDCs, Residents vs. Non-residents, 1995-2002



Source WIPO: 2006

TRIPS works like an electric conductor. When it is set up, any failures occurring somewhere (in the rich countries) will place the whole system at risk. In other words, TRIPS means that LDCs are not immune to – and in fact are extremely exposed to – the negative excesses of the patent system in rich countries. In others words, such excesses, which are the manifestation of a problem of pure bad governance of the system in the rich countries, impose costs and blockages not only in the countries responsible for these excesses, but also in any country that is signatory to the Agreement.

Secondly, in an era of global integration, countries are not immune to repercussions from the (IPR strengthening) policies of other countries (Hall, 2001). The strengthening of IPRs in rapidly catching-up economies creates a negative externality for LDCs (reducing the incentive for innovative activity in LDCs by both attracting R&D to move within its borders and raising the costs of follow-on invention elsewhere).

So TRIPS is not a magic solution for promoting TTs in LDCs. For LDCs, as far as IPRs and patents are concerned, the correct policy orientation should be to place more emphasis on protecting these countries from the potential collateral damage likely to be caused by IP protection strengthening, rather than using IP protection as a positive market incentive to support entrepreneurship and attract FDI. Indeed, not only does TRIPS not solve development issues, it also creates new problems for LDCs.

3.4.2 One size does not fit all and the need for flexibility in patent and copyright systems

The fact that the costs and benefits of a stronger IPR system are unequally distributed in a multi-country system and that the less advanced countries will bear high static and dynamic costs while not enjoying any benefit (at least in the mid-term) creates a strong case for adapting the system to particular socio-economic contexts. A one-size-fits-all principle would be suboptimal where countries' heterogeneities are concerned. As discussed in the 2002 Report of the UK Commission on IPRs, one size does not fit all. The poorest nations clearly need some flexibility as well as ad hoc mechanisms to solve their access and knowledge production challenges.

Strong arguments against this one-size-does-not-fit-all position have been developed and are worth considering. The most relevant arguments against this principle, however, do not deal with differences between countries but differences between technologies. Indeed, Jaffe (2005) argues that while it is relatively easy for economic theory to demonstrate that optimal patent design should differ significantly across technological areas and industries and that optimisation is achievable in a purely theoretical world, a strong case can be made for not opening this particular Pandora's Box. Efforts toward some kind of fine-tuning according to technological heterogeneities will ultimately fail and are likely to weaken the patent system. Indeed, the theory identifies certain features of a technology that make strong or long patents less desirable (for example, the cumulative nature of some technological knowledge, or its importance and generality). However, it is extremely difficult to identify these features in particular technologies (this is a matter of degree and not clear categories). Even if in principle the applicability of patents based on such analysis of intrinsic technological principles could be restricted, it is likely that – in practice – such efforts would fail. Drafters of patent applications will always prove more ingenious than writers of patent rules. Thus, prescribing patent protection for certain classes of technology will simply force applications to be written in such a way that they appear in other classes. These strong arguments against the principle of one-size-does-not-fit-all do not apply, however, when heterogeneity concerns not technologies but "socio-economic" contexts.

The argument is well expressed by David in an unpublished paper, in which he states:

> Historical studies reveal that although patents, copyrights, and legal protection

> of trade secrets are recognisable institutions familiar in western societies for centuries, policies bearing upon the protection accorded to intellectual property and the juridical-institutional arrangements used to implement them have been mutable things, adapting over time and across societies to the perceived needs and advantages of interested parties. The adaptations of the IPR systems have occurred within the historical context of other, related, institutional arrangements affecting the costs and benefits of maintaining specific IPRs. An implication of this observation is that externally-dictated efforts to achieve national compliance with a uniform international regime of IPR protection are almost bound to occasion conflict and controversy. Even where it is possible to argue that a new IPR regime could be constructed that would be Pareto-improving for the countries involved, the need to align domestic and international laws introduces additional constraints that tend to render such solutions impractical. **As a result discussions on the 'correct' international system to protect intellectual property are more likely than not to degenerate into rhetorical efforts to impose institutional arrangements that may well be adapted to the national purposes and the domestic legal contexts of one country (or several similar countries) upon societies that are quite different in those respects.**

Two types of flexibility should be particularly scrutinised: the internal flexibility offered to countries by TRIPS to limit (or extend) exclusion rights, and an external flexibility, which mainly consists of using the power of legal institutions to reconstruct research and information commons and support open-source initiatives as a way of mitigating the adverse effects of a highly protectionist IPR environment and promoting low cost TT models in LDCs (see section 3.5, below).

Fully exploiting the scope of TRIPS flexibility in one sense or another (limitations to or extension of exclusion rights) is a crucial issue.[12] But exploiting the autonomy left open to LDCs by TRIPS not only raises questions about the legal rights to do so, but more importantly about the technical capabilities to use the opportunities offered by the system in the best interests of the knowledge ecology of LDCs.

3.4.3 Learning to use flexibility: a role for national patent offices

TRIPS clearly offers some degree of autonomy to LDCs. However, having these provisions available is a different matter than being able to apply them effectively.

Firstly, as already mentioned, there are cases where LDCs formally renounce their use as a condition for obtaining further trade advantages through bilateral agreements.

Secondly, these mechanisms are difficult to implement and sophisticated knowledge and skills concerning law and international agreements are needed. This is why a TRIPS provision involves the obligation for the developed countries to provide bilateral technical assistance to LDCs that request it (see Article 67). Recent experiences have clearly demonstrated however that developed countries provide valuable help in establishing the appropriate measures to strengthen IPR protection in the country considered, but do not extend that help to the use of mechanisms like compulsory licensing (Kostecki, 2006). For example, the US IPR training coordination group, which exemplifies the application of Article 67 by the US, is dominated by private firms and only focuses on strengthening IPR systems in the less advanced countries. "NGOs and academics with the knowledge and expertise to redress the balance by highlighting the scope for TRIPS flexibilities alongside issues of protection and enforcement of intellectual property rights are excluded from the US

IPR training coordination group altogether" (Matthew, 2005).

There is certainly a role for national patent offices to create political awareness that these mechanisms are critically important for performing TTs in LDCs and, therefore, should not be regarded as bargaining chips in trade agreements. Another role for national patent offices is to build and maintain the legal skills essential for using these mechanisms effectively.

3.5 Beyond IPRs: the New Knowledge Economy Paradigm

Any analysis of the relationship between IP policies and TTs in the twenty-first century should not neglect the fact that the innovation process itself has changed: there is a degree of innovation within the process of innovation (Ghosh and Soete, 2006).

The old model of innovation was based on a relatively clear dichotomy between those with the capacities to discover new technological principles and those without such capacities. In such a model, TTs were dedicated to helping the latter upgrade their technologies, while the former did not expect any retro-spillovers from TTs and the incentives to promote TTs were designed accordingly. The new model is one in which rapid collaborative processes for incremental innovations based on free access create multiple sources of new knowledge, leading to more efficient and faster technical innovation, with the entrepreneurial risks of innovation widely spread.

The idea is to use open-source licensing to keep discoveries freely available to researchers and eventually manufacturing. What seemed unfeasible a decade ago appears possible today thanks to the greater size and variety of chemical, biological and medical databases, new software and more powerful computers (Maurer et al., 2004). All these features have strongly enhanced the productivity of collaborative efforts to rapidly develop knowledge and products in certain fields.

Today, technological changes make it possible to extend open-source mechanisms far beyond the field of software where this model has proved to be remarkably successful in generating a high rate of innovation and reliable products at very low costs. This is the case of drug research, for example. The rise of *in silico* biology has dramatically lowered the cost of conducting useful drug research. It blurs traditional distinctions between drug discovery, academic database production, and open-source. Common features include (Maurer et al., 2004):

- Community-wide collaborations that produce scale and network effects (the scale of the problems requires many contributors);
- Loose, non-hierarchical groups working together to perform complex tasks and create specific products;
- On-line collaboration, which dramatically increases the productivity of collaborative research; and
- Unpaid volunteers who contribute to such projects for a host of reasons, including idealism, learning new skills, gaining reputations, and impressing potential employers.

Open-source discovery beyond software would operate like open-source software projects. There is no reason not to expect similarly positive results in terms of cost effectiveness and innovation performance.

The main advantage of open-source is that it is likely to reduce the total life cycle cost required to get the job done. Cost effectiveness is based on the fact that such projects do not offer financial incentives but create proper incentives for voluntary contributions. A second reason for cost containment concerns the absence of patents and above marginal cost pricing.

Innovative performance is a second advantage. It is related to the expected productivity of such projects, which in turn is related to rich

spillovers that are created *de facto* in an open-source environment.

Last but not least, the most important enabling feature of this model is **access**. TTs are interactive and reciprocal. In this paradigm, providing access to technologies and knowledge should not be seen as charity or aid, but as a necessary step to enlarge the resource base of potential innovators, i.e. a way to increase efficiency at system level (Ghosh and Soete, 2006).

As argued by Maurer et al. (2004), no known scientific or economic barrier bars the way for open-source discovery and collaborative models of TT.

4. CURRENT TRENDS IN TECHNOLOGY TRANSFER

This section analyses recent data about technology diffusion and TT toward developing countries to determine whether the various TT mechanisms (shown in chapter 2) are used effectively by countries; the extent to which those mechanisms play a role as an engine for growth; and if there is any need to reconsider the general dominant policy that is based on the premise of the centrality of FDI and trade as TT mechanisms. The recent World Bank report offers a complete set of data that will be used below, with a focus on technology diffusion.

4.1 The World Bank Framework

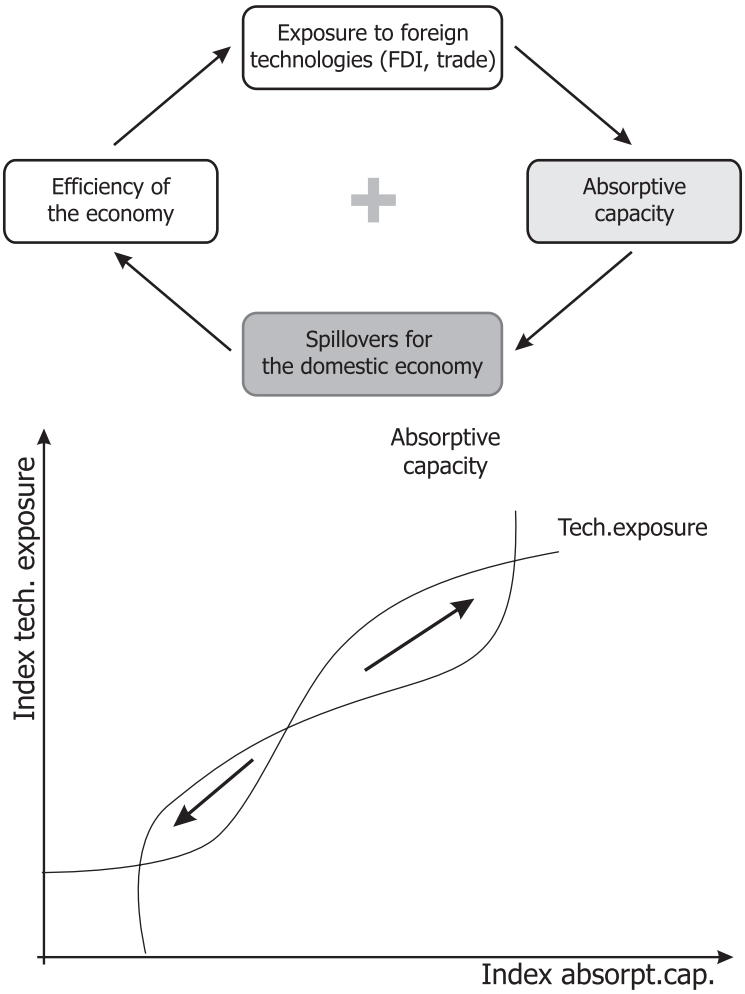
There are two fundamental determinants of technology diffusion in the LDCs that the World Bank places at the centre of its framework of analysis. The first determinant involves the three main channels by which developing countries are exposed to external technologies. This includes trade, FDI (and licensing that can be used as a substitute for FDI), and highly-skilled diaspora.

The other important determinant of technology diffusion is the absorptive capacity or technological adaptive capacity of the country. Proper policy actions that create improvements in governance, the business climate, human capital (increase of basic technology literacy), technological capacities of firms, and access to credit on capital markets (innovation policy) increase this capacity.

These two determinants are interrelated and create externalities to each other, thereby forming a dynamic system with positive feedbacks; they generate multiple equilibriums through virtuous (or vicious) circles (see e.g. Stiglitz, 1991). Such systems are well known and well studied in the literature of economic development.

For example, the fact that a country becomes more exposed to foreign technologies (through the increase of FDI) may actually increase returns to additional improvements of absorptive capacity. And the fact that the absorptive capacity is improving in turn increases the probability of spillovers being diffused within the domestic economy. As a consequence, the overall efficiency of the economy is increased, which positively influences FDI in the country. As for any positive feedback system, there are virtuous circles (taking the structural form of what has been just described) but also vicious circles (Figure 3).

Figure 3. Positive Feedback Systems, Virtuous and Vicious Processes



4.2 Virtuous Circles

The basic message of the World Bank report is that many developing countries – notably middle-income countries – have entered a virtuous circle: the basic components of the feedback system described above are mutually improving each other. The increased exposure to foreign technology (through FDI and trade) is co-evolving with the growth in dissemination and spillovers of these technologies within the domestic economy. As such, by many measures, these countries have made outstanding progress in technology diffusion. The main indicators of such trends involve:

- The rising share of high tech and capital goods imports;
- The expansion of exports of technological goods;
- The increase of FDI as a percentage of GDP, as well as the increase of FDI as a percentage of fixed capital formation; and
- All these trends leading to the overall increase in exposure to external technologies index.

Therefore, it appears that for these countries, trade and FDI are the main channels for accessing foreign technologies; TTs as a *joint product* work well, while absorptive capacities are sufficiently positive to allow spillovers from the technology to be transferred to the rest of the economy. Good policies and governance remain of course central. This involves keeping FDI and trade at a high level and continuously improving the absorptive capacity.

This trend is consistent with evidence on the positive relation between IPR reform and the stimulation of TTs in middle-income countries. The recent study by Park and Lippoldt (2008) finds that stronger patent systems tend to be positively associated with inward FDI and trade, and the strength of the patent system is positively and significantly associated with TT (i.e. the inflows of high tech products, like pharmaceutical goods, chemicals, aerospace, computer services, information, and office and telecom equipment). It is also consistent with recent empirical evidence produced by Branstetter et al. (2007), which suggests that due to IPR reform, increased multinational activity in developing countries is sufficiently high to offset potential declines in imitative activity, suggesting an overall enhancement of Southern industrial development.

4.3 Vicious (or Non Virtuous) Circles: the Case of LDCs

Unfortunately, in the case of low-income countries, things do not happen as described above. Empirical evidence suggests that the various channels by which countries are exposed to foreign technologies are far less powerful. FDI remains at a very low level (less than 1 per cent of GDP) and the share of FDI in low-income countries capital formation is low as well. In addition, the ratio high tech product import/GDP is also low – LDCs remain marginal players in the world market for high tech goods. Finally, having a licensing-based strategy to acquire technology to complement or substitute FDI is not proven to be efficient due to the lack of capabilities both in technological and legal terms and the inefficiency of technological markets, particularly in case of transactions between heterogeneous players.

Least developed countries have not succeeded in improving their absorptive capacities, which limits the potential for the improvement of foreign technologies to strengthen the domestic economy. How these countries make use of foreign technologies is qualified by the World Bank as a "passive approach and limited effort to leverage the technology imported by foreign firms operating on their soil" (World Bank, 2008).

So not only has the exposure to foreign technology not increased that much through FDI and trade, but the extent to which these economies have benefited from this exposure is limited by weak capabilities. As a result, the gap between middle-income and low income countries is widening. This is seen, for instance, in terms of the share of capital goods in GDP.

What works in middle-income countries – TT as a *joint product* of main economic operations involving FDI and trade – does not work well in LDCs. This argument leads to one of the main messages of this paper:

In the case of LDCs, the number, scale, and domains of TTs cannot be allowed to depend on general economic operations such as FDI or infrastructure construction; neither can they take the form of market transactions alone (licences). In all these cases, the particular circumstances and conditions prevailing in LDCs imply a suboptimal level of TT in relation to the needs of these countries.

Therefore, augmenting FDI to emulate the successful model of some middle-income countries cannot be the only policy response. First, it is a long-term issue.

Second, as already mentioned, TT as a *joint product* of FDI raises a "balancing incentives problem;" a problem that is likely to be properly solved in the case of middle-income countries but not in the case of LDCs. Let me discuss an example to illustrate the last point. Chapter 2 discussed both the advantages and drawbacks of FDI as a TT channel. The drawbacks involve the fact that decisions concerning most aspects of TT remain in the hands of the foreign investors and as a consequence there are doubts about foreign investors devoting sufficient resources and time to the learning process. For example, foreign investors are likely to have little incentives to initiate a shift in responsibilities for technological adaptations to local suppliers or staff, preferring instead to delay the

replacement of expatriates. This prevents the learning process from taking place. Now these drawbacks are clearly mitigated in the case of countries with stronger absorptive capacities and thus these countries rightly rely on FDI to operate TTs. But as absorptive capacities are low, the FDI's drawbacks are not reduced. In the example above, the cost of increasing capabilities so that at some point local staff can replace expatriates can be so high that the foreign investor will not consider this replacement as an economically viable option. In the case of LDCs, TTs cannot only be a *by-product* or *joint product* of another kind of economic operations. Incentives are likely to be strongly imbalanced between making the investment operational and effective, and succeeding in TT and learning. The other policy response is to provide additional incentives to undertake projects in which TT is the *main operation*.

There is therefore an economic rationality for specific projects in which the TT is the primary operation (an economic project in itself, not linked with another economic operation), but entails a very low expected private profitability for the technology-owning firm. Such a prospect would involve acknowledging the existence of TT operations with far smaller commercial returns or no commercial return at all and finding operational mechanisms to incentivise these firms to sink costs in these operations. Such a strategy obviously requires the provision of additional incentives.

5. THE ECONOMICS OF PUBLIC–PRIVATE PARTNERSHIPS FOR TECHNOLOGY TRANSFERS BETWEEN DEVELOPED COUNTRIES AND LDCS

This study has shown that there is an obvious economic rationale for specific projects in which TT is the primary operation (an economic project in itself not linked with another economic operation). TT as a *main operation* provides opportunities for shifting the locus of decision to "local agents." This would affect the modes and quality of learning, technology transfer and the choice of the area to be concentrated on. In contrast with TT as a *joint product*, TT as a *main operation* offers an opportunity to prioritise some domains.

But TT as a *main operation* is costly when the recipient has weak capabilities. This is due to the cost of building capabilities and supporting absorption, adaptation, assimilation of subsequent improvements, and the generalisation of the technology in a system exhibiting low absorptive capacities.

Given these arguments, private firms that hold the technology cannot realistically be expected to find sufficient market incentives to invest in this activity at the socially desirable level any more than governments of rich countries can be expected to force companies to do so. Without additional incentives, TTs carried out with LDCs would mainly be the result of more general economic operations, such as FDI or the construction of infrastructures. In all these cases, TT is at best a *joint product* (or even *by-product*), which is therefore dependent on the *main operation*.

Incentivising foreign firms to enter such transactions is an opportunity for developed country governments to properly fulfil their obligations as contained in Article 66.2 of TRIPS. In somewhat vague terms, Article 66.2 calls for the provision of additional incentives for developed country firms and other organisations to undertake TTs to LDCs.

This section provides some recommendations on the best approach for developed countries to fulfil their obligations in this domain. It also discusses the centrality of "specialised agents" (PPPs) to ensure both the effectiveness of governments' interventions and the efficiency of the TT operation.

5.1 The Economic Rationale of TRIPS Article 66.2: the Potential and Limitations of Incentives

Article 66.2 of the TRIPS Agreement asks developed country members to provide incentives to their enterprises and institutions for promoting and encouraging transfer to LDCs. This is indeed an economically valid prescription as argued above. However, many obstacles and limitations impede the ability of governments to influence firms' decisions regarding the undertaking of TTs with LDCs. In its report, the European Community (2007) acknowledges the difficulty of putting Article 66.2 into practice. Some issues that it notes are:

- The private and commercial sector is clearly the main source of technologies, and in this context, TT is often one component of a more complex project, rather than a stand-alone activity;
- In their efforts to encourage and promote TTs, governments are limited by two factors: they do not own the vast majority of the technologies and they cannot force the private sector to transfer its technologies;
- Government incentives to undertake TTs to LDCs are only one of many factors relevant to companies' decisions on where to direct FDI and TTs. Other factors like macroeconomic stability, a safe legal framework, and a well-functioning government administration are also important drivers;
- Incentives can only take the form of encouragement, promotion, and facilitation of the most fruitful projects.

Against this background, the report considers that the following incentives are relevant and must be activated by governments:

- Promotion of projects such as FDI, subcontracting, licensing, franchising;
- Improvement of access to techniques and industrial processes;
- Support of joint projects;
- Provision of training in management of technology and production methods;
- Improvement of absorptive capacities; and
- Encouragement of trade in technological goods.

5.2 Historical Precedents: Both Incentives and Specialised Agents in PPPs Matter

There are historical precedents showing that the manipulation of incentives in an area of low private profitability can profoundly change the strategic behaviours of economic agents. The reader must understand that the following example does not directly concern incentives to undertake TTs. Rather, it shows that it is possible to create sufficient incentives and contain costs in an effective way so that private companies commit resources to projects initially characterised by low profitability expectations.

While the usual approach had been to estimate the minimum level of commercial profits and then supplement low developing country purchasing power with large market pull incentives (advanced purchase commitments), the newer approach is to recognise the existence of R&D operations with far smaller commercial returns (for small business) or no commercial return at all (but no loss) for large companies and to find operational mechanisms to incentivise these firms to sink costs in these operations. But such a strategy requires strong cost containment mechanisms. As argued by Maurer et al. (2004), the failure of Western governments and pharmaceutical companies to cure developing country diseases is almost entirely about cost. It is therefore reasonable to assume that the mechanisms presented below can break the impasse and help to support R&D investments addressing neglected needs.

The evidence is striking. Over the last four years, the number of neglected-disease drug projects has increased significantly. As Moran (2005) put it, there were 63 neglected-disease drug projects under way at the end of 2004, including two new drugs at the registration stage and eighteen new products in clinical trials. Assuming standard attrition rates, these projects would be expected to deliver eight to nine new neglected disease drugs within the next five years, even if no further projects were commenced after this time. But new projects have been launched since the end of 2004, amplifying a trend that leads to deep-seated structural change in the economics and organisation of neglected disease R&D.

Commitment to such R&D by for-profit companies that are constrained by shareholders' values should not exist (according to economic theory), but it does. As Galileo is said to have murmured after officially recanting his statement that the Earth moves around the sun: "and yet it moves!".

Moran (2005) argues that such an increase in "non-profitable R&D" addressing the neglected needs of LDCs indicates deep-seated structural changes. Three main characteristics are observable:

- Multinational companies work on a non-commercial basis – that is, they are not motivated by commercial returns for this kind of project and agree to provide the final products to poor countries at not-for-profit prices. Long-term business considerations include reputation effects, corporate social responsibility, ethical concerns, and strategic considerations, such as the growth potential of LDC markets in the long run. One important change that helped these companies undertake these strategies was moving upstream to the less expensive and more

innovative drug discovery stages, allowing them to maintain costs and resource inputs at levels more acceptable to shareholders.

- Smaller scale commercial firms do not abandon the idea of profit-making from their projects but are motivated by far smaller commercial returns than large companies. They see LDC markets as sufficiently attractive to warrant some positive returns, although not at a rate that would be required by larger firms or external investors.

- Public-private partnerships. None of the commitments from the large MNCs and smaller businesses would be possible without the contribution of PPPs. In the case of large companies, PPPs facilitate further development by subsidising clinical trial costs and etc. The intervention of PPPs is critical to sustain this "no profit no loss model," which allows large companies to participate in neglected disease research while still protecting shareholder value and manufacturing. It also enables them to distribute final products to developing country patients at no mark-up. In the case of smaller businesses, these companies need substantial PPP support, including full cost coverage and significant skills input. Thus PPPs seem to be the critical institutional innovation for new models of research, something that seemed impossible (because it was unprofitable) some years ago.

But the operational role of PPPs goes far beyond targeting funding at ad hoc R&D projects. PPPs play a role in coordinating and assembling dispersed resources that gain value through their association.

The very economics of R&D in certain fields tells us that R&D investments constantly generate excess capacity. This is due to indivisibilities of R&D investments (you cannot invest below a certain threshold and this applies to both physical and human resources); and patent races phenomena that may lead either to overinvestment in R&D or the proliferation of IPRs – not all appreciated by firms in the context of the patent race considered.

The context of excess capacity is a structural feature of the economic organisation of R&D based on certain characteristics, such as minimum efficient scale, lumpiness, and indivisibility, as well as incentive structures, like patent races.

While some of these resources can be sold on a second-hand market, the role of PPPs is to create a feasibility space for social sharing rather than requiring a model of second best pricing, and reallocate these resources efficiently (i.e. to socially useful projects). While indivisibilities, overinvestment, and the generation of profusion of IP (through patent races) generate challenges for efficient pricing, they also create conditions in which new institutional machinery is likely to provide a more efficient framework to supply and exchange those goods than would the price system.

5.3 Public–Private Partnerships for Technology Transfer

As pointed earlier in the paper, the complexity and difficulties of TT operations as supported and incentivised by governments of rich countries make it necessary to use "specialised agents" that have accumulated experiences in TT's operations.[14] The essence of a public-private partnership – to put this institutional mechanism in contrast with the more usual "public funding of private initiative" kind of arrangement – resides in **the involvement of a third party, which is specialised in linking public donors, private firms, and local entrepreneurial activities to ensure the effectiveness of the operation**. The third party is a not-for-profit organisation whose objective is to efficiently manage public or philanthropic funding. As a general statement, the PPPs will establish the link and make it operational and effective between the public donor, a private company that holds the technology, and local demand.

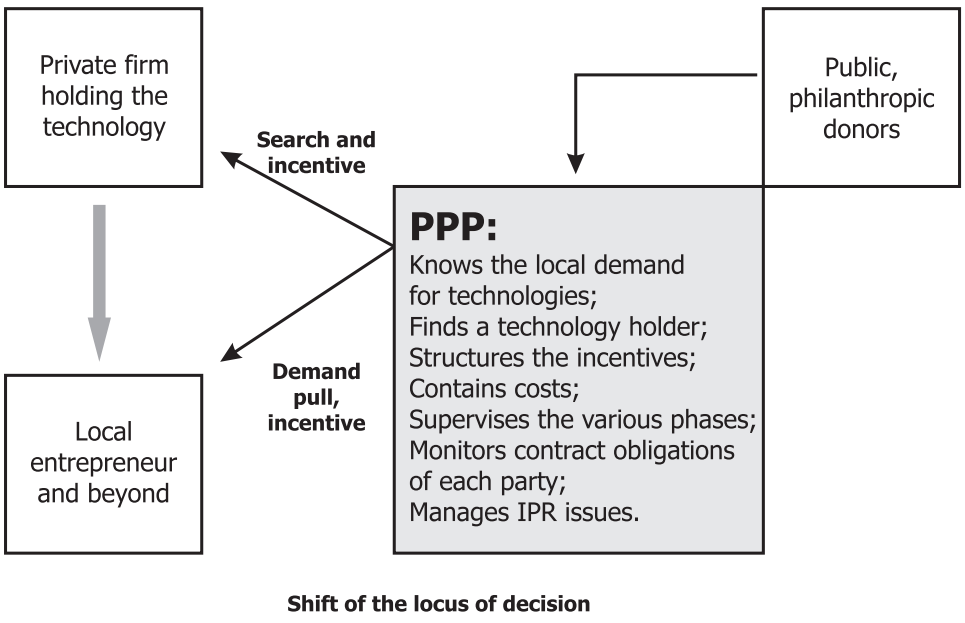
5.3.1 The essence of a PPP: the functional role of a third party

As a specialised entity, the PPP will compensate **for the critical deficit of institutional mechanisms both in the LDC and the developed country,** which are needed to address problems arising from the management of a TT as a main operation (see Figure 4). The PPP will:

- Make sure that the whole process is "demand pull" (i.e. an area or field of TT that clearly matches a local entrepreneurial need) and create the proper incentive structure for the local entrepreneurs to engage resources in the project;
- Target the appropriate partner (technology holder) and generate the incentive to involve it into the transaction;
- Create the proper conditions to contain costs – a crucial condition for increasing the anticipated private profitability of TTs;
- Generate the proper organisational forms (internal and external, i.e. platforms) to ensure the TT will successfully meet the different phases (absorption, adaptation, assimilation of subsequent improvements, generalisation), since there is no "superior" economic operation that will provide the organisational structure, such as when the TT is a *joint product* of a direct investment;
- Supervise the whole process so that the various phases of the TT are successfully managed;
- Create mutual contractual obligations so that no party can leave the project before its completion; and
- Last but not least, manage the IPR side.

As already argued (chapter 2, 2.5) the locus of decision-making with regard to undertaking the TT in a certain field and under specific conditions is also an important variable *when* TT is the main operation. In circumstances where TT is the main operation, the locus of decision-making should not be kept in foreign assistance bodies but transferred to local government initiatives and entrepreneurs. PPPs will be central in managing such a shift.

Figure 4. Functions and Role of a PPP as TT Operator



5.3.2 Supply side: "right" technology holders?

Are there any "model of firms" in developed countries that might be more capable than others to enter such operations of TT toward LDCs, given the constraints mentioned above (disarticulated system, weak capabilities, low affordability of the potential clients")? If the answer is yes, one role of government policy is to identify and enrol those firms into TT's projects.

Arora et al. (2001) developed interesting case studies of specialised technology suppliers in the chemical industry. They studied how the development of specialised upstream technology suppliers in developed countries improves technology access and lowers investment costs for downstream firms in developing countries. Testing this idea they showed that investments in chemical plants are greater in developing countries where the number of technology suppliers that operate in developed countries is greater. According to the authors, what matters is therefore the vertical organisation of the industry in the developed world. That is, investment is taking place earlier and more rapidly than if developing countries had to rely solely upon chemical producers in the developed world to transfer the technology. The mechanism is quite simple: specialised suppliers develop technological capabilities that are then sold to downstream firms. Because the expertise and the technologies developed are process (and not location) specific, they can be made available to downstream firms in other countries. Moreover, competition between suppliers implies that the expertise and the technology will be made available to prices close to the marginal cost of transfer. The economic logic of this story is therefore that the fixed cost of developing the technology is paid by the industries or countries that emerge earlier, while the industries or countries that come later pay only the marginal cost.

As a consequence of a certain stage of vertical disintegration of the industry, the presence of independent suppliers that do not produce the downstream product is important. Downstream producers (chemical firms) are less likely to sell technology to potential competitors (located in less developed economies). Thus, specialisation and division of labour can have a benefit for industrial growth – that is, the ability and interest of independent suppliers to operate TTs while not undermining their competitive position.

Given this result, governments should not randomly screen the entire firm's pool of rich countries to identify potentially reliable partners able and willing to take part in TT's operations. Rather, there is the critical task of identifying the right firms that are naturally and logically adapted to this kind of operation.

5.3.3 Prioritising

Domains to be prioritised by governments in their effort to comply with Article 66.2 obligations involve two basic criteria:

1. **Domains where additional incentives are actually needed**. There are domains where market incentives are sufficiently high for motivating foreign firms to commit resources; and

2. **Domains where there is clear demand for technology from local entrepreneurs**, who then are incentivised to develop innovation projects to suit local needs and markets and are likely to generate spillovers more easily captured by the local economy (more easily than those spillovers generated through FDI and the production of knowledge for global markets).

To summarise, prioritisation undertaken as a response to the 66.2 provision should emphasise domains that correspond to a certain model of innovation, which is central to LDCs: locally-oriented innovations addressing local needs through local entrepreneurial activities that allow the country to develop absorptive capacities. These domains are important for

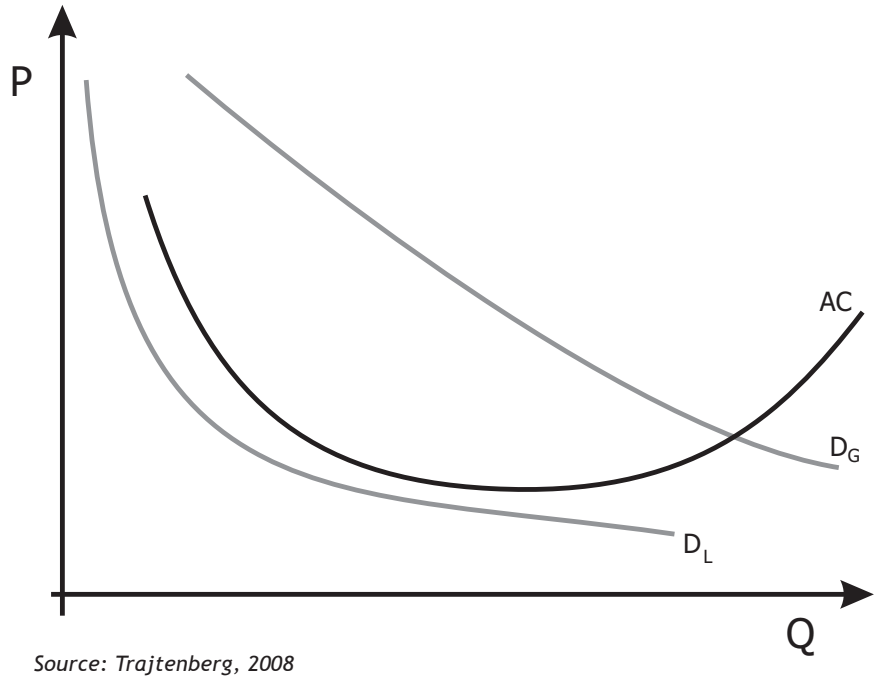
growth because the spillovers generated in the course of such projects are likely to be captured by the *local* economy. Moreover, these domains *need* additional incentives so the donor's intervention will be effective and respond fully to the TRIPS provision. This is not necessarily the case for export-oriented sectors in which market incentives alone are sufficiently strong to motivate firms in rich countries to operate TTs.

The other domains – for instance, the export goods-oriented manufacturing and processing sectors – are also important but they will, in any case, be served through TTs operating as a joint product of FDI. TTs in these domains do not require additional incentives provided by the government. They are the natural result of rationale and profit-maximising strategies of foreign firms.

Having made the point that local innovations are socially useful and are likely to generate a virtuous process of diffusion and information spillovers within the domestic economy does not mean that market incentives would be enough to initiate local entrepreneurial initiative towards these local needs.

The figure below illustrates why the issue of incentives needs to be addressed in this particular case. DG denotes the demand from advanced countries (the global demand); DL is the local demand; and AC is the average cost curve facing local innovators (with a shape driven by a fixed cost like R&D).

Figure 5. Global and Local Demand and the Need for Special Incentives for Local Entrepreneurs



Source: Trajtenberg, 2008

The DL slope shows buyers for whom quantities purchased are extremely price sensitive, as compared with buyers whose demands are more inelastic (DG). In this case, local entrepreneurs – if they have the capacity – will likely develop an innovation to serve the global demand because doing so would result in positive profits, whereas, as it stands, serving the local market would not cover the fixed cost.

A small R&D subsidy may tip the balance and make it profitable to innovate for the local market, and the local surplus generated may be significantly larger than the subsidy. The social gains of serving the local market with

regard to consumer surplus may be significant, as is likely to be the case in the area of medical care. Moreover, local spillovers may, in some cases, be more significant and widespread if innovating for the local market, if only because of the demonstration effects.

This case shows clearly that even if the technology is transferred for free – due to the additional incentives received by the technology holder – it might not be enough to incentivise local entrepreneurial activities. Subsidies allocated to the local side might be needed to operate the various tasks that are necessary (absorption, adaptation, assimilation of improvements) to make the TT a successful operation. Investing in innovation oriented towards local needs may, therefore, require additional support from the government to the local entrepreneurial activities.

5.3.4 Special IPRs for public–private partnerships

There is a growing awareness of the potential role of PPPs to address the issues of access to and management of IPRs in cases of TTs (see for instance de Boer, 2008, about such a role in the area of environmentally-sound technology transfers).

A first issue to be addressed is related to the fact that most local entrepreneurs and research institutions in developing countries lack even minimal capacity in IPR management and negotiations. The PPP should, therefore, contribute to clarifying institutional roles, identifying proprietary technologies, negotiating ownerships of IP from the TT, and guiding the management of IPRs.

A second issue, well addressed by Byerlee and Fischer (2002), is the contribution of the high transaction costs of patent searches to the market failure in the international transfer of proprietary technology. The PPP should there-fore assume the role of reducing the cost to developing countries of patent searches and offer a "one-stop" brokerage service for buying and selling IP.

Finally, as argued by Karapinar and Temmerman (2007), IP-related accessibility issues could be resolved on a purely contractual or free will basis. However, it is likely that PPPs simply based on contractual arrangements do not reduce the risk of disagreements between partners on commercialisation and royalty sharing. Moreover the same authors observe that dealing with complex licensing and contractual issues in each PPP results in high transaction costs (ibid.). It is important for PPPs to create a space for technology transferring at low transaction costs. There is thus a need for devising a special IP-regime tailored for PPPs that could provide a more effective environment ensuring both incentives for technology holders to be part of the transaction and easier access for local entrepreneurs.

Depending on the capacity and capability level of the recipient country, the PPP should either focus on negotiating commercial licensing agreements directly with private companies for accessing tools and technologies for commercial and emerging markets, or bargaining for access to products under royalty-free license (Byerlee and Fischer, 2002).

5.4 Effectiveness Conditions: Appropriate Donor Assistance

The use of public money to undertake TT (in order to create more incentives for the private partner) will be considered as efficient not only because the TT meets some measure of success at the end of the day (enhancing efficiency and growth in the host country) but also because the operation would not have been possible without this money. This section discusses the latter condition, which is obvious but harder for any public agency to control and meet.

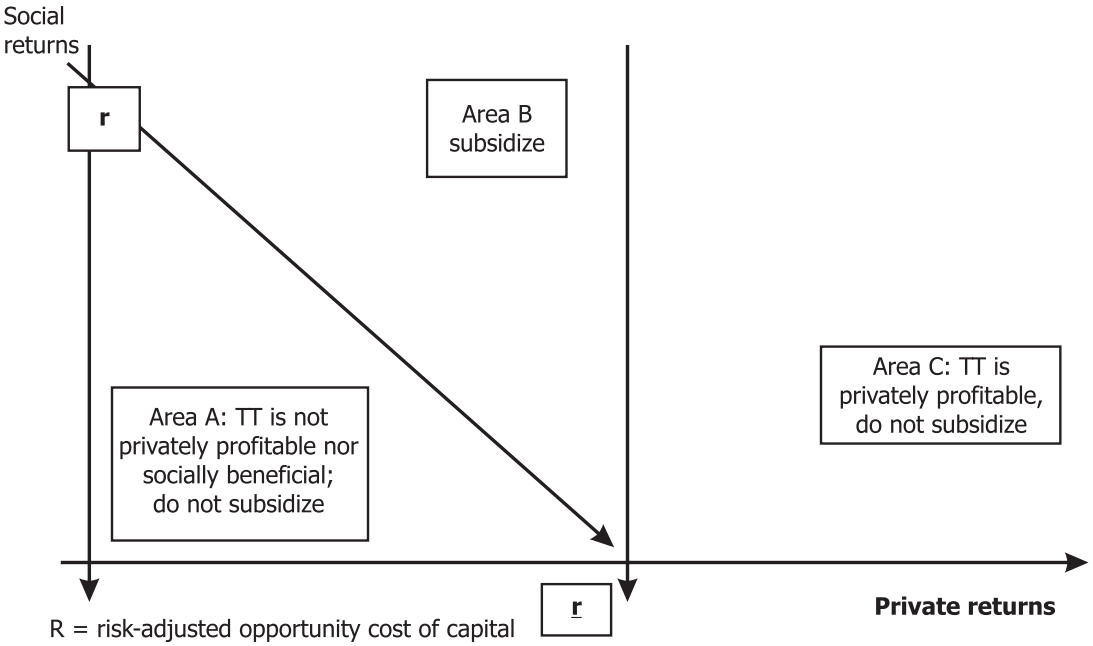
5.4.1 The basic model

Figure 6 below shows when and why public incentives have to be provided to get the private sector to carry out more TTs toward LDCs. This figure can help us evaluate the effectiveness of subsidising TT. The figure shows the expected returns on TT in two dimensions, social and private (private for the firm which masters the technology). The expected total returns on a TT project are the sum of the expected social and private returns.

Government support has several possible outcomes. In some cases, government support goes to infra-marginal projects, which are high return projects that would have been undertaken anyway (projects in Area C). In this instance, government support is just a transfer of payment. In our example, a TT aimed at improving the manufacturing of a good facing deteriorating terms of trade is a case in point. There is no need for further incentives for a company in a developed country to transfer technologies in such domains.

Some of the money may go to marginal projects, such as projects in Areas A and B, which firms will not undertake on their own. If the government cannot really estimate the potential social return on these projects, the subsidy causes firms to undertake some TT projects that are (at the margin) unproductive projects (in Area A), and also some projects that (at the margin) have a total return in excess of the opportunity cost of capital that would not otherwise have been undertaken (Area B).

Figure 6. Projects Targeted by an Optimal Government–Industry TT Programme



Source: Stiglitz and Wallsten, 1999

If the government is effective in identifying projects with social returns not captured by the private sector (in Area B), then the support unambiguously increases economic efficiency.

TTs of course have to be operated in many domains, including export-oriented industry. But, they must be particularly supported in the domains corresponding to the model of innovation, which, as identified above, are entrepreneurial activities dealing with needs on local markets that are likely to generate domestic spillovers. Two reasons have been given:

1. These domains are potentially very significant for growth because of the spillovers that are likely to be captured by the *local* economy;

2. These domains *need* additional incentives so that the donor's intervention will be effective and respond fully to the TRIPS provision, which is not necessarily the case of export-oriented sectors in which market incentives are only sufficiently strong to motivate the firms of the rich countries to operate TTs.

5.4.2 Implementation issues

Stiglitz and Wallsten (1999) argue that the better a government is at funding projects in Area B (projects with relatively high social benefits and low private returns), the more effective TT programmes will be. However, these authors also argue that it is unclear how this goal can best be accomplished. Most of these programmes require industry to propose projects and the government to decide whether to subsidise them. Often, government subsidies are less expensive than capital from other sources, meaning that firms may be tempted to look to government before looking to other sources for financial support. In other words, there is no reason to believe that firms will provide TT projects only in Area B. Firms may be tempted to first propose projects that fall within Area C which, being subsidised, will be privately super-profitable. It is up to the government to determine which of these research projects would benefit LDCs but would not be privately profitable without a subsidy. This means that government should not simply fund the best proposals it receives. Instead, it should fund the best among those that could not be funded elsewhere. In other words, programme managers who make funding decisions must reject not only projects of dubious technical merit, but also technologically-sound proposals that are very likely to yield commercial successes and could therefore be funded elsewhere. In practice, it is difficult to follow such allocation principles and the next section details that many projects reported as a response of developed countries to the 66.2 provision should not be subsidised by government since they clearly fall within Area C.

5.5 Drawing from TRIPS Council Country Reports under Article 66.2

The TRIPS Council at the WTO decided in 2002 that developed countries should submit reports about their policy of incentives and regulatory measures that they are implementing in order to support and promote TTs from the business sector to LDCs. It was specified that the information provided should show that the particular incentive regimes are not simply part of the general overseas development assistance (ODA) that benefits all developing countries but specifically address the LDCs' target to promote TT. It was also requested that developed countries should provide detailed reports on the practical functioning of these incentives and update the Council regularly regarding the results of these policies.

At the TRIPS Council of 2007, however, the Bangladesh representative, while appreciating the fact that several countries "did the job" and regularly update the Council concerning their activities in this area, complained about the lack of information on how the technical assistance featured in these reports had actually led to TTs and how the private sector is responding to these incentives (June 5, 2007). In general, LDCs expressed frustration about the fact that rich countries are not really fulfilling their obligations in relation to Article 66.2.[15]

There are roughly four main domains where incentives of some kind are provided to encourage TTs with LDCs:

- Domain 1: TT to improve the manufacturing and processing of export goods (cacao, coffee, teas) that are facing deteriorating terms of trade;

- Domain 2: TT to meet vital needs (drugs and vaccines). This is of course an important mission but relates less to TT than to R&D

carried out in developed countries, the results of which are then distributed in LDCs for passive consumption;

- Domain 3: TT to build infrastructures. It is not clear however whether firms contracting with governments to build an infrastructure have strong TT duties; and

- Domain 4: TT in the area of simple and traditional capital goods and services oriented toward local entrepreneurial activities in relation to domestic needs.

Studying country reports leads to the conclusion that governments report a high concentration of projects in Domain 1, moderate concentration in Domains 2 and 3, and low concentration in Domain 4 (see Table 5 below as an example). This does not represent a very strong result in terms of government effectiveness since Domain 1 clearly corresponds to Area C in Figure 6, i.e. projects that would have been undertaken anyway. Domain 2 clearly corresponds to Area B in Figure 6, i.e. projects that need to be subsidised but are not pure TT projects. Domain 4 also corresponds to Area B and does involve true TT operations but very few projects are actually undertaken.

Some government interventions entail the risk of super-inefficiency. This is the case of subsidies to projects in Domain 1. These projects do not need further incentives since the positive effects of efficiency improvements will be primarily beneficial to firms from developed countries importing these goods. As already explained (chapter 4), since these goods are characterised by deteriorating terms of trade, successful TTs are likely to worsen the economic situation of the considered sector in the LDCs. In helping such projects, governments are therefore being super-inefficient. They are helping projects that would be carried out anyway and these projects are not likely to improve the economic situation of the poorest countries.

To conclude, it appears that the locus of decision-making concerning areas and domains for TTs are kept in foreign assistance bodies, leading to suboptimal decisions. For example, many projects are actually serving trade policy needs rather than innovation policy. In addition, governments of developed countries are not very effective in their allocation decisions. Many subsidised projects do not in fact require further support to be carried out. And finally, country reports should be more transparent and informative regarding which domains are supported and helped through TTs and the provision of incentives. The development of a standard typology of areas for TTs that developed countries would use systematically to report on their activities could go a long way towards making these reports more informative (see table below).

Table 5. Mapping Technology Transfers: An Example Based On Country Reports to the TRIPS Council under Article 66.2

TT domains Institutional sources	Export-oriented goods Deteriorating terms of trade	Vital needs: education, health	Infrastructure	Simple capital goods and services to serve entrepreneurial activities
Private	Organic cotton (Mali) Cashew nuts, fruits, cotton (Mozambique) Coffee, cashew nuts (Tanzania) Mango (Burkina) Coffee (Zambia)			Efficiency in the brick sector (Nepal)
Public Production Public Procurement		Reform of health system (Tanzania) Malaria research (Tanzania)	Water management (Burkina) Bridge and road building(Tanzania)	

Source: This table is based on a country report submitted to the Council for TRIPS, WTO, 2006.

The recent Policy Brief by S. Moon (2008), that systematically analyses the reports submitted by countries to the TRIPS Council, provides similar conclusions. It concludes that the evidence produced by her study "does not paint a rosy picture of compliance with Article 66.2." Moon points to the lack of definition of the basic terms (technology transfer, developed country), the absence of data and indicators requirement to measure efforts, and the vagueness of the description of the general obligations. A majority of projects listed by countries as part of their efforts to comply with 66.2 just miss the target: a significant proportion of programmes actually do not encourage TT while a majority of them do not specifically target LDCs. Given this poor activities reporting, which creates a very opaque situation and makes it difficult to evaluate efforts and observe progress (or stagnation) over time and between countries, short-term recommendations are obviously very practical, involving the standardisation of the reporting procedure, the definition of common format and categories, the emphasis on data collection, and presentation. However these needed efforts should not hide the long-term objective, which has been articulated and clarified in this paper: making TT an effective tool for innovation and growth in LDCs.

CONCLUSION

Technology transfer is a difficult and complex process, particularly for LDCs which suffer from a limited exposure to foreign technologies and a weak absorptive capacity. These countries cannot only rely on FDI and trade to access foreign technologies and TTs which are likely to spillover into the domestic economy as a result.

Effective TTs to LDCs call for new types of PPPs with the involvement of a third party, which is specialised in linking public donors, private firms, and local entrepreneurial activities to ensure the effectiveness of the TT operation. The PPP will work to ensure that the locus of decision-making on TT is shifted to local actors and authorities. The PPP would also contribute to clarifying institutional roles, identifying proprietary technologies and guiding the management of IPRs.

Practical means to make the implementation of TRIPS Article 66.2 more effective should include developed countries providing more effective incentives, by offering assistance to projects that are socially beneficial but not profitable for the firms that own and could transfer the technology.

In this connection, developed countries should also ensure that conditions for efficient TT operations involve the choice of relevant partners on supply and demand sides, the selection of the right areas for focus (related to a clearly expressed local demand for technology) and the creation of organisational forms that will favour the consolidation of the transfer (absorption, adaptation and subsequent spillover), as well as the related entrepreneurial dynamic.

ENDNOTES

1 See Linsu Kim (2003), *Technology Transfer and Intellectual Property Rights: Lessons from Korea's Experience*, ICTSD Issue Paper No. 2; Sanjaya Lall, with the collaboration of Manuel Albaladejo (2003), *Indicators of the Relative Importance of IPRs in Developing Countries*, ICTSD Issue Paper No.3; UNCTAD-ICTSD *Policy Discussion Paper, Intellectual Property Rights: Implications for Development* (2003); John Barton (2004), *Nutrition and Technology Transfer Policies*, ICTSD Issue Paper No. 6; Keith Maskus (2004), *Encouraging International Technology Transfer*, UNCTAD-ICTSD Issue Paper No.7; UNCTAD-ICTSD *Resource Book on TRIPS and Development*, Cambridge University Press; John Barton (2007), *New Trends in Technology Transfer: Implications for National and International Policy,* ICTSD Issue Paper No. 18.

2 These concepts are defined as they are employed in accounting: *joint products* are two products that are simultaneously yielded from one shared cost and they have comparably high (sales) value. *By-products* for their part are produced along with a main product. The latter constitutes the major portion of the total (sales) value. *By-product*s have a considerably lower (sales) value than these main products. We can apply these concepts to TTs, substituting "perceived value to technology holders" for "sales value."

3 The discussion in this section draws heavily on my scholarly exchange and many discussions with M.Trajtenberg whose synthetic view on these issues for LDCs can be found in Trajtenberg (2007).

4 This section draws on the literature that focuses on TT channels, their respective advantages and shortcomings. It refers especially to Maskus, 2004, Barton, 2007, and the World Bank, 2008.

5 This is for instance a fundamental weakness of the provisions made under Article 66.2 of the TRIPS, which are intended to encourage firms in developed countries to transfer technologies towards LDCs. Nothing in this article specifies how (and where) decisions should be made. These provisions are obviously not providing the anticipated results.

6 The transitional period expired in this case on 1 January 2005.

7 It is also useful to recall that countries like Switzerland or Japan did the same thing in the 19th and early 20th centuries to build their own competitive industries.

8 Reverse engineering of software is acceptable within the TRIPS framework but legal conditions are implemented differently at the national level, making the legal framework for reverse engineering difficult to understand and to cope with (see UNCTAD-ICTSD, 2005).

9 These industries share the following characteristics that obviously make patents a quite effective incentive mechanism: high R&D cost, reverse engineering, and other means of innovation reproduction allow competitors for rapid and inexpensive imitations, and low costs of manufacturing the final product.

10 The author warmly thanks K.Karachalios from the EPO for calling attention to this argument and providing some very interesting documentation on the Ethiopian case.

11 Open-source and community-based user innovation projects can be interpreted as a mechanism to mitigate the formation of asymmetry between final user and commercial producer during a period of IP protection strengthening.

12 See Roffe et al. (2007) for an overview of the various types of flexibility in TRIPS.

13 PPPs are not-for-profit organisations that support and coordinate R&D for neglected needs. They are financed by philanthropic and public donors, who have collectively pledged more than one billion US dollars to PPPs. Almost all PPPs have been created within the last ten years.

14 Recall that TT is a decreasing cost activity (chapter 2, section 3): the more extensive the experience previously acquired by the organisations involved in the process, the lower the transfer costs in relation to total project size.

15 See Correa (2007) for a careful analysis and discussion of the country reports and more generally of the problems raised by the Article 66.2.

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