INTERNATIONAL TECHNOLOGY TRANSFER: EMERGING CORPORATE STRATEGIES*

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International or multinational corporations have changed in the ways in which they handle technology development and transfer. Responding to various pressures that have emerged since the late 1970s, these international firms have moved towards increasing rationalisation of their technology activities. An increasingly significant development has involved the emergence of technology co-operation agreements amongst firms in various industries. The trend amongst some companies towards increasing cartelisation in both the development and the use of technology may have important implications for the markets in which technology is transferred. This has important ramifications for the governments of countries which are significant purchasers, such as Australia.

Keywords: multinational corporations, technology transfer, technology cooperation, corporate strategy, technology cartels

INTRODUCTION

The international transfer of technology is one of the key areas of international commercial relationships. The development of and access to technology is of major concern to modern, industrial firms, and the use of technology within and across different national markets is an important part of corporate strategy. In addition to the interest of firms in technology development and use, the industrialised nations have increasingly directed attention to the role of new-technology (or "sunrise") activities as a part of the adjustment responses appropriate to industrial policy. Australia has been involved in this focus on new-technology activities in recent years, and such an orientation is seen by some as critical to the success of overall adjustment policies.[1] Partly related to the potential role of new-technology in the adjustment policies of several of the industrialised nations, a number of governments have moved towards tighter controls over the access of third parties to new technology.

There have been changes in the way in which international companies deal with technology development and transfer. One of the

* I am grateful for suggestions from a referee.

main trends has been the increasing importance of technology co-operation arrangements between firms. In addition, home-country governments have indicated a concern with completely free access to new technology and, in some cases, have attempted to control technology outflows. These developments have potentially important implications for the development and transfer of technology and conditions in the markets in which such transfer takes place. This paper examines some of the more important developments in international technology transfer and considers some of the issues arising for technology users, including technology-dependent countries such as Australia.

MULTINATIONAL CORPORATE STRATEGY AND TECHNOLOGY TRANSFER

Technology has long been recognised as an important factor underlying the direct investment and other activities of multinational enterprises (MNEs). Indeed, recent developments in the theory of the MNE attach importance to the best use of technology in different markets in explaining the form of MNE operations. Thus, for example, Magee[2] argues that multinational firms face difficulties in protecting their proprietary rights to information and in securing rents on know-how in different markets over time. At best, the patent system provides only limited protection over a part of the MNE's proprietary know-how. Because large, modern corporations rely on the creation and use of technology and know-how in their development of products and exploitation of markets and organisations, the ability of the firm to capture maximum rents from know-how becomes critical to the operations of the MNE.

According to this appropriability theory, MNEs seek to protect and maintain certain types of tangible proprietary assets by taking over various market transactions and internalising information and knowledge-related activities within the corporate structure. The more sophisticated the know-how, the more likely is the transaction embodying the know-how to be internal to the firm with maximum rents from the transaction appropriated by that firm. To the extent that the proprietary assets of the MNE are generated by or, at least, related to the firm's own research and development activity, then it is more likely, *ceteris paribus,* that the firm's international production and international technology transfer will be in the form of internalised activities via direct foreign-affiliate operations, rather than more market-based transactions such as exporting and licensing.

Another recent variant in this theory of MNE operations explains multinational activities in terms of the costs of firms' transactions and

the organisational and control structure of the enterprise: the markets and hierarchies approach.[3] The markets and hierarchies approach to the MNE also takes as its starting point the argument that the firm has some asset or advantage which is potentially exploitable in different national markets. Teece stresses the role of technology and know-how factors in the underlying advantage possessed by the MNE. The form of operations by the MNE which maximises rents on the firm's assets, according to the markets and hierarchies approach, will be determined by the nature of the transactions costs associated with market (contractual) transactions compared with internalised (intra-firm) transactions. As Calvet puts it:

> . . . why would a firm prefer to establish hierarchical links abroad rather than contract at arm's length? Stated differently, what advantages do firms find in hierarchical structures which make the latter preferable to the outright sale or licence of proprietary assets to foreign-owned firms?[4]

The answer is related to the relative enforcement costs of market (contract) transactions compared with internalised (hierarchical) transactions. When the enforcement costs of market transactions are relatively high, then the MNE will tend to replace market transactions with its own internal control and enforcement producers. This may explain why MNEs have some preference for majority-ownership in some of the developing-country markets.

There are several issues which *a priori* arise from the emphasis of the appropriability and "markets and hierarchies" approaches to the MNE. Firstly, MNEs are likely to operate in such a way as to protect their technology-related advantages and will rely on those types of transfer mechanisms which are best suited to this protection. For example, more advanced proprietary technology will tend to be bundled via the direct investment channel in order to ensure the firm's control over the technology and maximise rents from the use of the technology. The control costs of intra-firm transfers, such as via direct investment, relative to the costs of enforcement via contractual transfers will dictate the choice of the transfer mode, *ceteris paribus.*

Firms may also attempt to develop their proprietary technology in such a way that it is difficult for third parties to gain access. Hence, product formulations and process techniques may be deliberately complicated in order to protect the firm's proprietary know-how. In such cases, the transfer process may be influenced by the choice of the appropriate technology package and, hence, the transfer mode may be constrained by this choice. *A priori,* more complicated product and process technology will be less easily transferred and this may act as an obstacle to certain types of technology transfer, particularly to the less-developed recipient markets.

THE INCREASING IMPORTANCE OF TECHNOLOGY TO MNE ACTIVITIES

The technology base of MNE operations and its best use appear to have become even more important as firms have responded to the pressures of the 1980s: slower market growth, cost increases, shifts in comparative advantage as between firms and production centres and changes in financial markets. There has been increased pressure on many firms to rationalise their operations and make more effective use of their existing assets and advantages. This rationalisation has taken place via the integration of various of the firm's activities, while at the same time the more effective use of proprietary advantages has led to some diversification in other areas by MNEs. In addition, many MNEs have sought to strengthen their specific technology base as a key part of the corporate strategic responses to the pressures that firms now face.[5] Not only are large firms devoting more of their own resources to an enhanced technological capacity via in-house R&D but also these firms are seeking to improve their access to and use of external (to the firm) technology. Indeed, Ergas[6] argues that corporate strategy is increasingly based on the rationalisation of products around the firm's integrated technology activities. The advantage of this strategy arises from the more effective use of product- and process-specific technology and corporate skills directed to an integrated product base.

There is no doubt that a more effective use of technology and know-how by the firm has become an increasingly important consideration. Given the pressures that firms are facing, the optimum use and development of all resources, including know-how related resources, is critical to profit margins and, indeed, longer-run survival. In some cases, this has undoubtedly meant a narrowing of the product base consistent with an integration of technology and know-how activities. Companies in the electronics and communications' industries have been cited as examples of the 'narrowing' response — General Electric, R.C.A., Bendix and I.T.T., for example.[7] At the same time this strategy has meant a move away from a loosely connected group of products towards a stronger "core" technology with applications in a range of user industries.

There are MNEs, however, whose know-how advantages are such that diversification of product lines is the best means of taking advantage of their proprietary technology or know-how advantages. In such cases, the technology is not bound to narrow product lines but is associated with more general process technology or non-production corporate activities, such as marketing, distribution and finance, for example, which can be exploited across product and industry groupings. The diversified conglomerates in the food,

communications and transport sectors, for example, represent this type of know-how based diversification.

The particular strategies of MNEs in terms of the development and use of their technology base will have some effect on technology transfer. On the one hand, technology-based integration may lead to more efficient technology transfer between countries as a result of firms' specialisation. On the other hand, there may be a reduction in competition on the supply side as a result of specialisation and a reduction of potential suppliers which may have adverse consequences for technology transfer.

Related to the possible reduction in potential sources of technology has been the trend in corporate strategy towards the increasing use of co-operative and joint ventures in the development of technology. In a number of industries large firms have entered into co-operative agreements for the co-ordination of research and development activities as well as design and manufacturing. In the aircraft industry, for example, joint research and production has become an important trend. Similarly, in the computer industry a number of companies have entered into joint technology development, extending in the United States to the formation of a joint research company by a number of producers — The Microelectronics and Computer Technology Corporation.

Co-operative agreements have become increasingly important in a range of activities and in a number of industries. According to the findings from a study of 70 co-operative agreements amongst European firms in the automobile, basic metals, computer and electronic systems industries, some of the major elements of co-operative agreements involved technology in general and technology transfer in particular.[8] A number of motives are explored in the study, with some emphasis on economies of scale, complementarities and risk sharing emerging in the explanation of the increasing importance of co-operative agreements amongst firms.

Co-operative agreements and ventures in the technology area appear to be most important in electrical and electronic applicances, computers and micro-chip processes, communications and data processing, automobiles, chemicals, including pharmaceuticals, and oil refining. In several of these industries, 'it is common for technology-sharing agreements and co-operative arrangements in underlying R&D to be closely tied to joint production arrangements. As mentioned, the aircraft industry has been a forerunner in the joint production area. For example, the European Airbus has been developed and subsequently produced in a number of countries, and components for Boeing Aircraft are being produced and parts designed in several locations. A part of the joint-production activities in aircraft manufacture has involved design agreements and other

technology-related activities. To a large extent, joint production arrangements have been a response to offset requirements imposed by various national governments, including Australia. However, the economies of technology development have provided an important impetus to such arrangements apart from any incentives such as the offsets programmes of various countries.

Within the automobile sector, production agreements have been more important to date than technology co-operation agreements, though this appears to be rapidly changing. The integration of production activities in the international automotive industry is well established and is closely related to the increasingly important equity linkages which have emerged between various international companies (such as Ford — Toyo Kogyo; G.M. — Isuzu; Chrysler — PSA). Another emerging trend in the automobile sector is the use of long-run technology agreements between automobile manufacturers and suppliers such as electronic instrument's producers.[9] This form of technological co-operation has largely been independent of the equity links which have been common in joint production arrangements within the automobile industry proper.

The emerging technology co-operation between automobile manufacturers and specialised components manufacturers represents a form of inter-industry agreement which appears to be increasingly common in the case of automobiles. To take a specific example of an inter-industry agreement for technology development, Nissan Motor Corporation entered a technology-development agreement with Dunlop in the U.K. to develop a new fuel efficient tyre. It is likely that inter-industry technology co-operation will continue to be important in the case of automobiles and the various components and supplier industries related to automobiles. The inter-industry form of agreement is also likely to emerge as increasingly important in other industries, such as, for example, computer hardware and software; electronic and communications/data processing.

Apart from inter-industry technology co-operation agreements, inter-country agreements between firms are important in a number of industries. Cross-country licensing of technology once developed has traditionally been important in industries such as paper production, chemicals, pharmaceuticals, and electrical products. Inter-country co-operation in the development of technology seems to be emerging as important in several of these industries as well. However the logistics of technology development has meant that, in general, inter-country co-operation to date has concentrated on cross-licensing of developed technology rather more than inter-country co-operation in the underlying technology development work.

In recent years, however, cross-country technology co-operation is becoming more important in several industries. In the pharmaceutical

industry, for example, genetic research has been undertaken by United States' specialised biotechnology companies for Japanese pharmaceutical companies and the early research work on the development of artificial blood involved a consortium (since disbanded) between a Japanese firm and United States companies. In the automobile, aircraft and aerospace industries, partly as a response to government activities such as the previously noted offset requirements, and partly as a consequence of production-sharing arrangements, cross-country co-operation in R&D proper may become as important as cross-country licensing of developed technology.

As co-operative agreements in the production as well as the transfer of technology become more common, there are likely to be significant changes in the market for technology and know-how. The cartelisation of technology production and supply which accompanies many forms of joint technology agreement has important implications for competitive conditions in the relevant markets. Such cartelisation on the supply side may limit access to technology to that group of firms directly involved in or associated with the technology cartel. Supply-side cartelisation may also lead to an increase in cartelisation amongst technology-buying companies and technology-buying countries. The only real evidence of this trend date has been the approach of the Andean pact countries which has not been notably successful.

Technology co-operation will have different implications for competition in the market depending on the type of agreement as well as the nature of the linkages between suppliers and purchasers. Inter-country technology co-operation agreements can extend cartel practices across national boundaries in the form of market-sharing arrangements which encompass technology creation and use. A good example of this latter type of cartel arrangement has been the electrical products industry. In the electrical products industry traditionally there have been market-sharing arrangements; cross-licensing; cross-equity linkages; as well as technology co-operation agreements amongst the major firms in the industry since the 1950s.[10] Indeed, the UNCTAD study of the electrical products industry concluded that there had been strong centralised control over advanced electrical technology exerted by the major firms in the industry — all of them major MNEs.[11] In addition, the use of restrictive export franchises has been a common condition attached to technology agreements in the Australian manufacturing sector between firms operating in Australia and overseas technology suppliers (including parent firms).[12]

The questions that arise are how widespread an impact has there been from such technology co-operation agreements on concentration and market power, and what has been the effect on technology

purchasers who lie outside these arrangements? This issue is of obvious relevance to governments of smaller, technology importing countries whose firms are not generally engaged in these technology-sharing arrangements.

The first point that should be made is that technology co-operation agreements often arise in industries and activities where other factors have had an influence on the nature of competition. Indeed, one of the general characteristics of the more technology-intensive industries is that these industries tend to have higher levels of seller concentration within national markets compared with less technology-intensive industries. This observation would appear to hold, at least for national markets, in the case of automobiles, aircraft, aerospace. electrical and electronics products, office equipment and similar industrial equipment industries. The extent to which technology agreements and technology co-operation do in fact add to the market power of those participating companies is an empirical issue that requires detailed examination.

While the industries in which technology co-operation has become increasingly important are typically characterised by a high degree of seller concentration in national markets, and, hence, implies, *a priori,* a degree of market power, the same does not appear to be true at a global level. A recent examination of the world's leading MNEs has concluded that, while concentration appears to have been generally increasing within national markets, competition has generally been increasing at the global level.[13] Measuring concentration as the proportion of output of the top 20 world firms accounted for by the largest three firms, the study concluded that there has been a general trend to less global concentration. This has been most marked in the case of automobiles; office equipment, including computer equipment; electronics and electrical appliances; industrial and farm equipment and, to a lesser extent, food and petroleum. Only in tobacco and building products has there been an apparent increase in global concentration over the 1960s and 1970s.

It is possible that the increasing trend to technology co-operation agreements amongst companies in the one industry within a national market will carry over to increasing co-operation between firms across countries. In this case, there may develop strong incentives to extend the cartelisation of operations which are based on technology across international markets as well as national markets. The experience of the international electrical products industry has been a good example of the powers of cartel type arrangments, partly involving technology co-operation and technology transfer agreements, in substantially weakening competitive pressures in international markets.

It is difficult to identify the overall extent to which technology creation and technology co-operation have become the domain of the

larger MNEs operating in international markets, and the extent to which smaller, more nationally-oriented firms have been excluded from these developments. The experience does differ between various industries. There are industries, such as micro-chip production for example, where smaller, non-MNE firms have been dominant in early technology creation activities. There are other industries, however, where large MNEs appear to dominate — automobiles, aircraft, electrical products, for example. The trend does appear to involve an increase in co-operative arrangements in the technology (and related) areas in more technology-intensive industries, such as the recent move towards technology co-operation amongst major United States computer manufacturers (other than IBM).

These developments will lead to an increase in the imperfections in technology markets, with likely consequences for the international technology transfer process. At the same time, however, co-operative arrangements in the technology area may be associated with significant improvements in the efficiency with which resources are used for both technology development and transfer which may potentially benefit some users of technology. In the final analysis the distribution of any gains from more efficient technology development associated with co-operation agreements will depend on the competitive pressures that link buyers and sellers in the market. It is the nature of competitive conditions in the market for technology which has been one of the increasingly important concerns of governments in this area.

GOVERNMENT INVOLVEMENT

Governments have seen the unequal bargaining power of participants in the market for technology as a cause for concern and, in some cases, intervention. Hence, some countries require all licensing and technology-transfer agreements to be subject to government approval over agreements related to costs and conditions. It is likely that governments, particularly in the smaller, developed and the developing nations, will want to exercise more scrutiny over transactions in technology markets as technology co-operation agreements increasingly affect conduct and competition in those markets. There are newer concerns amongst governments, however, including governments of nations where new technology development is taking place.

One area where government involvement in technology transfer has become more apparent is the increased concern of home (source) countries over outflows of technology. There are several dimensions to home-country concern about outward technology transfer. In the

first place, controls over the export of technology are part of a more general attempt by many industrialised nations to protect home-country industries which are subject to intense competitive pressures and associated adjustment problems. The problems facing industries such as clothing, textiles and footwear, shipbuilding, iron and steel, automobiles and consumer electronics in the industrial nations are related to the cyclical downturn of the 1980s as well as to a more fundamental shift in the international pattern of comparative advantage. A number of the newly-industrialised countries such as Taiwan, Singapore, Hong Kong, South Korea, Brazil and Mexico, for example, as well as Japan, have become increasingly important suppliers in these industries. A part of the reaction of the industrial nations of Europe and North America has been to encourage developments in new-technology, "sunrise" industries such as information, communications, and biomedical engineering, and protect the position of these industries by limiting outsiders' access to technology developed by and for the new industries.

A second dimension of home-country controls over the export of technology has involved the extra-territorial application of home-country foreign policies. The major example of this has been the attempt to prevent flows of technology to the Soviet Bloc nations whereby various restrictions have been imposed on U.S. companies and their overseas subsidiaries by the United States government. In addition, the U.S. has signed agreements with a number of other countries designed to restrict the transfer of "sensitive" U.S. technology, including products which embody the technology, to third parties. There have also been proposals to impose restrictions on U.S. firms which would limit the access of overseas subsidiaries to "sensitive" technology of MNE-parents based in the U.S. home economy.

Regardless of whether home-country controls over technology outflows are designed to protect domestic high-technology industries from a too rapid erosion of their emerging comparative advantage, or are a part of a more general foreign policy concern of home countries, there are obvious problems in actually controlling technology outflow. Such controls are difficult to monitor and enforce — transfer channels for technology flows can often circumvent home-country controls. More fundamentally, the logic of policies designed to control the export of technology in order to safeguard new-technology industries is itself suspect; MNEs may find it difficult to take advantage of the technology in overseas markets, and, hence, earn full rents on that technology, in the face of technology-export restrictions. The increasing emphasis of home-country controls such as in the U.S., particularly the concern with protecting new-technology industries, inevitably creates additional imperfections in the market and sets in

place obstacles to efficient technology transfer. MNEs may be able to circumvent controls, but their second-best responses to these controls are likely to have adverse consequences for the efficiency of the transfer process. This problem may be compounded where co-operative agreements in technology development and transfer already weaken the workings of the market and place constraints on technology transfer mechanisms.

A continuing area of concern to nations which are dependent on imported technology, especially the developing nations, involves the costs, benefits and conditions attached to technology transfer through its various modes. McCulloch has characterised the traditional concern about technology transfer "as a straightforward resource-transfer problem: developing nations wanted more technology at lower costs".[14] While more recent policy initiatives by some host nations regarding access to technology are still based on this view, the objectives of host countries, particularly (though not only) the developing countries, are becoming somewhat more complex. The United Nations Centre on TNCs has succinctly stated the technology policy objectives which bear on the transfer issue:

> . . . identification of technological needs, selection of suitable technology and technology suppliers, strengthening the capacity of national enterprises in acquiring foreign technology, regulation of the terms and conditions of technology transfer arrangements, facilitating the absorption of imported technologies and promotion of indigenous technological capabilities.[15]

As a result of this broad set of objectives, many host countries, in varying degree and with quite different policy specifics, have attempted to influence technology transfer. The degree and nature of host-government involvement ranges from guidelines for both suppliers and recipients of technology to specific rules about terms and conditions for technology agreements. Not only have individual host nations interfered in this way, but groups of nations, such as the Andean pact countries, have attempted to co-ordinate their policies in this area. International agencies have also been moving in the direction of codes of conduct and model laws in the area of technology transfer.[16]

The issues and details of host-country controls over technology transfer have been examined in great detail.[17] There is a great diversity in the way different countries treat technology transfer — the degree of openness of the economy; the controls over transfer and the regulation of price, terms and conditions. What is still at issue is the way in which different types of regulations act as obstacles to technology transfer.

CONCLUDING REMARKS

The trends discussed in this paper suggest quite different broad influences on international technology transfer. On the one hand, there have been developments which are likely to facilitate and improve the international technology transfer process. Co-operative arrangements for technology development and use by both firms and nations are likely to have favourable implications for the efficiency with which resources are devoted to technology dvelopment. It is also likely that participants in such arrangements will have better access to the results of co-operative technology development. On the other hand, however, any reduction in competition on the supply side of the market for technology resulting from co-operative arrangements is likely to erode potential gains for technology users who lie outside of the network of co-operative technology arrangements. Similarly, attempts by various home countries to limit technology outflows will also have adverse effects in the market for technology.

Clearly countries such as Australia which are heavily dependent on overseas-sourced technology have an interest in the developments noted in this paper. One possible response is to ensure that Australian firms are active participants in technology co-operation and sharing agreements, both directly and via those overseas enterprises into which Australian firms have equity and licensing links. Another potential area for policy activity is co-operation in technology projects on a government-to-government level. It seems clear that changes in the way in which MNEs focus on technology development and transfer need to be kept in mind in addressing technology policy for technology-dependent nations such as Australia.

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