Radosevic, Slavo, International Technology Transfer and 'Catch Up' in Economic Development, Edward Elgar, Cheltenham, 1999.

1. Introduction

"Most of the change we think we see in life
is due to truths being in and out of favour"

Robert Frost, 'Black Cottage' (1914)

International technology transfer policy was an important issue in international relations between developed and developing countries during the 1960s and 1970s. Thirty-odd years later significant changes have occurred in the world economy which have altered not only the major issues in international technology transfer for developing countries but also the link between technology transfer and opportunities for their growth. The basic assumption of this book is that developing countries' requirements for 'catching up' have changed since the 1960s/70s period in ways which have important consequences for the manner in which developing countries will use technology transfer as a mechanism for fostering growth.

During the 1980s and 1990s we have seen significant changes taking place in the world economy. It is no longer polarized East-West. Countries of central and eastern Europe have joined world markets and are becoming part of regional and global production networks. The North-South divide still exists but the boundaries of this division are becoming increasingly fuzzy. Developing countries are today much more differentiated not only in terms of growth but also in terms of the extent and nature of their integration into the world economy. Some are integrated only through product markets while others are integrated to different degrees through regional or global production networks. During the 1980s and early 1990s some developing countries became highly integrated in the global financial system as emerging markets.

The increasing interconnectedness within the world economy is driven by several seemingly independent processes. Technological opportunities and the diffusion of information and communication technologies have contributed to the increasing multiplicity of linkages between countries. The renewed dominance of the US as currently the only economic superpower has contributed to the acceptance of liberalized trading and investment systems within the GATT/WTO jurisdiction. This shift came also as a result

of long-term trends within the developing countries. The trade-led growth of east Asian economies, structural reforms in debt-burdened developing countries and the economic deterioration of central and eastern European countries during the 1980s are forcing many developing countries to deregulate, privatize and open their economies.

This has created a new situation in which issues of technology transfer and technology transfer policy, in particular, have been considered as secondary. As an academic issue technology transfer has faded, at least in explicit debate. Yet, it seems obvious that the increasing differentiation among developing countries, now linked to diversity of their modes of integration into the global economy or marginalization from it, is closely linked to technology transfer issues. By being integrated into the global economy as markets, developing countries do not automatically get integrated into production and technology networks. The global economy and global political system by their very nature generate different degrees of political, financial, market, production and technological integration of national economies into the world economy. The final outcome is shaped not only by the global economy but also by the actions of individual economies and national political systems (McGrew and Lewes, 1992; Bretherton and Ponton, 1996). The growth of individual economies in such a situation is determined by domestic growth factors but also by ways in which an individual economy is integrated into the global economy. The endogenous generation of innovation when coupled with the active adoption of imported technologies is essential for long-term growth. Those developing countries which will be able to go beyond simple market integration and, in addition, improve their technological integration into the world economy should improve their chances of catching up. This is important not only for the countries concerned but also for the stability of the global economy. This is also the main rationale for this book whose principal concern is to understand what are the major issues relating to technology transfer for developing countries in a globalized and liberalized economic environment.

In the remainder of this introductory chapter, we first set the scene by offering some initial observations on the relationship between technology transfer and 'catching-up'. In the second section we summarize the remaining chapters of the book in an overview of how possibilities for catching up have changed from the 1960s/70s to today and how this affects technology transfer. In the last section we highlight the character of the book and to whom it is addressed.

1.1. TECHNOLOGY TRANSFER AND 'CATCHING UP'

The generation of new knowledge embodied in new products and processes and its diffusion throughout the economy is the main source of economic growth. This knowledge is only partly the result of endogenous technological

effort. The more a country is lagging behind the technological frontier the more it has to rely on foreign knowledge and the import of technology through equipment, machinery, licences or through copying ('reverse engineering').

Historical evidence suggests that latecomer countries grew by effectively exploiting an international pool of existing technologies available from leaders (Madison, 1995; Gerschenkron, 1962). This was not done through a simple 'borrowing' or purchase of ready-made solutions but through an active effort by latecomer enterprises to master various elements of technology. The second feature of successful latecomer economies was that they grew by accumulating technological knowledge in growing sectors and product groups. Historically, technological accumulation was faster in manufacturing than in agriculture or in extractive industries. Also, within manufacturing technological opportunities differ widely between different sectors and groups of products. Countries that successfully grew over a protracted period of time usually managed to accumulate technological knowledge in sectors that are considered the main drivers of economic growth.

In these sectors the knowledge base is expanding and a one-off import of foreign technologies would not generate the technological dynamism which forms the basis of economic growth. For this to take place latecomers have to develop their own capability to generate technical change. An important input for this process is coming from markets which generate continuous demand for better products and processes. Large but also demanding markets are usually not available domestically which suggests that export is an essential ingredient of latecomers' growth. One of the accepted facts of growth literature is that growth in output and growth in the volume of international trade are closely related (Jones, 1998). Export and domestic growth interact in a dynamic way. Foreign markets are not only a source of demand but also sources of knowledge, competitive pressure and close interaction with foreign suppliers and buyers. Buyers are very often a valuable source of knowledge on technical and marketing aspects of products. As a result of this interaction there appear to be robust correlations between the capabilities of innovating and quickly adopting new technologies and export shares in the world markets (Dosi *et al.*, 1994). Rising exports require imports of capital goods and thus technological mastery of foreign technologies in different forms (know-how, licences, reverse engineering or visits abroad).

Successful latecomers have combined heavy imports of technology with strong expansion of indigenous efforts devoted to technical change (*ibid.*). The main locus of these activities were large domestic enterprises (Chandler *et al.*, 1997). These were complemented by domestic infrastructure and investment in education and training activities. So, the import of foreign technology is a necessary but not a sufficient condition for growth. Imports of technology and autonomous innovative efforts are not alternatives but

complements. The historical experience of countries of central and eastern Europe shows what happens in the absence of this complementarity. The import of technology was not integrated into domestic technological efforts and the link with demanding foreign markets was absent. So, despite intensive endogenous technological efforts and a large pool of scientists and engineers, technical change which would lead to long term growth was not generated.

The example of central and eastern Europe is also illustrative in understanding why some countries have done better than others in 'catching up'. The initial endowments of skilled labour in the countries of central Europe such as Hungary and the Czech Republic or of natural resources in Russia were not turned to advantage. Equally, in the 1950s the countries of Latin America were much better 'endowed' than east Asian countries. As Dosi *et al.* (1994) point out, initial endowments did not play any major role in explaining what happened afterwards. Growth is not the automatic result of initial availability of factors of production be they backward or advanced. Factors of production may be put to bad or good use only through economic organization which generates incentives, experimentation and institutional changes. Technology transfer is not an automatic result of the simple availability of technical knowledge or markets abroad but requires an institutional set-up which may exploit these opportunities and which may complement them with domestic technology accumulation. This suggests that the process and context are extremely important in understanding why some countries have made good use of external opportunities and why others have not. This also helps us to understand why general explanations of growth are very limited in their relevance or apply only to similar groups of countries (Barro and Sala-i-Martin, 1995). The good or bad use of external technological opportunities is, in other words, highly country specific.

However, external technological opportunities are changing and new responses to them are required. Our main argument is that changes in the world economy have made policy responses in technology transfer from the 1960s/70s inadequate. Developing countries are faced with the challenge to find new solutions in technology transfer which are compatible with an increasingly globalized world economy. Whether they will find these solutions will also contribute to the stability of the global economy itself. We pointed out above that growth is determined by endogenous technological effort and is complemented by imported technology from leaders. This applies to the global economy as well. However, the boundary between what is domestic and what is not domestic becomes rather blurred in an environment where political, economic, financial and other interdependencies among countries and enterprises are so pervasive. This suggests that managing complementarities between domestic technological activities and the import of technology becomes even more important in a globalized economy. This brings us to the topic of this book with which we deal in the next section.

1.2. CHANGING OPPORTUNITIES FOR 'CATCHING UP' AND TECHNOLOGY TRANSFER

Changes that have taken place in international technology transfer policy during the 1980s and 1990s in the direction of liberalization and deregulation cannot be understood without taking into account the assumptions and objectives of the policies from the 1960s and early 1970s (Chapter 2). Their basic assumptions and objectives should be understood in the context of import substitution regimes within which they generally operated. The metaphor we use to describe the spirit of the mainstream policy from that period is 'contract bargaining'. By this we understand the focus of policy on terms of technology transfer, as stipulated in contract clauses and related agreements, which are seen as the key mechanism for the distribution of technological rents between transferor and transferee.

The following six basic assumptions underlie the mainstream consensus of that period:

- the unrestricted flow of knowledge leads to high and rising costs in transferring technology;
- the unrestricted import of technology inhibits the development of local technological capacity and the learning process;
- technology can be developed equally well in a protected environment;
- the mechanisms for technology transfer do matter and equity control and ownership play important roles in it;
- the business of pricing technology determines the international distribution of gains from technological advances;
- the main problem in technology transfer is not availability or access to technology but its price and other terms of transfer.

Based on these assumptions technology transfer policies from that period had basically two objectives. The first and main objective was to reduce the costs and terms of transfer. The second objective was to maximize the learning effects of technology import. The trade-off between these two objectives was managed differently in different countries and required heavy interventions in the process, which often produced considerable costs. The problems in this approach were the following:

- the control of costs tells us very little about the interaction between technology transfer and technology accumulation;
- the context in which protection can be productive is a more complex one as the examples of export-led economies show;
- the empirical evidence on the costs of 'packaged' technology was quite narrow;
- the issue of control cannot be reduced to the problem of equity control and ownership;

- in practice the emphasis on short run financial issues associated with transfers virtually ignored problems associated with the accumulation of technological capability.

There is agreement that the direct objectives of these policies have essentially been achieved and the cost reduction measures seem to have had the desired impact. Its effects on local technological capability building are much more difficult to discern. It is difficult to arrive at clear-cut conclusions. However, the problem of the (in)appropriateness of these policies became even more pronounced when external conditions had begun to change, making the policies obsolete and increasingly inadequate for the new conditions.

The changes which have made old responses in technology transfer inadequate have occurred on several mutually linked levels and we confine the discussion to those that have a direct impact on technology transfer. A new phase of globalization of the world economy, the impact of new technologies, and institutional and industrial change in developing countries which tries to accommodate the impact of external changes seem to be the most relevant for understanding changes in technology transfer (Chapter 3).

The most important change for technology transfer brought by the new stage of globalization is the changing relationship between finance, trade and production. The interaction between financial and trade liberalization ('shallow integration') and production and technology integration at the level of networks ('deep integration') is generating dynamics distinctively different from the situation in the 1960s/70s. Trade patterns are increasingly determining the distribution of production tasks across national borders. These processes are facilitated through financial globalization which enables new modes of interlinking of production and foreign capital in developing countries through mergers and acquisitions and quasi equity as well as outward investment strategies of enterprises from developing countries. 'Deep integration' has been facilitated by the liberalization of the international framework governing the flow of technology (mergers and acquisitions legislatures; joint venture rules; local content regulations; technology transfer controls). Compared to the 1960s and 1970s, developing countries are now much less in a position to control the interaction between finance, trade and production in old ways. That capacity to control these links through parastatal enterprises, banking systems, foreign trade protection, FDI and technology transfer regulations is significantly reduced. For enterprises these changes have weakened the link with the national base. The possibility and necessity of detachment from a national base in finance, markets and production processes generates new frictions between the national and global interests of enterprises. The example of Korean enterprises which are going global illustrates this problem in the case of developing countries' enterprises. However, the importance of local or national systems of innovation has not been reduced. This generates

problems for national technology transfer policy which now has reduced control over its economic space.

In the period since the 1960s/70s significant technical and related institutional changes have taken place which rendered obsolete the previous technology transfer policies. The rising systemic character of new technologies, and especially the network character of IT with the important role of users, make technology transfer an increasingly complex process as systemic gains are more difficult to achieve through one-off waves of technology import as was possible in the past. They can only be achieved effectively through long-term relationships with suppliers of core design and components. The organizational basis of these processes are production networks. For technology transfer this implies a need to open multiple technology transfer channels in order to cope with the dispersed organization basis of technology inflows.

The transferability of new technologies is an important element to be taken into account by technology transfer policy. Opinions differ regarding whether new technologies are becoming easier to appropriate or whether they are becoming a kind of 'black box', difficult to 'reverse engineer' and open. However, the tightening of intellectual property rights and the harmonization of this aspect of control over technology will undoubtedly reduce possibilities for technology import for developing countries. Whether the effects of that in the long term will be positive through stimulation of innovation in developing countries themselves is very much industry specific and generalizations are not possible. The problem of technology access arises due to different degrees of openness of TNC networks and national systems. In a liberalized trade and investment environment this is now becoming an important issue for technology transfer as the capability of developing countries to bargain on terms of technology transfer at the 'border' is significantly reduced. The changes in the features of new technologies (systemic character, the important role of users, increasing knowledge intensity) and the changing institutional rules of access (intellectual property rights, structural openness of national systems of innovation) have significant implications for technology transfer policy. Instead of trying to favour licences over FDI or joint ventures, or trying to 'unpack' technology at the 'border' through control of technology transfer agreements, policy now has to foster interaction between domestic and foreign enterprises abroad or at home in the hope that the production integration will generate knowledge transfers.

Liberalization of trade and investment environment has led to deep and far-reaching changes in the industry and in technology accumulation patterns of developing countries. In most post-import substitutive developing economies, the most significant reduction was in engineering-intensive activities. The production capability and operation efficiency of enterprises has improved through tightening of domestic competition and the need to export. But, the diversity of technological activities has suffered set-backs

through the increasing specialization of domestic enterprises and import competition. Technological activities which were often commercially unviable in open markets are now avoided, but these are not automatically replaced by an equal depth and range of technological activities. The effects of liberalization on technological capability are sectorally very specific and general assessment is not possible. Trade liberalization has laid the foundation for a restructuring of previously domestic-market-oriented FDI in the direction of regionally-oriented corporate networks.

The novelty of the emerging WTO-governed regime of the global economy is in the mutual interaction between trade and financial liberalization and production and technology networks. Fragmentation and specialization of production tasks across different economies is not necessarily compatible with the interests of national governments who are concerned with employment and in the long term with technology accumulation. The emerging problem is how to manage the trade-off between 'shallow' and 'deep' integration. An acceptance of 'shallow' integration by developing countries will not automatically lead to 'deep integration': just as in the past dynamic learning did not follow from trade protection, this is unlikely to happen through trade opening alone. An emerging policy agenda is how to build mechanisms of technology accumulation and technology transfer appropriate to the new phase of globalization. Before we turn to this agenda let us summarize how in this book we understand globalization.

Globalization of the world economy has progressed significantly in the period since the 1960s and has entered into a qualitatively new phase. Its essential feature is an increasing multiplicity of linkages and interconnections between the states and societies which make up the present world system (McGrew, 1992, p. 23). This creates close economic interdependence among the leading nations in trade, investment and co-operative commercial relationships, with few artificial restrictions on cross border commerce, or discrimination against foreign affiliates (Dunning, 1992a). As McGrew (1992) points out globalization has two distinct characteristics: scope (or stretching) and intensity (or deepening) of links. These correspond to the previously discussed 'shallow' integration through trade and financial liberalization, and 'deep' integration through production and technology networks. The qualitative difference in the globalization by the end of this century and the beginning of the next, is not the process of trade and financial or 'shallow' integration. Its novelty is the extent and depth of micro links through production and technology networks. This 'deep' integration of world economy has the most important effects on technology transfer for developing countries. Expanding production networks are only partly under the direct control of large TNCs. In fact, only a small number of developing countries have a strong production presence of large TNCs. Although TNCs operate complex internal networks of relationships they are also locked into external networks of relationships with

a myriad of other firms (Dicken, 1992, p. 212). So, to understand the way developing countries get integrated into the world economy at the level of production networks we have to look beyond the TNCs to a wider web of inter-firm links which are emerging in the world economy. The disintegration of production chains into constituent functions has allowed individual tasks to be increasingly contracted out to independent producers wherever those companies are located in the global economy. Such networks boost a proliferation of non-equity, non-arm's length, cross-border, inter-firm relationships in which significant value is added outside the lead firm (Borrus and Zysman, 1997). Although still limited, these networks now extend from production to design and other non-production activities like marketing, logistics, etc.

This emerging variety of inter-firm relationships is here defined as sourcing. By this we understand the non-arm's length, hierarchical relationships between firms where one firm purchases sub-assemblies, components, or processed materials produced by an (in)dependent firm located in another country. The legal position of the enterprise, i.e. whether it is a subsidiary or independent firm, is secondary. What matters from a technology transfer point of view is the sourcing position of partners, which ultimately determines the extent and scope of knowledge flows between firms. The key objective of technology transfer policy in a liberalized trade and investment environment is then to move domestic firms from technologically simpler to more complex sourcing positions based on dynamic learning. By this we understand learning through continuous market and technology access which puts a firm on the path of technology accumulation and enables its 'catching-up' or 'forging ahead'. This is in contrast to the one-off import of technology and subsequent learning behind the protective barrier. The experience of developing countries suggests that the learning behind the barrier is inferior in a dynamic sense to learning which is linked to continuous access to foreign markets.

The driving forces behind sourcing can be grouped into three main areas (Chapter 6). Some forms of sourcing are driven by institutional arrangements in the trading system which allow for preferential access to specific markets (outward processing sourcing) or are induced by the enforcement of required local-content rules. Cost-based sourcing is driven by increasing competition in the world economy and the need to find low cost locations. However, sourcing may also be a technology enhancing relationship or may lead to the formation of innovative and productive capabilities greater than the sum of the technological capabilities of the individual participant firms and institutions. Whether sourcing relationships will acquire resource-, value- and surplus-creating potentialities is something that cannot be guaranteed. Sourcing may simply reaffirm the advantages which large firms have and their ability to internalize technologically complex activities and externalize the cost of cumbersome and low-skill activities. The institutional context in

which sourcing may develop into one or other direction is the main issue for technology transfer policy.

Technology transfer issues for developing countries in a globalized economic context evolve around several issues within what we call a 'sourcing framework'. By this we mean the following four sets of issues: the issue of simultaneous market and technology access which is essential for dynamic learning; the role of latecomer firms as the main carriers of technology transfer and the ways they compensate for the disadvantages in their immediate environment; the position of national enterprises in regional or global production networks and the possibilities for dynamic learning through being plugged into these networks; and the issue of the macro-organizational and networking strategies of governments in order to enhance production and technology integration of the domestic economy .

Continuous access to foreign markets through subcontracting, alliances and FDI becomes crucial to the dynamic effects of imported technology. As new technologies are systemic in character their adoption and assimilation occur at multiple receiving points and via several channels. In this context it is the nurturing of the multiplicity of channels, not the hierarchy of the technology transfer channels, which is the driving concern of policy. The objective is to increase connectivity between a national system of innovation and a foreign science and technology (S&T) base across a wide range of contact points. In the globalized economy the way that developing countries combine market and technology access has strong effects on their opportunities for 'catching-up'.

Technology is firm-specific, i.e. in developing countries it is localized and organizationally embedded within latecomer firms. Domestic firms are a crucial agent of the transfer process and how they complement foreign sources with their own technology effort is decisive in the effectiveness of technology transfer. Latecomer firms, and strategies at corporate level, are crucial to the transfer of firm specific capabilities. Due to the systemic character of new technologies the S&T infrastructure continues to be important, but is effective only when it is focused on the firms' current and future needs.

Links with foreign buyers and constant feedback effects from foreign markets, coupled with organizational capabilities, are vital if latecomer firms are to move from a technologically simple towards a technologically more complex sourcing position. The issue is how latecomer firms exploit the opportunities afforded by globalization and overcome obstacles to growth through technology transfer.

While the terms of technology transfer ('contract bargaining') were the important problems in the import substitutive regimes of the 1960s and 1970s the problem today is how to move towards higher value-added activities within global production systems. The use of FDI and sourcing links as tools of domestic technology upgrading in the sourcing context raises several new issues. TNCs and different forms of partnership may well

increase local capacity, assist the dissemination of new knowledge to suppliers and customers, raise the quality of output, and spur local rivals, thereby reinforcing the industry's 'virtuous circle'. The initial position in subcontracting relations, in export through regional free trade agreements or different forms of alliances, determines the scope of technology inflows.

However, there is also a danger that countries will become 'locked-in' to low value-added activities by foreign partners. Inward FDI may not only drive out local competitors, but may also restrict the creation of new technology by local suppliers, even if more technology disseminates to them from the TNCs. In short, TNCs may enforce both 'virtuous' and 'vicious' circles of increasing dependency on external sources of technology supply.

'Catching-up' in such a context requires several technological upgradings within international and technology networks. An issue of concern here is how technology transfer is used in the process of improving one's technological position within the international production chains. It seems that in a liberalized trade and investment environment governments in developing countries have fewer opportunities to structure interaction between domestic and foreign enterprises, which has significant effects on technology transfer. The scope for pursuing technology transfer objectives through foreign trade policy is significantly reduced in a liberalized trade and investment environment. The remaining areas of foreign trade where governments pursue these policies are investment incentives and performance requirements. However, with the increasing harmonization of trade and investment regimes, technology transfer will be increasingly pursued through domestic regulations. The process of international harmonization is likely to progress also into this domain through harmonization of intellectual property rights systems, industrial subsidies and competition policies. This will further reduce the scope for domestic measures to manage FDI or maximize the effects of its presence.

The emerging role for the developmental state in the globalized economy is the networking role or support of government to enterprises, as Bressand (1997) put it, "to penetrate the linkages of deep integration". This will require capability to stimulate public-private co-operation and integration of what are considered domestic enterprises into a global economy. From being a controller of technology transfer governments will have to develop a role of network supporter or organizer. As in the past the formal mechanisms of control in technology transfer or today only access to production networks will not distinguish success from failures. The final results will depend much less on specific policies than on the policy implementation capability of governments and the kind of social organization and governance mechanisms that they build for an economy increasingly dependent on foreign markets, finance, production and technology networks.

1.3. ABOUT THE BOOK AND TO WHOM IT IS ADDRESSED

This book is about the changing role of technology transfer in the catching up process of developing countries and is focused on changes in technology transfer from the 1960s/70s to the present day. The book is written from a public policy perspective and has in mind an informed reader, student or policy analyst interested in technological and industrial changes in a global economy. Its objective is not to treat the issues covered entirely from an academic angle but to have in mind the policy relevance of the issues.

The book refers to developing countries and a few words of explanation are needed in this respect. The very notion of developing countries becomes problematic as the degrees of involvement of different countries in the world economy become increasingly divergent and as their income levels are diverging as well. We think that there is no perfect solution to this and any label should be understood as a convention or compromise. By developing countries we here refer to countries which are often termed newly industrializing economies, or emerging markets. However, we also include in this category the economies of central and eastern Europe which in developmental terms share common features with newly industrializing economies. We think that the issues covered in the book are of lesser relevance for the least-developed developing countries. However, they are of relevance for less developed OECD economies. Until a new common denominator is found for all these countries we continue to use the term developing countries for two reasons. First, in developing countries the issues of development as distinct from more growth is regarded as very important. These countries share common problems in technology transfer due to their position as latecomers or 'catching up' countries. Second, these countries are defined by their counterpart in the most developed countries.

In the second chapter we briefly discuss the notion of technology and its implications for an understanding of technology transfer and then present an overview of technology transfer mechanisms. In the third chapter we reconsider the assumptions and effects of technology transfer policies from the 1960s and early 1970s. This is not done purely for the sake of history but in order to understand better changes in technology transfer policy since that period. In the fourth chapter factors and elements of the changing technology transfer context are analysed. This chapter is not exhaustive as the subject matter would require several separate reviews. Three aspects of changes are seen as the most important for technology transfer: the changing relationship between finance, trade and production; changes in the character of new technologies; and the recognition of significant technological learning in some groups of developing countries as well as industrial changes in these countries which have taken place during the 1980s. The fifth chapter reviews the main analytical issues in technology transfer, based mainly on the academic literature. However, the presentation of issues seeks to avoid an

overly academic tone and has in mind primarily a reader who is interested in the policy relevance of the research in this area. In the sixth chapter we discuss the new technology transfer issues created by the globalized economy within, as we call it, a 'sourcing framework'. Finally, the last chapter summarizes the main conclusions in the context of a shift in international technology transfer from 'contract bargaining' to a 'sourcing' context.

Keeping the main line of argument throughout a very wide set of issues was the biggest challenge in this work. We hope that the necessary coherence of issues and arguments – not very easy in such a wide-ranging area as technology transfer – is maintained.

For many arguments in the paper there is not yet systematic evidence and we had to rely on rather weak 'signals' which may not satisfy those with a passion for scientific rigour. However, the alternative was not to deal with the issues at all. Our objective is primarily to open up new questions and to focus the attention of the reader on newly emerging policy problems rather than to give definite answers. This effort should be judged from that perspective.