
Transnational corporations and policy dilemmas: the problems of the machine-tool industry in the United Kingdom

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The objective of this article is to illustrate some of the implications for the United Kingdom and European economies of the evolution of the machine-tool industry and its transnationality, and to highlight policy dilemmas that emerge from this. The article discusses changes in characteristics of the machine-tool environment, national competitive advantage and activities of transnational corporations and shows some of the effects on the balance of trade and employment and on indigenous activity of the United Kingdom. The generally *laissez-faire* policy approach is criticized, while recognizing the problems of policy formulation in an era of rapid technological innovation, blurring industry boundaries and emerging globalization, alongside the decline of United States competitive advantage and the rise of Japan.

Industry evolution

This article draws on research funded by the United Kingdom Economic and Social Research Council into the operations of transnational corporations (TNCs) in the United Kingdom, including personal interviews

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with 30 machine-tool manufacturing companies. It also incorporates material from follow-up research into the distribution and marketing strategies of machine-tool importers in the United Kingdom.¹

The basic argument may be presented quite succinctly. As the machine-tool industry has evolved through its three eras — pre-computer-numerical control, computer-numerical control and “factory of the future” — key competitive advantage factors have changed, as have generic strategies and modes of internationalization. Companies pursuing optimal strategies for one era could find themselves in very difficult circumstances when faced with the totally different conditions of a new era. The links between environmental factors, machine-tool corporate strategies and entry modes into international markets are presented in figure 1.

In the pre-computer-numerical control era dominated by the United States and Germany, machine tools was a typical mechanical engineering industry (Rendeiro, 1985). In a sector composed mostly of small but highly vertically integrated firms, specialized products were manufactured for niche markets on the basis of reputation, reliability and performance. The introduction of electronics and computer numerical control and their early adoption by Japanese firms radically altered the environmental characteristics of the industry and competitive advantage factors. With computer-numerical control came a step change in technological trajectories (Rendeiro, 1988), dramatically shortened product life cycles, new machine-tool concepts with applications in rapidly growing industries (such as instrument engineering and office machinery) and much improved machine-tool performance (Collis, 1988). Exacerbating the industry upheaval, the strategy of Japanese

¹ The primary research on TNCs in the United Kingdom machine-tool industry had several levels: firstly, interviews with machine-tool organisations and industry leaders; secondly, a special analysis of Census of Production data was commissioned to identify the size and performance characteristics of foreign-owned and indigenous companies for selected years; and thirdly, personal interviews with 30 machine-tool companies (18 foreign-owned affiliates in the United Kingdom and 12 United Kingdom-based firms). The survey of TNC affiliates was close to a census, as the sample matched the number of foreign-owned firms included in the 1987 Census of Production data. For purposes of comparison, 12 United Kingdom-owned companies were interviewed.

Research on importing and distribution arrangements in the United Kingdom machine-tool industry was undertaken in 1991. A structured mail questionnaire was sent to machine-tool importers, drawing on the United Kingdom Machine Tool Technologies Association membership directory. Of the 93 companies in the contact sample, 3 were found to have ceased trading. From the relevant sample of 90 firms, 50 replies were received, of which 2 were unusable. The usable response rate was, therefore, 53 per cent.

Figure 1. Linking environments, strategies and entry modes^a

Item	Pre-1970s pre-computer-numerical control era	1970s and 1980s computer-numerical control era	1990s "factory of the future" era
Key environmental and competitive advantage factors	<ul style="list-style-type: none"> - Reputation and customer loyalty - Product specialisation - High materials and skill intensity - High levels of vertical integration - Manufacturing customization 	<ul style="list-style-type: none"> - Increased economies of scale and scope - Faster pace of product change and rising R & D expenditures - Vertical disintegration - Growing importance of sales and service networks 	<ul style="list-style-type: none"> - Systems: growth in demand; new entrants; software and consultancy capabilities required - Further increase in economies of scope - New entrants, protectionism - Downstream customisation
Generic strategy	Specialization	Volume	Differentiation
Major international competitors	United States/Europe	Japan	Germany/Japan
Internationalisation phase	International	Continental	Global
Entry modes	<ul style="list-style-type: none"> - Exporting via agents/distributors - Licensing of manufacturers (evolving into acquisition of licensee)^b 	<ul style="list-style-type: none"> - Exporting via agents/distributors evolving into sales subsidiaries - Licensing of assemblers - Greenfield assembly investments (as response to protectionism) 	<ul style="list-style-type: none"> - Exporting via sales, engineering and consultancy subsidiaries - Strategic alliances in sales, engineering and consultancy - Acquisitions to create global machine-tool groups (horizontal and vertical)

Source: S. Young and S. Dunlop (1992).

a Prepared from personal interviews in the United Kingdom.

b A number of these have now been divested, involving either plant closure or a fundamental change of activity, such as cessation of manufacturing.

firms did not emphasize specialist niches, but rather the general purpose sector (which accounted for about 60 per cent of world production by the early 1980s — Sciberras and Payne, 1985). With such volume strategies, major Japanese producers were able to reduce costs, through the exploitation of economies of scale and scope and through out-sourcing to low wage countries, and speed up new product introductions.

The "factory of the future" era foresees the role of machine tools in factory automation and computer-integrated manufacturing. This is not occurring in quantum leaps, but iteratively via flexible manufacturing cells (cells or groups of machine tools to handle different sub-processes) and flexible manufacturing systems (where the entire manufacturing process is fully computer-controlled or automated, incorporating robots, automatic guided vehicles etc.). According to the Boston Consulting Group (1985), end users will progressively build up "islands of automation" in their factories. Data from Japan indicate 259 flexible manufacturing systems in operation during the late 1980s, while flexible manufacturing cells were growing at the rate of 1,000-1,500 systems per year. Generally, the factory-automation equipment industry is forecasted to grow at a rate of 8-10 per cent annually during the 1990s (Japan Machine Tool Builders' Association, 1989). In this era, firm size and resources, and the ability to provide capabilities in machine tools, computers and production engineering, either in-house or through alliances, will be critical. Typical of globalizing industries, blurring industry boundaries means great uncertainties as to the successful competitors of the future, but Japanese and German firms are likely to be in the forefront. Competitive capabilities of the United States are being reduced, reflected in the fact, for example, that the United States has had no industrial robot maker since 1991.

It is worth stressing that these phases of industry development overlap. Numerically controlled tools represented more than 40 per cent of production value at the end of the 1980s, and are forecasted to stabilize at 65-75 per cent by the mid-1990s (Atkins, 1990). The demand for conventional machines will show a parallel decline, with the modest growth in flexible manufacturing cells, flexible manufacturing systems and computer-integrated manufacturing being limited by disappointing experiences with factory automation in some user countries (Kearney, 1991). The implication remains, however, that producers of conventional machines and those pursuing niche strategies, even if numerically controlled technology is being applied, are facing major problems. The overall market is showing little or no growth in volume terms, and the industry is notoriously cyclical and, thus, disproportionately influenced by recession conditions, such as those prevailing during the early 1990s.

Activities of foreign affiliates in the United Kingdom

Figure 1 characterizes the internationalization phases of the industry as international, continental and global, respectively in its three eras. The main changes have been in the strategic perspectives of producers and in the entry modes, as the share of trade in the output of the major producing nations is high and growing. During the international phase, producers sought out markets abroad in neighbouring countries, supplying the same niches as at home. Exporting was the dominant form of market supply but, turning specifically to the United Kingdom as a market, evidence from the survey revealed that a number of United States companies set up licensing agreements there. The main locational influence on the latter was import restrictions; licensing was appropriate since it made use of the capacity and production capabilities of producers in the United Kingdom, as well as their market contacts for niche machine-tools products. The follow-up to licensing was, frequently, acquisition of the licensee, as mostly United States enterprises sought to increase market penetration and/or overcome the frustrations of working through third parties. By the beginning of the 1980s, 33 foreign-owned manufacturers produced almost 23 per cent of net output in the machine-tools industry of the United Kingdom (table 1).

A number of special tabulations on machine tools were commissioned from Census of Production data of the United Kingdom to reveal, for the first time, the extent of foreign-owned manufacturing activity in the machine-tools industry of the United Kingdom. The data show the radical upheaval of the industry which took place during the 1980s (table 1): the number of foreign companies halved through divestments and sell-offs, and their share of employment declined from 19 per cent in 1981 to 9 per cent in 1988. For disclosure reasons it is not possible to distinguish nationality of foreign ownership; there is little doubt, however, as confirmed by the results of the survey, that the foreign-owned sector was dominated by TNCs from the United States. The slight increase in the number of foreign-owned firms as recorded in the 1989 data and, especially, the significant increase in net output undoubtedly reflect the build-up of activity at Japanese-owned Yamazaki Mazak (discussed later).

The explanation for the declining involvement of the United States in the market of the United Kingdom relates to the competitiveness of Japanese machine-tools producers in the computer-numerical control era. Initially, this was entirely trade-related and occurred despite protectionist measures imposed by the European Community. Between 1977 and 1980,

Table 1. Selected indicators of size and performance of foreign-owned and indigenous companies in the United Kingdom machine tool industry^a

Year, domestic/ foreign	Number of businesses	Total employment	Net output (Million pounds)	Employment per business	Net output per employee (Million pounds)
1981					
United Kingdom	901 ^b	29 766	276.6	..	9 292
Foreign-owned	33	7 120	81.2	215.8	11 411
Total	934	36 886	357.9	..	9.7
Foreign-owned share (Per cent)	..	19.3	22.7	-	-
1984					
United Kingdom	1 856	22 617	320	12.2	14 140
Foreign-owned	20	3 591	54.6	179.6	15 198
Total	1 876	26 208	374.6	14	14 293
Foreign-owned share (Per cent)	1.1	13.7	14.6	-	-
1987					
United Kingdom	2 177	22 454	408.2	10.3	18 181
Foreign-owned	19	2 915	54.4	153.4	18 665
Total	2 196	25 369	462.7	11.6	18 239
Foreign-owned share (Per cent)	0.9	11.5	11.8	-	-
1988					
United Kingdom	2 238	23 172	465.3	10.3	20 080
Foreign-owned	16	2 165	56	135.3	25 849
Total	2 254	25 337	521.3	11.2	20 575
Foreign-owned share (Per cent)	0.7	8.5	10.7	-	-
1989 ^c					
United Kingdom	2 429	24 478	542.1	10.1	22 148
Foreign-owned	18	2 678	89.3	148.7	33 361
Total	2 447	27 156	631.5	11.1	23 253
Foreign-owned share (Per cent)	0.7	9.9	14.1	-	-

Source: Produced by the United Kingdom Central Statistical Office from Census of Production data.

^a Activity heading 3221.

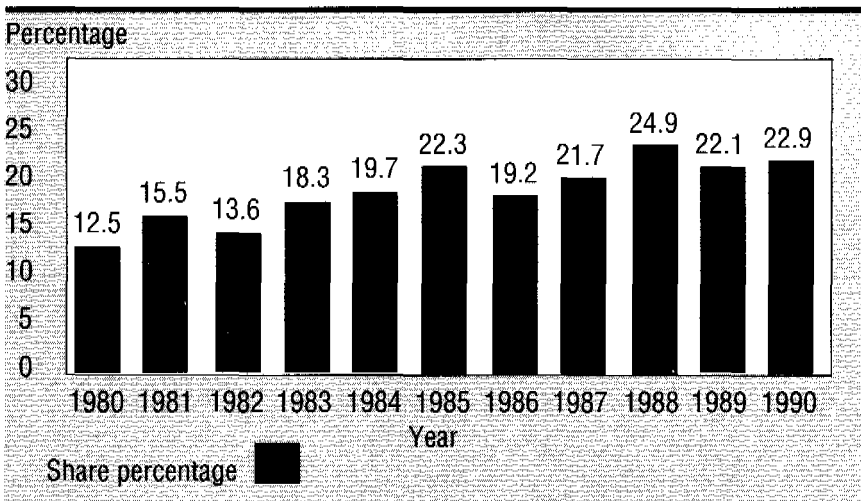
^b The figure for the number of United Kingdom businesses is substantially underrated. The best estimate is of a marginal increase in the number of United Kingdom businesses between 1981 and 1984. The foreign-owned share figure has, therefore, been omitted.

^c Most up-to-date information available from the United Kingdom Central Statistical Office.

imports from Japan into the European Community grew from 15 billion yen to 70 billion yen; under pressure from the European Community, the Government of Japan imposed a floor-price system in January 1981, under which export licences were only granted to producers whose prices achieved minimum levels (Japan Machine Tool Builders' Association, 1989). The system was applied to Japanese numerical control lathes and machining centres exported to fifteen European countries; volume limitations arising from unilateral declarations to restrict exports of machine tools to Europe are still in effect. Regarding imports into the United Kingdom, a voluntary restraint agreement operated between 1982 and June 1988 in regard to computer-numerical control lathes and machining centres. This was ended because the United Kingdom could see no long-term advantage: on the one hand, the agreement favoured indigenous manufacturers of machine tools; on the other, it was restrictive in terms of the limitations it placed on the freedom of engineering companies to source where quality and prices, among other things, were most favourable.

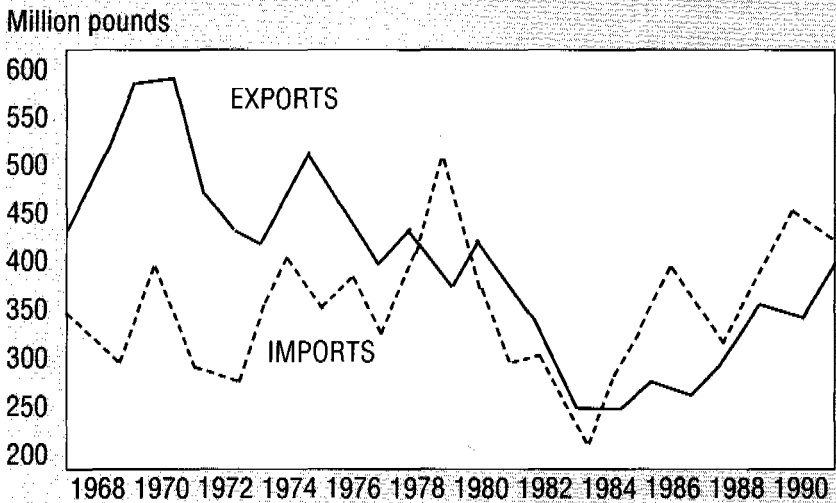
From the perspective of the United Kingdom, the outcome of the decline of exports by foreign affiliates of TNCs from the United States and the rise of (mainly) Japanese imports (figure 2) led to a reversal in the healthy trade surplus that had normally existed in the machine-tools industry (figure 3).

Figure 2. Japanese share of machine-tool imports into the United Kingdom, 1980-1990



Source: Machine Tool Technologies Association (1991).

Figure 3. Exports and imports at 1985 prices, 1968-1990



Source: Machine Tool Technologies Association (1991).

For Japanese exporters of machine tools, such factors as protectionism in Europe, fears of the Single European Market in 1993, the expansion into Europe of their Japanese customers and strong growth in some numerical control sub-sectors were important elements in decisions relating to the mode of market servicing. For one firm, Yamazaki Mazak, the decision was to build a greenfield facility in the United Kingdom to assemble and manufacture small computer-numerical control lathes and machining centres for the European market. Success meant an early decision to expand capacity and a subsequent announcement of a manufacturing facility of components to be established in France. On the policy side, an informal undertaking was reached between Yamazaki and the Government of the United Kingdom that the company would raise local content to 70 per cent as quickly as possible.

A number of other Japanese companies have evolved into European manufacturing, with joint ventures being the most common route. By 1991, there were six Japanese transplants in Europe, two of which were in the United Kingdom; all, except one, were facilities for the production of numerically controlled lathes and machining centres, for which Japanese competitive advantage was particularly strong (Young and Dunlop, 1992). Aside from these instances, there are a number of Japanese licensing agree-

ments in Europe; indications are that most United Kingdom production of machining centres, for example, is under licence from Japanese producers. Further investments may be likely if some of the barriers identified by the Japan Machine Tool Builders' Association are overcome (Japan Machine Tool Builders' Association, 1989). Barriers include the problems of satisfying the diverse needs of European countries and markets; demanding local content requirements; problematic labour relations; and the large capital requirements for investment relative to the limited financial capabilities of individual manufacturers.

As suggested earlier, the 1990s will also witness the gradual emergence of the factory-automation era, for which Japanese, but also German producers, are well-placed.² The indications are that downstream value added will be increasingly emphasized during this phase. The machine tool becomes only one part of the hardware component, with the total solution incorporating pre-sale and after-sale activities with consultancy and software as key dimensions. From a market-servicing perspective, further increases in economies of scope will reduce the incentive for production outside the home country but, conversely, the requirement for increased software and consulting capabilities at host-country levels suggests the establishment of sales, engineering and consultancy affiliates. Among German companies, evidence from the survey revealed other factors at work emphasizing the same pattern of market servicing. One German company had identified large cost savings from assembling machine tools for the whole of Europe outside Germany, but objections of trade unions were a major barrier. More commonly, the philosophy has been to emphasise greater centralization because of the advantages of concentrating technical resources at the centre.

In part to test these suggestions, a survey of machine-tool importers in the United Kingdom was undertaken in 1991 (Jones, Wheeler and Young, 1992). The results of relevance to the present article include the following:

- Of the 48 importers covered by the survey, 22 were foreign affiliates; of these, 11 were German and 6 Swiss. Foreign affiliates were more recently established, on average, than agents and distributors, which made up the rest of the sample (a number of them were set up only during the last few years).
- Regarding major changes in types of machine tools sold and services provided by importers over the five years to 1991, the following were reported: in the first place, in terms of importance, was greater "sale

² On the issue of German competitiveness in machine tools, see Rommel, 1991.

of systems with significant design involvement by the MT supplier"; this was followed by greater "sale of standardized machines with design modifications involving technical interaction between the importer and the customer". In the third place was greater "sale of customised machines with technical interaction between the importer and the customer". By comparison, the sale of catalogue machines with no or limited options was reduced, with some form of customisation being widespread.

- Considering the perceived likelihood of change and reorganization in the machine-tool industry as a response to changes in the European environment, forecasts included: greater specialization among foreign sales affiliates, distributors and agents; and the replacement of agents or distributors by foreign affiliates. Support was also found for the view that non-European manufacturers would establish assembly plants in Europe for the development of supplier-owned pan-European distribution networks and for the emergence of pan-European agencies or distributorships.

Given that the focus of the above research was only partially directed to the themes of this article, there is some support for the proposition concerning the importance of downstream competitive advantage. Since this implies export-based strategies by major producers, with foreign sales affiliates to handle increasingly significant customer-interface issues, there are again major implications for the United Kingdom trade balance in machine tools.

The implications of activities of transnational corporations for the economy of the United Kingdom

Taking a snapshot of the pattern of TNC activity in the United Kingdom at a particular point in time (as was done by the interview survey of foreign-owned assemblers and manufacturers) reveals different groupings of firms pursuing different generic strategies.

Firms pursuing specialization strategies in the machine-tool industry are selling to niche markets based on product or application characteristics. Such strategies were typical of the types of approaches followed by companies in the pre-computer-numerical control era. While the companies concerned have moved increasingly towards the provision of computer-numerical control machines, their strategy is still focused on a particular industry or product line. To illustrate, one Canadian company in the United Kingdom manufactures machinery for making drums and car exhausts; while consis-

tently profitable to date, such companies are faced with a relatively small and declining market size, even on a world-wide basis.

Companies pursuing volume strategies compete on the basis of volume and cost, mainly in the supply of small computer-numerical control machining centres and lathes to a broad target market. Yamazaki Mazak of Japan fits into this category, but there were also some United States companies in the sample pursuing this strategy. One machine-tools maker from the United States was attempting to implement a volume strategy, with the United Kingdom as one of a series of "focus factories" supplying world markets. However, that company is suffering from a history of scattered manufacturing facilities and a plethora of low-volume products, which have yet to be phased out.

The final group of TNCs were pursuing differentiation strategies, with concentric diversification in evidence in order to broaden the product range. The latter has the advantages of widening the range of customer industries and achieving greater scale economies where, as in machining, the optimal scale is greater than that for a single production facility. However, the key to such strategies has been to move downstream in value-chain capabilities of companies, that is, towards software, consultancy and turnkey activities. The previous discussion suggested that exporting via sales affiliates would be typical of companies in this category. In the sample (which included only assembly and manufacturing affiliates) were, however, a number of foreign-owned companies that undertook limited assembly work in support of their primary engineering support, consultancy and other customer-service activities.

Some performance figures for the foreign-owned companies pursuing the various generic strategies described earlier are presented in tables 2 and 3. Caution must be applied in interpreting the data. On the face of it, however, foreign-owned enterprises pursuing specialization strategies showed the strongest export performance; when combined with a relatively low import content, the balance of trade was positive. However, it was in this category of companies that the greatest rationalization occurred during the 1980s (table 1). The future of the sample companies is by no means assured — two of the companies have merged at United States parent level since the date of interview. Volume producers are much larger and strongly export-oriented, but the import content of their turnover was high. This is related to the whole issue of vertical disintegration within the industry, which saw, for example, the managing director of United States-owned Cincinnati Milacron commenting that: "In today's CNC machine tool, the

Table 2. Sales and sourcing strategies for foreign-owned machine-tool companies (1988)^a

(Thousands of pounds and percentage)

	Generic Strategy		
	Specialisation	Volume	Differentiation
Number of firms	8	4	5
Inputs (as percentage of turnover)			
Imported machines from parent firms for resale	11.7	21.2	46.2
Imported components and raw materials	21.1	28.4	13.5
Total Imports	32.8	49.6	59.7
United Kingdom-sourced components and raw materials	29.2	23.5	12.5
United Kingdom factory activity, marketing, sales and service	38.0	26.9	27.8
Outputs (as percentage of turnover)			
Total exports	48.9	44.7	12.6
United Kingdom sales	51.1	55.3	87.4

Source: Personal interviews.

^a Partly estimated for some companies; no data were available for one firm.

bought-in content can be as high as 75 per cent taking into account castings, control systems, motors and drives, and we expect that percentage to increase". Expectations for the future are difficult to determine. The export share of turnover, however, can be expected to rise; conversely, the bought-in content is also likely to increase. While Japanese companies may be forced to purchase more in Europe to satisfy local-content rules, this does not help the balance of trade of the United Kingdom, unless "local sourcing" refers to sourcing from the United Kingdom as opposed to other European Community countries. Since more Japanese investments are located in European Community countries than in the United Kingdom, prospects for local sourcing in the latter are not encouraging.

Table 3. Performance indicators for a sample of foreign-owned machine-tool companies, average 1987 and 1988
(Thousands of pounds and percentage)

	Generic Strategy		
	Specialisation	Volume	Differentiation
Number of firms	9	4	5
Average per firm 1987 and 1988 ^a			
Fixed assets	984	9 477	921
Turnover	5 814	28 016	8 211
Exports	2 383	13 726	930
Pre-tax profits	113	934	29
Number of employees	131	368	95
Exports to turnover ratio	41	49	11.4
Pre-tax profits to turnover ratio	1.9	3.3	0.4
Fixed assets per employee	7.5	25.8	9.7
Turnover per employee	44.4	76.1	89.3
Pre-tax profits per employee	0.9	2.5	0.3

Source: Personal interviews and company accounts.

^a Average for calendar or fiscal years 1987 and 1988.

As the discussion of the growth of sales affiliates showed, as this method of market servicing grows, it will absorb substantial imports. The sample companies in the differentiation category, with some limited United Kingdom value-adding assembly activities and some exports, still show a substantial deficit in their trade balances. Overall, therefore, the implication is that the changing basis of international competitive advantage in machine tools, reflected in the nationalities of the major producers, generic strategies and ultimately methods of market servicing in the United Kingdom, has had an adverse effect on the competitive position of the United Kingdom, at least in terms of its balance of trade. Future prospects regarding this industry will depend chiefly upon the extent of Japanese inward FDI during the 1990s, the location of this investment within Europe and sourcing strategies, which in turn will reflect local content rules of the European Community.

With the contribution of manufacturing by TNCs declining, the competitive position of the United Kingdom will depend to a greater extent than hitherto on the performance of indigenous machine-tool producers. Applying the arguments of this article, long-term success will require a focus on growing user industries with competitive products and the ability

to satisfy customers through greater specialization on customer-focused activities, both pre- and post-sale and through the provision of consultancy and advisory services. Many United Kingdom producers are still (like their United States counterparts) selling into specialized niche segments of the market. The requirement is for a broadening of the market base and size of niche through market research and better market definition. Synergistic mergers are probably necessary and should be encouraged as a means of broadening the product offering to the customer. Weak financial resources, however, are a barrier to the successful implementation of merger strategies.

Policy dilemmas

This longitudinal study of the machine-tools industry in the United Kingdom has illustrated the rise and fall of United States foreign affiliates, the emergence of Japanese firms first as exporters and, more recently, as foreign investors and some likely trends in market servicing as the industry moves into its factory-automation phase. From a traditional mechanical engineering industry, machine tools have developed into an innovative, R&D-intensive industry at both hardware and software ends, with emerging global features.

United Kingdom and current European Community policy are, at one level, attraction-oriented, with regional and national investment agencies competing aggressively to encourage TNC investment into their economies. Superimposed upon this in the case of machine tools are export restraints, apparently imposed unilaterally by Japanese firms, and case-by-case negotiations on local content guidelines for inward FDI. These policies — once termed “benign neglect” (Hodges, 1974) and now more accurately “bounded prejudice” (Young, Hood and Hamill, 1988) — are ad hoc, pragmatic and lacking in clear objectives. Clearly, it is necessary to ensure that the domestic machine-tool industry is exposed to world-class competition and to the latest in technological innovation. But this essentially *laissez-faire* policy has seen the severe shrinkage of a strategically important industry — which might be termed the “spider in the industrial web” — and the emergence of a significant trade deficit with a weakened indigenous industry and little TNC activity.

A “do-little” approach to TNC activity would, at least, require active efforts to encourage the development of a globally competitive indigenous industry, including setting priorities for R&D and promoting research initia-

tives in these areas, stimulating international marketing, among others. In both cases, cross-border collaboration within the European Community offers opportunities. The beginnings of the inflow of Japanese FDI (green-field or acquisitions) in machine tools would need to be screened carefully at both pre- and post-investment stages, impact issues would need to be evaluated and more would have to be done to enhance the "demonstration effect" of Japanese companies and to stimulate indigenous sourcing.

The evolution of the industry does, of course, pose some policy dilemmas. Would it have been desirable, or indeed possible, for example, to try and sustain the United States-owned TNC sector? What policies should be pursued in the factory-automation era? More generally, the issue of policy formulation in an era of rapid technological innovation, blurring industry boundaries, changing national competitive advantage and emerging globalization is highly problematic. Little attention has been given to this at national or European Community level: the costs of not doing so, however, may, as in the industry case studied here, be very high. ■

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