GLOBALISATION OF INDUSTRIAL R&D: POLICY ISSUES

Organization for Economic Co-operation and Development (OECD), Paris, France

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Keywords : Globalization ; research and development ; national system of innovation ; OECD countries ; technology trade ; technological networks ; technological and industrial clusters

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Summary

The globalisation of industrial research and development has important policy implications for OECD countries. Governments are concerned about finding new ways to foster innovation domestically as companies reorganise their activities globally. Countries have legitimate concerns about maintaining an attractive domestic research base, which would discourage the flight of R&D abroad while simultaneously increasing the ability to attract technology-intensive investments on a global basis. They are searching for mechanisms to integrate the research activities of foreign firms into the local economy and to maximise their domestic spillovers. And since advanced technological markets are increasingly found overseas, countries want their private sectors to better monitor and participate in these foreign centres of excellence.

The increasing pace of globalisation can be observed in the heightened importance of patenting by firms abroad; increases in the relative importance of both inward and outward research-related foreign direct investment; the explosion of international strategic alliances in science and technology; and increasing trade in technology. While these general trends touch all OECD members, they present different challenges for individual countries – depending mostly on their industrial structure, the size and openness of their economy and the strength of their science and technology base. In fact, the globalisation process has not markedly diminished differences in innovation systems and may be accentuating the technological specialisation of firms in different regions. Governments in OECD countries are reacting to the pressures of globalisation primarily through policies designed to improve their domestic innovation capacity. They are reinforcing the basic framework conditions for industrial innovation, and in particular concentrating on the promotion of a highly skilled labour force and a vibrant research base. A related set of policy measures addresses any *systemic failures* that prevent different parts of the innovation system – the institutions necessary to industrial innovation – from working in harmony with one another. Governments can facilitate the flow of knowledge throughout the system by providing technologies and information to firms and institutions and by facilitating co-operation among actors. Cluster analysis is one method by which governments refine the range of possible interventions in the innovation system, by helping them identify networks of firms, which can innovate together. An enhanced understanding of how firms are both globalising and clustering their R&D activities would help governments devise and implement the best innovation policies in an era of research globalisation

1. Introduction

The globalisation of economic activity and the concomitant changing nature of industrial research over the course of the past two decades has forced a re-evaluation of science, technology, and innovation policies in many countries. Countries are concerned that their present policies may not be appropriate to sustain an innovative industrial base necessary for future prosperity, given the increasingly international patterns of private sector investment in R&D. They are therefore searching for an appropriate mix of policy tools – be they economic, industrial, or science and technology policies – to meet the challenges posed by R&D globalisation.

Changes in business sector R&D are happening on multiple fronts. First, there was a slow down in the growth of OECD business enterprise R&D from the mid-1980s to the early 1990s, which was especially marked in Germany, the United States, and the United Kingdom. In part the shift can be explained by the business cycle, but it is also due to a reorganisation of research. Large firms are pulling back from long-term projects, and instead integrating R&D into product development. The focus is on R&D projects that have immediate and tangible results. Recognising that new technologies and innovative concepts are increasingly found outside company walls and outside national borders, international collaborations, joint ventures, and acquisitions have skyrocketed. These new organisational forms help firms respond rapidly to technological change and tap into clusters of specialised capabilities. But while such industry strategies may make corporations more efficient, governments fear that research programmes might be too short-sighted

Second, there has been a structural change in OECD economies away from traditional manufacturing industries, which rely on low cost factor inputs. As the industrial landscape shifts, the pressure on advanced countries to foster a base of high-growth and skill-intensive companies is felt more acutely. The future for advanced countries lies in transforming themselves into "knowledge-based" economies, in which new knowledge and technologies are rapidly incorporated by industry to increase productivity and product quality and to reduce time to market. This common goal may pit the industrialised nations against one another in a competition to attract the research and development activities of multinational corporations (MNCs).

Third, the need to encourage investment in innovation at home is felt by governments simply because the R&D activities of MNCs are no longer firmly anchored to their home bases. The most recent data available for the 14 countries responsible for more than 95 per cent of all industrial R&D undertaken by OECD Members indicate that foreign subsidiaries account for 12 per cent of total industrial R&D spending. For some of the smaller, outward-oriented countries more than half of the research in the private sector is performed abroad. Other evidence from patent statistics, international licensing and royalty payments, trade in technology-intensive products, and international joint venture formation, all point to a trend towards international dispersion of multinational corporations' research activities.

Governments are eager to halt the perceived *hollowing-out* of their research base and to increase the spillovers of foreign R&D projects and alliances to the domestic economy.

As a reaction to the globalisation of the research base, many governments are experimenting with new science and technology policy goals and new tools to reach those goals. For the larger countries, the end of the cold war has meant greater demand for economic pay-off from national investments in research and development. Many OECD countries are eager to facilitate the commercial application of know-how developed by the public sector. Investments in science and technology are, therefore, generally expected to contribute to productivity growth, wealth creation, the generation of well-paid jobs and technology based exports. But the increasingly complex linkages between economic, technology, industrial, and trade policies have made the tasks of recasting national innovation policies, and formulating a response to R&D globalisation, difficult

2. Trend in R & D Globalisation

Among OECD countries, there is convincing evidence that the organisation of industrial R&D is in the midst of a transformation. The main indicators of the R&D globalisation process include the growth in the relative importance of both inward and outward research-related foreign direct investment; the explosion of international strategic alliances; the growing importance of patenting by foreign firms abroad; and the increasing trade in technology-intensive goods.

2.1. Inward and outward R&D FDI

Foreign subsidiaries are now responsible for 12 per cent of total manufacturing R&D investments in OECD countries, and for most of these countries, this contribution is expected to grow. However, the contributions of foreign affiliates range widely by country, between a low of 5 per cent for Japan and a high of over 60 per cent in Ireland (Figure 1).

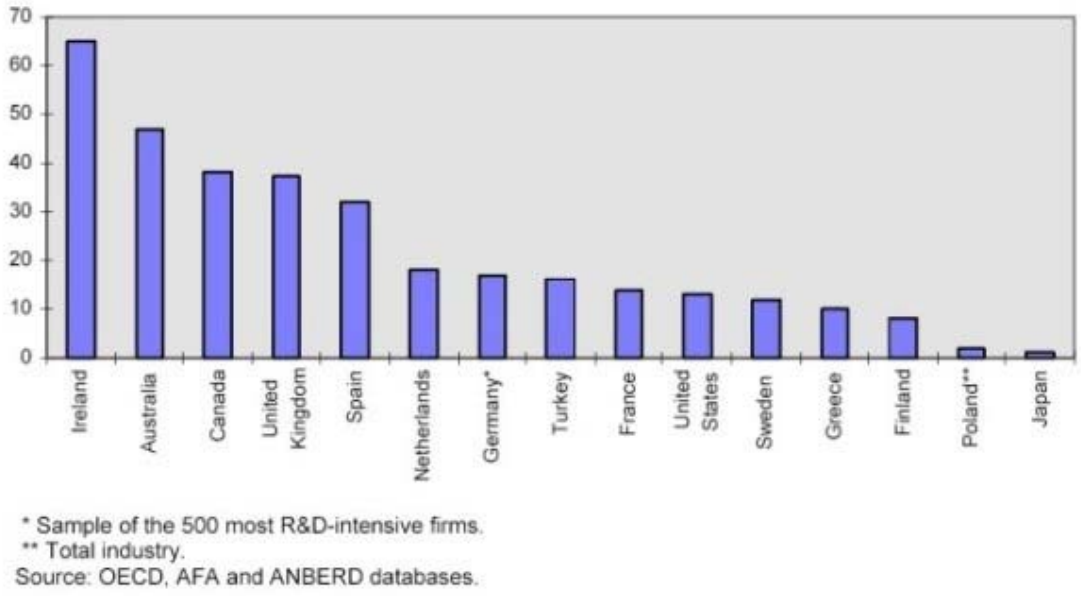


Figure 1. Share of foreign affiliates in total manufacturing R&D expenditures in 1994 (or nearest year)

Foreign affiliates are responsible for a larger share of industrial R&D investments in countries where their contribution to local production is important, where domestic firms have low R&D intensities, or where foreign affiliates are concentrated in industries, like pharmaceuticals, with high R&D intensities. With the exception of Japan, the seven largest R&D performing countries have all seen a considerable rise in the percentage of R&D expenditures financed from foreign sources since 1981 (Figure 2). Even though sales by foreign affiliates are now one and a half times the value of world exports, the data on research-related FDI are still incomplete. Not all OECD countries keep track of inward foreign direct investment and very few have information about the nature of outward direct investments of their national firms.

The number of foreign laboratories is also an indicator that MNCs are performing more research abroad. The establishment of new R&D sites abroad accelerated in the 1980s, even though select firms have had foreign laboratories since well before World War II. A study of 32 international pharmaceutical and electronic companies shows that the number of new foreign affiliate laboratories almost tripled in the 1985-95 period compared to the previous decade (Figure 3). The experience of the pharmaceutical industry is not typical of all industries, however, because its high degree of regulation favours direct investment by MNCs over trade as an entry strategy. Nevertheless, in the United States there are at least 635 foreign-owned and free-standing R&D facilities, more than half of which were established after 1986. In Europe, in 1995 there were over 300 Japanese R&D facilities, twice as many as in 1989.

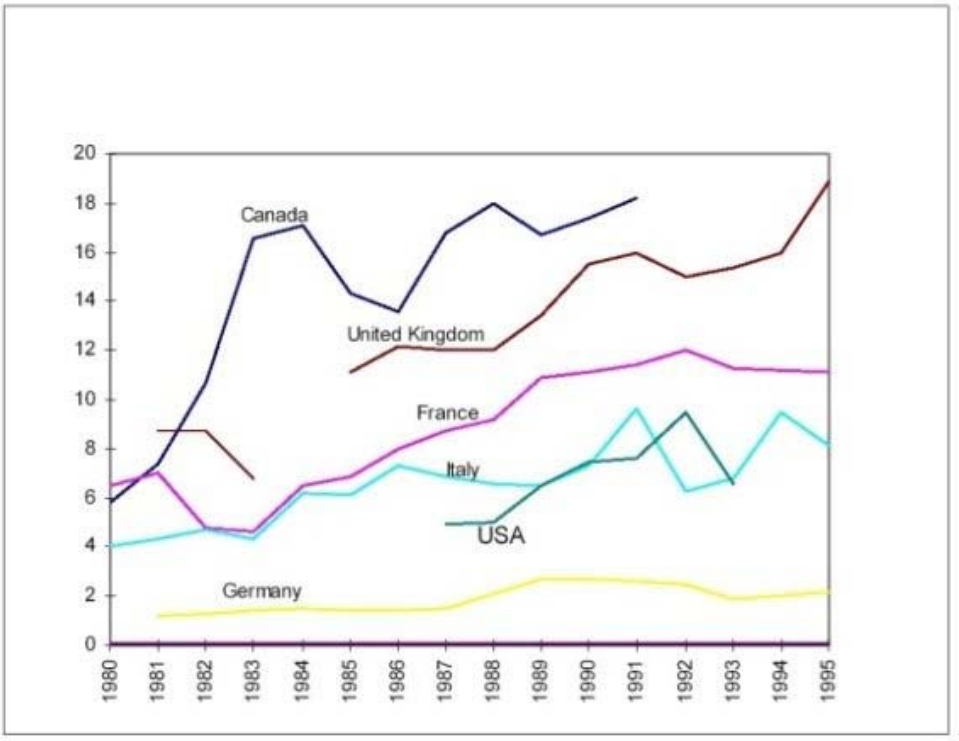
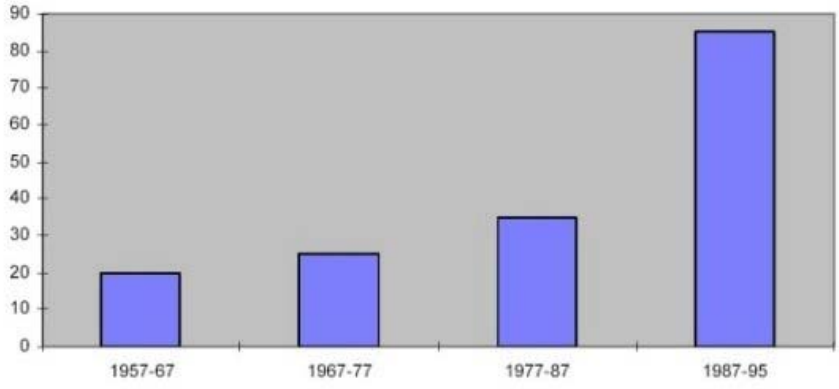


Figure 2. Share of industry domestic R&D financed from foreign sources, by country



Source : Estimated data by KUEMMERLE, W. "The Globalization of Industrial Research – An Investigation into its Determinants and Implications for Public Policy", unpublished paper, OECD.

Figure 3. Establishment of new R&D sites abroad by 32 pharmaceutical multinational companies

2.2. International strategic alliances

International strategic alliances in R&D exploded in the 1980s. Firms engage in science and technology partnerships in order to access foreign technologies and markets, as well as to minimise risks and rapidly recover the high costs of technological development. From 1980 to 1994, the total number of science and technology alliances grew at 10.8 per cent per year, and about 65 per cent of those alliances involved two partners from

different countries. Technology-based alliances are especially popular among the information technology, biotechnology and advanced material industries. International strategic alliances allow firms to rapidly exploit complex new technologies, and help smaller firms extend their markets globally. This new reliance on alliances testifies that companies believe key know-how is increasingly scattered internationally, although predominantly within the Triad countries of Europe, Japan, and North America.

2.3. International patenting

The data on patenting reminds us that R&D globalisation is not an entirely new phenomenon. When one calculates the share of patents which are based on research done abroad by US and European firms, one sees that some industries and some countries were already as global in the 1920s and 1930s as they are in the 1990s (Table 1). British, Dutch, and Swiss companies have performed a significant share of their R&D abroad since the inter-war period. French and German firms have experienced a gradual and continual rise in the degree of internationalisation of their technological activity from a low historical base in the 1920s, although internationalisation accelerated notably in the 1970s and 1980s. In contrast, the patenting of firms from the United States and Sweden was more international before World War II than after it. Only recently have their private sectors regained the level of internationalisation they experienced in the 1920s. Thus, the globalisation of R&D, as measured by patent statistics, has been most dramatic over the past two decades for Sweden and the United States.

	1920-39	**1940-68**	**1969-90**
United States	6.81	3.57	6.82
Europe	12.03	26.65	27.13
United Kingdom	27.71	41.95	43.17
Germany	4.03	8.68	13.72
Italy	29.03	24.76	14.24
France	3.35	8.19	9.55
Netherlands	15.57	29.51	52.97
Belgium	95.00	53.90	60.60
Switzerland	5.67	28.33	43.76
Sweden	31.04	13.18	25.51
Total	7.91	8.08	14.52

Source: US patent data compiled at the University of Reading, with assistance from the US Patent and Trademark Office, US Department of Commerce. As cited in Cantwell, 1995. "The Globalisation of Technology: What Remains of the Product Cycle Model?", *The Cambridge Journal of Economic*s, 19, No. 1.

Table 1. Shares of US patenting of the largest nationally owned industrial firms due to research located abroad (%)

International patent applications at the US Patent and Trademark Office (USPTO) and the European Patent Office (EPO) have doubled since the mid-1980s, such that about

half of the patents granted by the USPTO and the EPO were to foreign applicants in 1996. Interestingly, the largest jumps in foreign patent applications come from middle-income industrialising countries, rather than from the advanced industrialised world. All companies, even in the less advanced countries, want to exploit their inventions in multiple markets.

2.4. Technology trade

World trade in manufactured goods is increasingly technology-intensive. Since 1980, high-technology exports and imports have grown faster than other manufacturing sectors. High-technology trade accounted for 10 per cent of manufacturing imports and exports in 1980, and in 1994 they accounted for almost 17 per cent. The high-technology sectors include aerospace, computers and office equipment, electrical machinery, pharmaceuticals, and scientific equipment. By comparison, trade in medium-high technology sectors – which include sectors like motor vehicles, chemicals, non-ferrous metals – have remained relatively stable at around 45 per cent of the total. More trade in technology-intensive goods suggests that the rate of technology transfer among countries is also accelerating. Interestingly, the most dramatic growth in high-technology trade over the 1989-94 period was between advanced countries and Southeast Asia and, to a lesser extent, Latin America – the latter two groups of countries being otherwise marginal players in the globalisation of industrial R&D.

Governments use national comparisons of high-technology trade *(e.g.* export specialisation, degree of import penetration) and of innovative output (patents, licences and royalties) as benchmarks of their innovative capacity. Exports from technology-intensive industries accounted for 17.4 per cent of OECD manufactured exports, and the share has been growing since the mid-1980s. Governments are interested in increasing their participation in this dynamic aspect of trade.

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