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THE IRISH ENGINEERING INDUSTRY: STRATEGIC ANALYSIS AND POLICY RECOMMENDATIONS

EOIN O'MALLEY

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GENERAL SUMMARY

Since the 1950s the Metals & Engineering sector has played the leading role in Ireland's industrial development. It has grown a good deal faster than the rest of manufacturing so that its share of both manufacturing employment and output doubled from about 15 per cent in 1960 to over 30 per cent by the mid-1980s. By now Metals & Engineering, which is also referred to simply as the "engineering" industry in this paper, is Ireland's largest industrial sector. It includes a wide range of activities, such as the manufacture of metals, simple metal articles, productive machinery and equipment, electronic and electrical goods, medical and scientific instruments, motor vehicles and other means of transport such as railway equipment. In more advanced economies, such as other EEC countries or the USA, these industries make up an even larger proportion of manufacturing than in Ireland, typically accounting for close to half of all manufacturing employment, so that despite the growth of Metals & Engineering in Ireland since the 1950s, it is still of relatively small proportions here by international standards.

The general aim of this paper is to review the past development and present strengths and weaknesses of the Irish engineering industry and, having done so, to make some suggestions about the types of industry which might be most suitable for development in the future and the type of policy measures which would be required to make significant further progress. Section I of the paper describes the international and historical context within which Irish engineering has developed, and Section II reviews the performance and structure of the industry in Ireland, distinguishing between Irish indigenous and foreign-owned multinational firms. Section III then goes on to discuss strategies and policies for future development, including some discussion of what types of industries would be the most appropriate targets for development by indigenous firms under a more selective industrial policy.

Evolution of the International Engineering Industry

The Irish engineering industry, like any industry here, has naturally been shaped to a considerable degree by developments elsewhere. Competition from abroad, foreign technological developments and the growth of multinational companies, for example, have all contributed substantially to forming the type of industry we have or do not have today. Hence it is worth examining the pattern of development and present industrial structures in the advanced countries in trying to understand how the Irish industry emerged as it did and to gain an appreciation of its future prospects.

An important feature of the development of most engineering industries in advanced economies is that they have tended to grow up in large concentrated

industrial centres, initially at least. This is because there were advantages in having close contacts between customers, suppliers and related industries, and because it was easiest for new industries to emerge in locations which already had relatively large concentrations of engineers, technicians and skilled manual workers. Consequently, the areas which first succeeded in developing particular branches of engineering often continued to be the major centres of the industries concerned, and of new related industries as well, for long periods of time. Regions or countries which made a slower start on a smaller scale in developing the industries concerned found it difficult, therefore, to make significant progress when faced with competition from the larger advanced industrial centres which had the advantages (called "external economies") accruing from concentrations of companies and specialised skills and technologies.

Relatively late-industrialising regions or countries have also faced other difficulties arising from the competitive strengths of earlier established firms in more advanced industrial areas. For example, in some industries large established firms have advantages over small firms or newcomers arising from economies of scale, and if companies have to operate on a very large scale to be competitive it can be very difficult or impossible for new firms to raise the capital required to break into the industries concerned. In some industries, too, advanced technological capabilities are required and it is difficult for new firms in less-developed areas to catch up with the longer established firms. And in some industries there are significant learning or experience economies, which means that production costs decline and quality improves as engineers, technicians and skilled manual workers accumulate practical on-the-job experience. This effect also gives competitive advantages to the established experienced producers as compared with newcomers and hence it poses a deterrent or barrier to development of new producers in the industries concerned in less-developed areas.

Entry Barriers in Individual Sectors

Factors such as these are termed entry barriers or barriers to entry, and they can make it difficult to achieve development of indigenous firms in quite a number of industries in a late-industrialising country such as Ireland. On the other hand, attracting investment from abroad by large multinational companies can provide at least a partial substitute for indigenous development in some cases. An examination of the international Metals & Engineering industry indicates that the main entry barriers and development opportunities in the principal sectors within it are as follows:

— The international *Metals* industry tends to be highly concentrated in very large firms, suggesting that there are significant entry barriers for indigenous firms in late-developing countries arising from economies of scale and capital requirements. Since there is not a great deal of mobile multinational investment in the Metals industry, one would not expect to find very much foreign investment in Ireland in this sector.

— In contrast, the *Metal Articles* sector, even in advanced economies, is mostly fragmented among relatively small-scale firms, and they do not usually require particularly strong technological capabilities or a high level of skills. In general, entry barriers in this sector are consequently not very significant, so that one could expect fairly extensive development of this industry by Irish indigenous firms, but again there is not very much mobile international investment in this sector.

— The main entry barriers in *Mechanical Engineering* arise from learning economies since high skill levels are required, and from the advantages of external economies in strong established centres of the industry. These factors would impede indigenous development in Ireland and mobile international investment is also somewhat limited.

— In most of *Office & Data Processing Machinery*, substantial barriers to entry arise from both economies of scale and advanced technological requirements, which would tend to limit Irish indigenous development. But there has been a good deal of mobile international investment in this sector, since many of the companies are large and have been expanding rapidly, and this has presented opportunities to attract foreign firms to Ireland.

— Much the same is true of most of *Electrical Engineering*, except that the technological requirements are not quite so demanding in most of that sector.

— There are major entry barriers in most of the *Motor Vehicles* industry, arising particularly from economies of scale and capital requirements, so that one would not expect significant indigenous development here.

— For various reasons, the same holds true of most of the *Other Means of Transport* industries, namely shipbuilding, aerospace and railway equipment. However, there have been some opportunities to attract mobile international investment in these industries, particularly in the manufacture of components.

— Finally, in *Instrument Engineering* the main sources of barriers to entry are technological requirements and the advantages of external economies in strong centres of the industry. But significant opportunities from mobile international investment have been available in this sector.

In conclusion, there are quite widespread and substantial entry barriers in most engineering sectors, except Metal Articles, which would impede their development by Irish indigenous firms. At the same time, there have been opportunities to attract investment by foreign firms, especially in Office & Data Processing Machinery, Electrical and Instrument Engineering.

The Growth of Engineering Industries in Ireland

In view of the various barriers to development for a relatively late-industrialising country, there was little progress in developing engineering industries in Ireland during the nineteenth century, except in the north-east, and the first phase of significant development after Independence followed the introduction of protection against imports in the early 1930s. Employment in the sector roughly doubled between 1931 and 1951, which was similar to the experience of the rest of manufacturing. But this growth by means of protected import-substitution for the domestic market was halted during the 1950s and when significant expansion began again after 1958 it was due largely to an unprecedented development of exports, coming mainly from new foreign-owned firms, as a result of the adoption of more outward-looking policies.

In the new phase of export-oriented growth, engineering became the most important growth sector with a consistently greater rate of expansion than the rest of manufacturing. By 1982, the sector was employing 66,000 people as compared with 24,000 in 1960, and more than two-thirds of its output is now exported compared with only 12 per cent in 1960. The fastest growing sub-sectors since the early 1970s have been the high-technology Office & Data Processing Machinery and Instrument Engineering industries, while Metal Articles, Mechanical Engineering and Electrical Engineering have grown at about the average rate for Metals & Engineering as a whole. At the same time Metals, Motor Vehicles and Other Means of Transport have lagged behind noticeably and have experienced declines in employment since 1973.

Irish Indigenous Engineering Industries

When a distinction is made between Irish indigenous and foreign-owned firms, it is clear that most of the growth in engineering since the 1950s, as in industry in general, was due to the establishment of foreign multinational firms, which are not constrained by entry barriers, while the indigenous sector which does face this problem grew more slowly. And there was a substantial degree of continuity with historical experience in the performance of indigenous companies, in the sense that they have not proved very strong in competing internationally.

In the home market, competing imports began to win increasing market shares from Irish companies as soon as the reduction of tariff barriers began in 1966, and this trend of growing import penetration continued right through to the mid-1980s. At the same time, there was little or no compensating increase in shares of export markets held by indigenous firms. Nevertheless, despite the difficulties in successfully meeting international competition, and a weaker record in this respect in engineering than in other sectors, indigenous engineering did have a fairly substantial increase in employment until reaching a peak in the early 1980s, although this was followed by a decline in recent years.

This is explained by the fact that there was particularly strong growth in domestic demand for the products of indigenous engineering in the 1970s and, similarly, the fall in employment in the 1980s has been a reflection of weaker demand. In a context of low export-orientation and rising import penetration, strong domestic demand has been a necessary condition for growth in indigenous engineering.

Along with these trends, there has been a very marked change in the size structure of indigenous engineering since the early 1970s, with larger firms generally declining substantially while the proportion of employment in small firms increased. This can be explained by the fact that the larger companies which existed in the early 1970s were generally in industries characterised by significant economies of scale, and although they were large by Irish standards they could not compete successfully against even larger firms abroad as the trade barriers were dismantled. Small firms, on the other hand, are mostly in industries in which a large scale is of no great advantage so that they generally sell to limited local markets. Such industries, therefore, usually do not face very strong competition from abroad, but neither do they export much and so they are constrained by domestic demand.

Perhaps the most positive feature of the record of indigenous engineering has been the high rate of start-ups of new companies, even though they have nearly all remained small. In fact, the number of Irish companies in the sector doubled between 1973 and 1982, although this did not result in comparable employment growth due to the decline of existing large firms. It seems that Irish enterprises have been getting into the available small-scale niches at quite a rapid rate, suggesting that there is a spirit of active entrepreneurship and an ability to take advantage of the more obvious and accessible opportunities. But the major gap in the indigenous industry's development is the scarcity of larger-scale, high-technology or highly skilled activities, in which entry barriers are significant. Since these account for a major proportion of the engineering industry internationally, the Irish indigenous sector's development will inevitably remain rather stunted unless more of these types of activity can be established.

One reflection of this problem is the very unusual sectoral composition of indigenous engineering, in which about half of employment is now accounted for by the Metal Articles sub-sector while the other seven main sub-sectors are very underdeveloped by comparison with other EEC countries. This can be explained by the fact that there are not very significant barriers to entry in Metal Articles and it is mainly composed of small firms even in advanced economies, whereas the other sub-sectors are characterised by substantial entry barriers of one sort or another.

Foreign-Owned Multinational Industries

Since the late 1950s, foreign-owned multinational companies have established many new enterprises in Ireland, mostly in the type of relatively high-technology and/or large-scale industries in which indigenous firms are weakest. By 1985, foreign-owned companies employed 37,000 people in Metals & Engineering, or 59 per cent of total employment in the industry, and they accounted for an even larger proportion of the sector's output and the vast majority of its exports. They are mainly concentrated in Electrical Engineering, Office & Data Processing Machinery and Instrument Engineering, with fairly substantial activity also in Mechanical Engineering and Motor Vehicles. Whereas barriers to entry have impeded indigenous development in such modern large-scale industries, the multinationals have acted as something of a substitute in at least partially filling this gap in the country's industrialisation, although it is doubtful whether they could ever be an adequate substitute.

Although Electrical Engineering, Office & Data Processing Machinery and Instrument Engineering may be counted among the high-technology industries in countries like the USA, it is also true that foreign investment in Third World countries is disproportionately concentrated in these industries since it is often possible for firms to separate out low-technology processes and locate them in a less-developed area. Thus the growth of these industries in Ireland would not in itself necessarily be evidence of the development of genuinely high-technology activities here. In practice, skill levels in the Irish electronics industry (which includes most of Office & Data Processing Machinery and part of Electrical Engineering) are substantially greater than in Far Eastern newly-industrialising countries such as Singapore, but significantly lower than in advanced economies such as the USA or UK. And Research & Development activity, which is a key function for the industry, is far more limited in Ireland than in advanced economies and even a little below South Korea.

Skill levels in these industries have been increasing in Ireland, but this has been a rather slow process, and much the same can be said about linkages with the rest of the economy, which are still rather less than in other sectors. For these reasons rates of pay and secondary spin-off benefits contributing to further growth are less than one would expect from successful indigenous development of the same industries. For there is more limited development than in advanced industrial centres of the technical knowledge, skills and concentrations of sub-suppliers which could generate continuing self-sustained growth and diversification.

There has been a general pattern whereby employment in foreign firms tends to go into decline some time after their establishment in Ireland, and this means that overall employment growth has generally depended on additional first-time investment by new arrivals. But there are signs that new investment has become more difficult to attract since the early 1980s, so that employment in foreign-owned engineering declined after 1983. Similar trends occurred in other sectors too, and consequently it has become difficult to sustain the momentum of growth in foreign-owned industry which prevailed in the 1970s and early 1980s. In this context, no doubt correctly, the emphasis in industrial policy is now supposed to be shifting more to developing Irish indigenous industries, without ruling out new foreign investment.

An Approach to Future Development

The policy section of this paper discusses future development strategy for the engineering industry in the context of the change of emphasis in policy towards greater concentration on indigenous development. Thus it focuses primarily on the issues of how, and in what types of industry could indigenous development be most readily achieved, with foreign firms seen as playing a useful complementary role.

To date, indigenous firms have succeeded mainly in small-scale industries which are easily entered, but this alone is not and cannot be sufficient. The key issue now is to aim to build up stronger and larger Irish companies in some of the industries which are more difficult to develop. In the older industrial countries the growth of such industries came about, to a great extent, in an unconscious and unplanned manner. But some of the most successful late-industrialising countries, such as Japan or South Korea, have felt it necessary to implement quite specific plans to move progressively into selected more advanced industries in which they were initially weak or absent. Ireland, like them, is faced with the problem of having to overcome entry barriers for late developers, so it would also be appropriate for us to select particular industries in which to concentrate a major development effort sufficient to overcome the initial obstacles.

As well as selecting target industries for development, it would also be necessary for the state to adopt a more "active" approach, taking the initiative in ensuring that significant investments actually go into the industries concerned, rather than awaiting initiatives from companies which are likely to be deterred by the obstacles. Again, such an active approach has characterised the policies of some of the most successful late-developing countries since the state can mobilise or co-ordinate greater resources than individual companies and can adopt a longer term perspective.

Potential Target Industries

There are a number of different criteria which need to be taken into account in considering which industries would make promising targets for development by Irish companies. First, we would want to rule out the very large-scale activities which are dominated by giant firms. Second, the most capital-intensive industries should be regarded as unattractive since it would be desirable to maximise employment creation for a given investment. Third, we would need to avoid industries in which the low wages of less-developed countries give them a distinct advantage. Fourth, it would be preferable to develop industries enjoying strong growth in demand. Fifth, it would often be important not just to think in terms of individual industries in isolation, but to select groups of industries which use similar or related skills and technologies, or which may be purchasers of each other's products, so as to develop strong integrated industrial structures with a potential for continuing growth and diversification. And finally, we would ideally want to select industries for which we already have existing relevant indigenous capabilities, so as to apply our existing strengths to exploiting relatively promising openings in the international scene.

Applying these criteria, some of the major industries which appear to be least suitable for development by indigenous firms are cars, ships, aircraft, computers, aluminium and motor-cycles, for example, except for small specialised niches within these industries. Of the major engineering sub-sectors, the two which look most suitable targets for development of substantial integrated structures are mechanical and instrument engineering. Suitable products in these sectors include agricultural machinery (but not tractors or combine harvesters), process plants, e.g., for the food industry, mechanical handling equipment, precision toolmaking, medical instruments and equipment, and measuring and checking instruments. Outside mechanical and instrument engineering, other relatively suitable types of products include bicycles, boats, special-purpose vehicles, the smaller household electrical appliances, precision castings and forgings, and specialised applications or systems in electronics.

Policy Implementation

The state could play a more active role in developing substantial projects in selected target industries in a number of different ways. In some cases the best way might be to assemble and give financial backing to a consortium of companies which together have the necessary experience and skills required for a particular project. Or it might be more suitable to give special backing to a single strong enterprise, whether private or state-owned, to undertake direct state investment through the National Development Corporation, or to back joint ventures between foreign-owned and indigenous companies. The choice between the different methods depends a good deal on where one can find the necessary managerial competence and experience or the necessary labour skills for the industry concerned.

To undertake a full assessment of the options and to push ahead with the implementation of this approach, there would be a need for some sort of expert group or task force, combining people with a variety of experience in areas such as business management and corporate strategy, technology development and acquisition, and marketing. Such a task force, including people from commercial enterprises and the development agencies, could be organised by the Department of Industry and Commerce or the IDA, for example, but it would need a degree of autonomy. An important step for this task force would be to identify the more successful Irish companies and to ask them what possibilities they see for major expansions or diversifications which are beyond their capabilities with their present resources but could become viable propositions, given sufficient focused support to help them through the early stages until a fully competitive stature is attained.

Based on these consultations, together with its own assessment of opportunities apparent in the international economy, the task force could then decide on a number of target industries for development. The next step would be to enlist a company or consortium to undertake a major investment project in each area selected, leaving the detailed selection of products, processes and markets to the enterprises concerned. It would also be necessary to arrange an appropriate financial package, involving enough state backing to get each project off the ground and enough commitment by the enterprises involved to ensure that they have a responsible and determined approach. If it were possible to start up, say, from six to nine substantial selected projects each year, with a combined potential to employ 6,000 to 10,000 people on reaching the eventual target size five to ten years later, we could begin to make significant inroads on what would otherwise be a major long-term unemployment problem. Of course, suitable projects might be found in other sectors besides engineering, but engineering looks like one of the main areas offering potential for industrial expansion.

To minimise the risks involved, it should be possible — particularly in engineering — to develop large projects in phases, taking one step at a time. For example, one might aim to develop eventually a large company producing many different types of bicycles and making virtually all of the component parts. But this could begin with production of just one or two models and only those components which can be produced efficiently on a small scale, while other components could be bought in. Then the range of models could be gradually widened and the introduction of more component production could be phased in as the scale of operation grows.

There would still be financial risks with this approach, of course, but they have to be set against the risks of continuing with policies as they are, particularly when one considers the continuously declining trend in industrial employment since 1980. While there will inevitably be caution about any major new policy departure, it is also inevitable that major new departures have to be contemplated if we want results which differ quite radically from past experience.

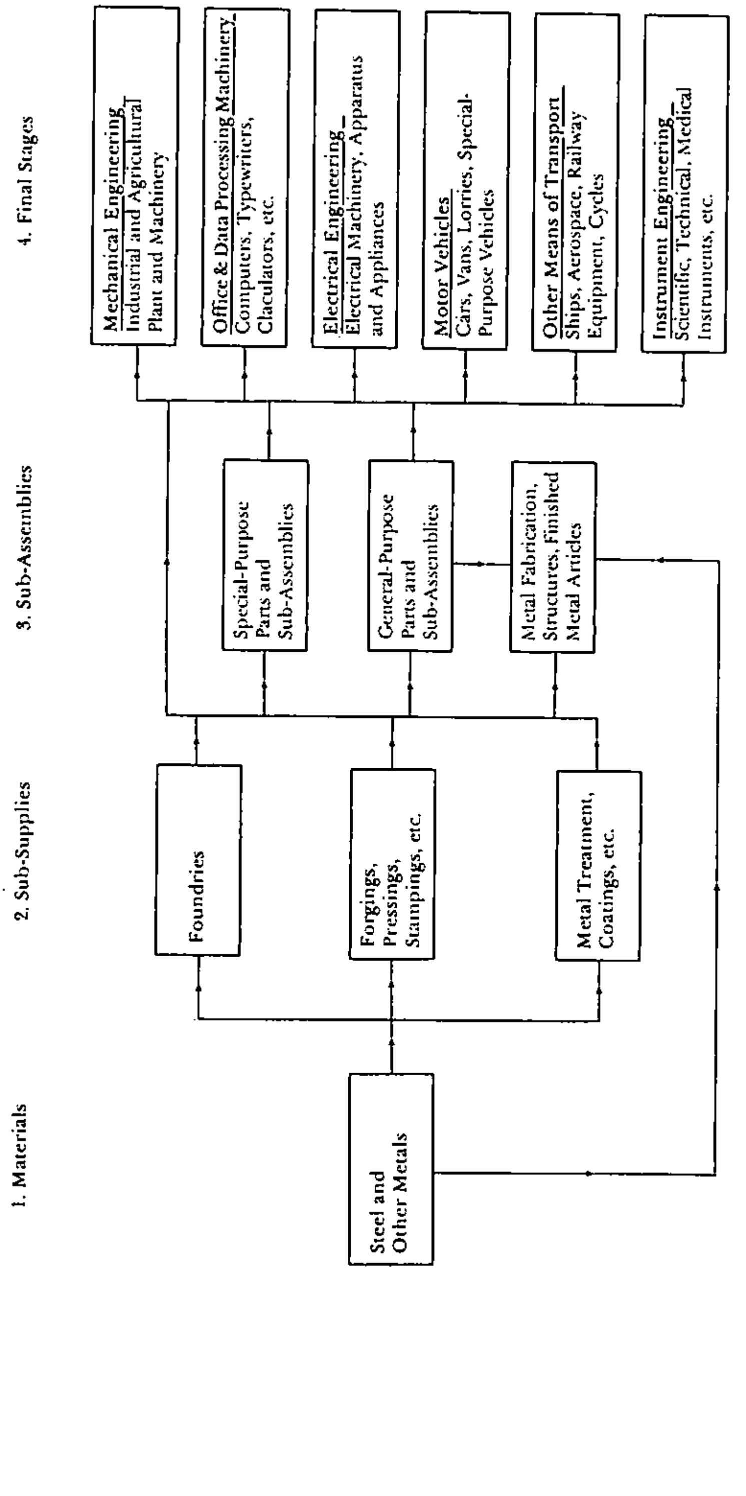
Chapter 1

INTRODUCTION

Since the 1950s the Metals & Engineering sector has played the leading role in Ireland's industrial development. It has grown faster than the rest of manufacturing so that its share of both manufacturing output and employment more than doubled from about 15 per cent in 1960 to over 30 per cent in the mid-1980s. By now Metals & Engineering is Ireland's largest industrial sector, employing more people than Food, Drink and Tobacco combined, and many hopes for future growth seem to be focused on this sector. Yet engineering industries often tend to have a rather low profile with the general public since much of their output consists of materials, machinery and equipment for use in further production rather than the consumer products used in daily life. The low profile of these industries is deceptive, however, since not only is Metals & Engineering Ireland's largest industry but in more advanced economies it typically accounts for an even larger proportion of manufacturing. For this reason, it is worthy of particular attention.

The scope of the "engineering industry" is commonly defined in different ways by different people, depending on their purpose. In this paper, the terms "Metals & Engineering" and "Engineering" are used interchangeably in referring to a broad group of industries. Figure 1 outlines the structure of this group, showing how its component parts relate to each other. First, the producers of steel and other metals provide the principal material inputs. At the next stage, "sub-suppliers" form metal into components such as castings (from foundries) or forgings, or they heat-treat and surface coat metals or components. The output of sub-suppliers can go to make sub-assemblies such as motors, pumps or gears, or it can go direct to producers of machinery, vehicles, etc., or it can go to fabrication of simple metal structures and articles which are then mostly sold to customers outside the engineering industry. The final stages of the industry include mechanical engineering (which produces plant and machinery), electrical, electronic and instrument engineering, and production of motor vehicles and other means of transport such as ships, aircraft and railway equipment. Most of the products concerned here are capital goods — meaning productive machinery and equipment for use in industry, agriculture and services — but there are also some important consumer products such as household electrical appliances, consumer electronic goods and cars.

Figure 1: *Structure of the Engineering Industry*



All of these industries come under the heading "Metals & Engineering" in the NACE industrial classification system used by EEC countries (NACE codes 22 and 31 to 37), and Appendix 1 gives a detailed listing of the NACE classes concerned. Table 1.1 shows the percentage of total manufacturing employment accounted for by Metals & Engineering in the other EEC economies as compared with Ireland. In all the other countries, the sector accounted for about 40 per cent or more of manufacturing employment in 1983 and 49

Table 1.1: *Percentage Share of Metals & Engineering in Manufacturing Employment, EEC Countries 1983*

Germany	54.7
United Kingdom	51.9
France	49.2
Belgium	43.7
Netherlands	40.4
Italy	39.9
Denmark	39.5
Ireland	29.9
EEC	49.2

Source: Eurostat, *Employment and Unemployment* (1985), Tables III/1 and III/2, except for Belgian data taken from Eurostat, *Regions Statistical Yearbook*, (1986), Table VI.1.

per cent in the EEC as a whole, making it by far the largest of the ten major sectors distinguished in the NACE classification system. In Ireland, it employed over 60,000 people, which was 30 per cent of total manufacturing employment — a substantially smaller proportion than in the other EEC countries. It is not only in these countries, but in every industrialised market economy with a higher GNP per capita than Ireland, that engineering is of considerably greater importance than in this country. In the USA, for example, metals and engineering industries (classified slightly differently) accounted for 45 per cent of manufacturing employment in 1977. It does not necessarily follow from these figures, of course, that Ireland must develop a stronger engineering sector in order to achieve further economic development. But in view of the great importance of engineering in manufacturing industry in more advanced economies, and in view of the high levels of value-added attainable in many branches of the sector, this clearly is a major area which cannot be overlooked in seeking ways to generate new employment opportunities and higher levels of income in Ireland.

The general aim of this paper is to review the past development and present strengths and weaknesses of the Irish engineering industry and, having done so, to make some suggestions about the types of industry in which Ireland's comparative advantage might be most readily developed further in the future. For this purpose, the paper is divided into three main sections. Section I, comprised of Chapters 2 and 3, describes the international and historical context within which Irish engineering has developed. It briefly outlines the process of development and structural change in engineering in advanced industrial countries, and the different characteristics of the main sectors, e.g. large/small scale, high/low technology and the extent of reliance on skilled labour. These characteristics reflect the different requirements for competitive success in different industries and they play an important part in explaining why Irish engineering has developed relatively well in some industries and is at a comparative disadvantage in others. Although there are also other macroeconomic factors which affect Irish industrial development in general — such as wage costs, macroeconomic policy, taxes or the strength of the spirit of enterprise — the focus of this paper is on the industry-specific structural factors which can explain why some industries are better developed than others in the same general environment.

Section II, comprised of Chapters 4, 5 and 6, reviews the performance and structure of Irish engineering and attempts to explain its strengths and weaknesses (or comparative advantage and disadvantage) in terms of the competitive constraints and opportunities created by the structure of the various industries internationally, as outlined in Section I. In doing this, Irish indigenous industry is treated separately, in Chapter 5, from foreign-owned multinational industries, in Chapter 6, since it is only in this way that one can explain the pattern of development of Irish engineering as a whole and thereby understand the constraints and opportunities which influence its evolution. For the factors which influence the development of indigenous and multinational industries in Ireland differ considerably.

Section III, comprised of the remaining chapters, then goes on to discuss strategies and policies for future development. The general approach here builds on Sections I and II which establish that Irish engineering is relatively well developed in industries with particular types of structural characteristics in advanced competing countries, but is largely excluded from others. Thus the approach of Section III is to analyse in somewhat greater detail the relevant characteristics of the whole range of engineering industries in advanced economies to see where the best opportunities for future development of Irish engineering are most likely to be found. This is a process which could, in theory, be extended and refined *ad infinitum,* if all of engineering were disaggregated into finely divided segments and each segment considered in great detail. But clearly it would be impossible for any one person to undertake such a task which could involve many thousands of segments and would require time-consuming research on each one. Inevitably, therefore, Section III of this paper has to be somewhat less ambitious, using various statistical indicators, for industries as defined in official classification systems, to suggest which industries offer the greatest or least opportunities for Ireland.

This process, therefore, does not produce effectively operational answers for industrial development agencies or enterprises attempting to assess or identify suitable investment projects. But it is intended to point to branches of engineering which could best repay more detailed investigation as possible areas for development.

In this context, it is worth referring to certain aspects of current thinking on industrial development policy in order to explain the practical relevance of Section III of this paper. In recent years the National Economic and Social Council and the government have undertaken fundamental reviews of industrial development policy. One conclusion which emerged from these reviews — most forcefully in Telesis (1982) and NESC (1982), but also in the White Paper on *Industrial Policy* (1984) — is that industrial policy should become more selective in focus. As the White Paper (p. 7) put it:

> industrial incentives and State advisory services will be applied selectively; this will entail the concentration of resources on internationally-traded manufacturing and service industries, particularly Irish-owned firms.

Since then, the Sectoral Development Committee (1985, p. 33) has been quite definite in recommending that sectoral selectivity should be a basic principle of industrial policy:

> Selectivity to support individual firms is already part of Ireland's industrial policy but there is a need to develop sectoral selectivity as well. This approach involves the identification of specific sub-sectors or niches where viable specialisation by Irish firms will give an internationally competitive advantage.

And more recently the NESC (1986, p. 269) has made a similar point:

> The over-riding requirement in deploying industrial policy instruments is that they be selective. This means that incentives must be focussed to the maximum degree possible on the sectors which are to be encouraged, on the firms which are deemed best-positioned to benefit most from the incentives, and on the disadvantages and penalties which it is desired to offset.

Nevertheless, it is still not entirely clear how far the principle of selectivity and concentration of resources is likely to be applied in practice — whether, for example, it is to be a matter of consciously selecting specific target industries and companies for development, or whether it will be simply a matter of excluding certain categories such as "non-traded" industries. But if industrial policy is moving, to any extent, in the direction of a more selective approach, it is essential to have a good understanding both of the strengths and weaknesses of existing Irish industries, and of the characteristics required for international competitive success in different types of industry. This is necessary in order to identify the types of industry which could be most readily developed in Ireland with a sound capability to compete internationally.

One of the aims of this paper is to contribute to developing this understanding in the case of the engineering sector of manufacturing industry. It is hoped that it will serve to complement the work of others, such as the IDA, the NBST, the Sectoral Consultative Committee -Engineering (1983) and the Sectoral Development Committee's (1986) report on electronic engineering. This paper cannot, as mentioned above, provide specific practical answers to the question of what projects to invest in. But it does aim to give some pointers in particular directions which are probably worthy of more detailed investigation, whether the search is for investment projects for private firms or for agents of selective state policy such as the National Development Corporation. In addition, it serves to highlight a number of issues which need to be considered in assessing industries for potential development. And perhaps, too, it contributes something to the continuing debate about whether it is necessary or wise for the state to adopt more selective and active policies. By examining the development of Irish engineering to date in the light of constraints and opportunities created by the structure of the industry internationally, one can gain some impression of how much is likely to be achieved by private initiative, and whether and how selective state initiatives could help to develop Ireland's comparative advantage further.

SECTION I

THE INTERNATIONAL AND HISTORICAL CONTEXT

Chapter 2

EVOLUTION OF ENGINEERING INDUSTRIES AND STRUCTURAL ENTRY BARRIERS

Before going on to look at the Irish engineering industry, this chapter sketches the pattern of historical development, structural change and the main barriers to entry which can arise in different branches of the industry in more advanced economies. It is worth considering these matters here because the Irish engineering sector, like any industry in Ireland, has naturally been shaped to a considerable degree by developments elsewhere. Competition from abroad, the changing basis of competition, foreign technological developments and the growth of multinational companies, for example, have all contributed significantly to forming the type of industry we have (or do not have) in this country. Hence one has to understand the historical pattern of development in the advanced countries, and the difficulties and opportunities that may result for relatively late developers, in order to understand how the Irish industry emerged as it did and to gain an appreciation of its future prospects.

Furthermore, the factors which determine competitive success today vary considerably between different types of engineering industry. For instance, in some branches a large scale of production is necessary. In others a smaller scale may be adequate but specialised skilled manual labour, good design or reliable after-sales service may be essential. Or in some branches it may be necessary to be located in an advanced industrial area while others can operate effectively in peripheral locations and take advantage of cheap labour. Historical and structural analysis suggests that these factors necessary for competitive success often change according to a fairly systematic pattern during the life-time of each industry. So by reviewing the past, discerning patterns of change and considering the various factors necessary for competitive success today in different industries, one can begin to understand why some types of industry are more developed than others in Ireland today and to assess which ones would be most suitable for future development here.

A. The Evolution of Engineering Industries

This chapter does not attempt to present a comprehensive and a detailed account of the history of engineering, since we are not primarily interested here in its history *per se.* Rather we are interested in general patterns of evolution, so the outline here focuses mainly on general trends, referring to individual industries as illustrative examples.

From the beginning of the industrial revolution over 200 years ago, a salient characteristic of industrialisation in each country was its centralisation in large towns or conurbations which grew rapidly. The development of each individual industry tended to be even more heavily concentrated in and around a small number of towns. In Britain, for example, the cotton industry was increasingly concentrated in and around Manchester and Glasgow, and woollen production was focused mainly on the Leeds-Bradford area of Yorkshire. Linen, too, became concentrated mainly in one or two British towns, but they were gradually squeezed out of this sector by competition from the even larger linen industry centralised in Belfast. Thus, despite the fact that cheaper labour was generally available outside the major towns, there appear to have been overwhelming advantages in concentrating mechanised industry in and around large specialised centres of production. And these advantages of centralisation appeared to cumulate since the competitive strength of the largest centres of mechanised production in each industry tended to squeeze out smaller competitors during the nineteenth century.

To a considerable extent, the forces underlying this centralisation of mechanised industry were to be found in the engineering industries and in their relationships with other sectors. Engineering industries, in a sense, often acted as the magnet which held the others together. Furthermore, new branches of engineering often tended to arise from existing branches in various ways, so that there were particularly strong forces causing the development and diversification of engineering itself to be highly centralised geographically.

In the early stages of the industrial revolution, the production of machines was not a specialised function of individual firms, so that, for example, there was still no separately identifiable mechanical engineering sector in the USA by the 1820s (Rosenberg, 1976, Ch. 1). Rather machinery was mostly produced on an *ad hoc* basis by establishments which were adjuncts to factories using the machines. Initially, the major machinery-users concerned were the textile industries, particularly cotton, which was the leading sector of early industrialisation. From the beginning, therefore, most production of machinery was carried on in close proximity to the textile industries. This close contact was necessary since the design of machines was experimental and continually evolving in response to the users' needs and their experience with earlier machines.

The production of machinery required a set of skills and technical knowledge which were acquired and improved largely through a learning process based on practical experience on the job. For this reason, the productivity of both engineering itself and the user industries could improve continuously through the cumulative learning process in engineering, which enabled steadily improving machinery to be produced more efficiently. Consequently, the earliest established engineering industries, operating in tandem with the largest user industries, gained cumulative advantages over smaller or late-developing competitors.

Once there was sufficient demand from large machine-using industries, it was possible for substantial enterprises to emerge which *specialised* in producing machinery. This development naturally tended to occur on a large scale first in the locality of the largest machine-using industries, particularly textiles. The extent of specialisation in mechanical engineering then became critically important in the further development of technology and skills. As Rosenberg (1976, Ch. 9) puts it:

> To appreciate this importance we must think in dynamic terms as well as in terms of static allocative efficiency. For there is a crucial learning process involved in machinery production, and a high degree of specialisation is conducive both to a more effective learning process and to a more effective *application* of that which is learned.

This is because technological know-how, particularly in the case of newly developing technologies, is not fully and freely available and waiting to be used by anybody, but rather has to be acquired and perfected through practical experience of quite specific applications. Svennilson (1964) explains:

> It would be far too crude to assume, as often seems to be the case, that there is a common fund of technical knowledge, which is available to anybody to use by applying his individual skill. We must take into account that only a part, and mainly the broad lines, of technical knowledge is codified by non-personal means of intellectual communication or communicated by teaching outside the production process itself.[1]

So the *application* of broad technical principles to *specific* uses requires practical experience and involves a learning process which becomes more rapid and effective as the extent of specialisation increases.

Given the advantages of specialisation in producing different types of machinery, and given that machine production had to be located close to the user industries, the most dynamic and progressive form of industrial development was an agglomeration of a large mass of machine-using industries in the same location as specialised mechanical engineering firms. The greater the demand for each type of machine generated by the user industries, the

1. I. Svennilson in K. Berrill (ed.), *Economic Development with Special Reference to East Asia*, New York, 1964. (Quoted in Rosenberg, 1976, Ch. 9).

greater was the degree of specialisation attainable in engineering, leading to increased efficiency and productivity both in engineering itself and in the sectors using its machines. Furthermore, as large industrial centres generated substantial local pools of skilled labour, the availability of these skills contributed to making the same locations especially attractive for new firms. Such mutual advantages, arising from interaction between a large group of industries in a centralised location, are termed external economies, because savings or "economies" are gained by each firm for reasons external to the firm. The largest industrial centres which developed relatively early tended to gain the earliest advantages of external economies to the greatest degree.

A further important development was the growth in production of machine tools or metal-working machines — i.e., the machines which are used to make machines — as demand from the growing machinery producers increased. Again, the emerging machine tool industries needed to be located close to a large mass of customers, in order to have close personal contact as they developed their machines for specialised purposes and to gain the advantages of increasing specialisation themselves. As demand increased, a considerable range of machine tools was developed to perform various metal-working tasks which were formerly done painstakingly by hand. Machine tool production itself became a highly specialised industry in the USA by 1900:

> . . . consisting of a large number of firms most of which confined their operations to a narrow range of products — frequently to a single type of machine tool, with minor modifications with respect to size, auxiliary attachments, or components (Rosenberg, 1976, Ch. 1).

Such specialisation was achieved rather more quickly in America than in Britain, which was probably a significant factor underlying America's increasing competitive strength in the second half of the nineteenth century (Rosenberg, 1976, Ch. 9). The development of a specialised machine tool industry gave further imeptus to productivity growth in related sectors, and hence to the advantages of external economies in large integrated industrial centres. Similarly, the development of specialised sub-suppliers — such as foundries supplying castings to a range of engineering industries — added to the advantages of external economies as did the continuing development of concentrations of skills.

Although there were considerable advantages in specialisation of production, it was still true that most machinery production posed a broadly similar set of problems and involved a broadly similar set of skills and technical knowledge in their solution. Consequently, engineering industries which had developed skills and technical knowledge in one line of production could often turn them to developing new products as the opportunity or need arose. In this way, generation after generation of new products tended to emerge in the same large established industrial centres where technology was most highly developed. The new products, as such, might have served purposes quite unrelated to previous ones, but they were related to earlier products by the nature of the process, the skills and the technology required to make them.

One important chain or sequence of related industries, which arose in heavy engineering, was the backbone of industrialisation in northern England, Scotland and northern Ireland. It ran as follows:

Textiles, or Mining

↓

Textile Machinery, or Mining Machinery, including Steam Engines

↓

Shipbuilding, Locomotives

↓

Other Heavy Engineering

Textiles, and mining to a lesser extent, created the initial demand for machinery which generated mechanical engineering industries in their locality. In Belfast, for example, the largest linen industry in the world developed in tandem with the world's largest industry producing machinery for preparing and spinning flax. The advantages of close proximity of the two industries are illustrated by an observer in 1874 (quoted by Coe, 1969, Ch. 5) who said that the machine-making establishments were:

> . . . *surrounded by spinning mills and were visited almost daily by* spinners, who thus were able to see the progress being made in the execution of their orders, and to point out their exact requirements and the defects of previous machines.

Having developed machines to work with flax, Belfast firms went on to become major suppliers of machines for textile industries working with similar hard fibres such as hemp, jute and sisal. The export of such machines from Northern Ireland to developing countries still continues.

Steam engines, including high-pressure boilers, became an important part of a machine-using economy, and these generally were produced in or near the large industrial centres because the mechanical and metal-working skills existed there and because engines often had to be designed for the particular circumstances in which they would work. Boilermaking, which was part of steam engine construction, in turn developed skills necessary for building iron ships. Thus:

> . . . the building of iron ships was not a further extension of wooden shipbuilding, but a different craft, a development of boilermaking. Thus the first iron vessel launched in Belfast was constructed, not in one of the existing shipbuilding yards, but in the engineering and boilermaking firm of Victor Coates & Co. (Coe, 1969, Ch. 6).

Furthermore, the shipbuilding firm of Harland & Wolff in Belfast originated as an ironworks making heavy iron plates to supply local industries.

In a similar way, skills developed in the textile machinery industry could lead eventually to the production of locomotives. Rosenberg (1976, Ch. 1) mentions several major examples of locomotive builders in America which grew out of firms initially devoted to production of machinery for the New England textile industry.

The flow of new product types emerging from this heavy engineering techology began to slow down in the twentieth century, a trend which partly explains the relative decline in importance of the old textile-based industrial centres such as Lancashire, Yorkshire, Clydeside and Northern Ireland. But another important chain of related industries arose elsewhere from the development of light, precision-engineering. Rosenberg (1976, Ch. 1) shows that it originated primarily with the production of firearms and ran as follows:

Firearms
↓
Precision Machine Tools
↙
Sewing Machines ⟶ Ready-Made Clothing and Footwear
↘
Bicycles, Cars, Other Motor Vehicles
↙ ↘
Diesel Locomotives General Light Engineering

As Rosenberg explains:

> Whereas the production of heavier, general-purpose machine tools — lathes, planers, boring machines — was initially undertaken by the early

> textile machine shops in response to the internal requirements of their own industry and of the railroad industry, the lighter, more specialised high-speed machine tools — turret lathes, milling machines, precision grinders — grew initially out of the production requirements of arms makers ... Throughout the whole of the first half of the nineteenth century ... the making of firearms occupied a position of decisive importance in the development of specialised, precision machinery.

Thus precision machine tool production developed initially in close liaison with the firearms industry, and in doing so acquired technical skills and developed machines which turned out to have direct application to production problems in other industries. The precision machine tool industry therefore became a pool or reservoir of skills and technical knowledge which were of great benefit in improving production processes in a wide range of industries and in making possible the development of major new products — from sewing machines to bicycles, cars, other vehicles and electrical goods.

Throughout this process, there was a continuing influence of external economies as the machine tool and user industries developed in close contact with each other and pools of different types of specialised skills and technical knowledge were acquired in centralised locations. Quite often, too, the continuing advantages of established producers were further demonstrated by the way in which new generations of products were made not just in the established industrial areas, but often by the existing firms which had begun with older technically related products. Car manufacturers, for example, had often begun as producers of machine tools or bicycles. Early aircraft, too, were made by people with experience in such industries.

Thus for several generations until well into the twentieth century, most of the new precision engineering industries which emerged remained largely situated in and around their original locations, which were not necessarily the same as the older heavy engineering centres. In Britain, for example, these industries remained concentrated where they first emerged on a substantial scale, mainly around Birmingham, London, and some smaller towns in between. This pattern of location was similar to the American experience since the manufacture of firearms in Britain had been largely confined to Birmingham and London. Right through to the mid-twentieth century these areas remained the main focus of British prosperity.

> In a broad belt stretching between the Birmingham and London regions, industry grew: the new motor manufacture was virtually confined to this

> zone. The new consumer-goods factories multiplied along the Great West Road out of London, while emigrants from Wales and the North moved to Coventry and Slough (Hobsbawm, 1969, p. 219).

The general pattern of centralised development around the early large industrial centres due to cumulative advantages of external economies had important consequences for those regions and countries which made a slower start on a smaller scale. They tended to be squeezed out of industrial production as the leading industrial areas grew stronger and captured larger markets during the nineteenth century with the help of improvements in transport and distribution. As the British and Irish textile industries, for example, became increasingly concentrated in Lancashire, Yorkshire, Clydeside and the North-East of Ireland, existing weaker textile industries in other areas such as Derbyshire, Norwich, the South-West of England and the other parts of Ireland were gradually eliminated (see Cullen, 1976, p. 107; Dickson, 1978; O'Malley, 1981).

As a major consequence for most of Ireland, the opportunity for development of engineering industries (and hence other important related sectors) was severely curtailed. Textiles would have been the most likely "leading sector" to generate demand for Irish engineering since neither mining nor firearms industries existed to any significant degree. And the potential of Irish agriculture as a leading sector was very limited since the small size of farms and the general shift to grazing in the nineteenth century meant there was insufficient demand for agricultural machinery and equipment in Ireland. As the advantages of external economies cumulated over time in the leading industrial areas, it would have become increasingly difficult for Irish industry to make a breakthrough. For the "critical mass" of producers, specialised technical knowledge and skills required for competitive production was increasing, presenting a growing barrier for newcomers. Other countries which were independent at the time could and did use protection against imports from stronger more advanced producers, of which Britain was the principal example for much of the nineteenth century, to foster relatively late industrialisation.

The advantages of external economies have tended to decline noticeably and production has become more dispersed in quite a number of branches of engineering in recent decades, for reasons to be discussed below. But they are still significant in other activities, particularly in those based on new technologies which are still evolving and developing relatively quickly and in others requiring a high input of specialised technical knowledge and labour skills which have to be acquired through practical experience. This is so for much the same sort of reasons already referred to in discussing the earlier development of older industries. Thus the more technically demanding activities in the American electronics industry, for example, are heavily concentrated in and around Boston and San Francisco (Silicon Valley), Los Angeles is the key location for aerospace, and Boston for medical instruments. As O'Brien (1985) explains, for research and development (R & D) intensive activities:

> The attractions are: access to skilled research labour (the single most important factor), to information on other R & D activities in the same field and to information from potential customers, to specialist services and special materials, and proximity to advanced customers who will be the first adopters of new products.

In the case of monitoring instruments and process control equipment, Freeman (1982, pp. 69, 70) also refers to the "particularly intimate nature" of the collaboration between those developing new chemicals or synthetic materials and those developing the new scientific instruments required for this work. Chemistry research laboratories have sometimes developed the instruments themselves and these were often commercialised by scientist-entrepreneurs setting up as instrument manufacturers. In other cases, scientists from chemical companies assist instrument engineering companies in the development of new products. This is reminiscent of the earlier pattern of development of mechanical engineering, involving close contact between producers and users, with the two often being one and the same initially.

The role of such factors in creating external economies for technologically evolving and highly skilled activities has thus not fundamentally changed, although the list of industries most influenced in this way has changed in the course of time. It is also worth noting that, for the modern high-technology industries, public sector purchasing now often plays the role of the "leading sector" which generates the crucial demand in the early phase of development. This has commonly applied to industries such as aerospace, telecommunications equipment, computers and integrated circuits. For example, Table 2.1 shows the proportion of sales of the American computer and integrated circuit industries going to public sector purchasers in the military and space fields during the early years of development of these industries. Thus, just as in the past weak or late development of industries such as textiles, mining or firearms could seriously curtail a country's prospects of building substantial engineering industries, so now a small or poor state faces difficulties in establishing a significant presence in some major industries based on new technologies.

Table 2.1: *Military/Space Share of US Production of Computers and Integrated Circuits, per cent*

Computers		*Integrated Circuits*	
1954	100	1962	100
1955	79	1963	94
1956	62	1964	85
1957	60	1965	72
1958	71	1966	53
1959	72	1967	43
1960	60		
1961	55		
1962	48		

Source: Schnee (1978).

As mentioned above, however, the advantages of external economies have declined for some older industries so that it now presents less of an entry barrier for newly-industrialising areas in such industries and they have become more dispersed geographically. The main reasons for this include a decline in the rate of technical change in older mature industries, the de-skilling of production jobs, the evolution of larger firms and improvements in transport and communications — all of which have helped to make it easier for firms to choose locations in less developed areas where wages and other costs are low.

As an industry ages, product innovations generally tend to occur less frequently as a standardised type of product evolves. With a more stable product design, in turn, it becomes worthwhile to develop and use machinery to a greater extent in making the product, so the process technology continues to develop for some time longer but eventually it too commonly becomes more stable and mature and the rate of process innovation slows down (Abernathy and Utterback, 1978). These changes can reduce the advantages of external economies in various ways, allowing the industries concerned to be established in less-developed areas (see Vernon, 1966). First, more capital-intensive production processes lead to de-skilling of production jobs, so the industry has less need for the specialised labour skills concentrated in advanced industrial areas. Second, a lower rate of process innovation reduces the advantages of close and frequent contact between suppliers and users of machinery and equipment. And third, a lower rate of product and process innovation reduces the reliance on specialist research, development and design skills located in highly developed areas.

Commonly enough, such changes affect different stages of a production process or different types of products at different times, so some parts of an industry become less subject to the influence of external economies while other parts remain concentrated in advanced industrial areas. For example, R & D and the more technically demanding production processes often remain tied to advanced areas while other activities, such as unskilled labour-intensive assembly processes, can be relocated. This trend has been facilitated by the growth of large firms which are capable of multi-product, multi-plant and multi-national operations (see Helleiner, 1973).

To conclude this discussion of centralisation and external economies, most engineering industries have tended to develop, initially at least, in advanced integrated industrial centres. This is due to benefits of external economies which consist mainly of the advantages of a pool of specialised technical knowledge and skilled labour, proximity to related firms, specialist services and suppliers, and a large demand from local customers. But these advantages can diminish in the long run as an industry matures.

From the point of view of a relatively late-industrialising country, the competitive advantages already enjoyed by more advanced existing industries in large established industrial areas present significant difficulties in developing the industries concerned. For it is hard for new enterprises to engage in such industries and develop to a competitive stature in the absence of the advantages of a pool of specialised technical and labour skills, local purchasers of a significant size and specialised suppliers and services. The implications for Ireland are referred to in Chapters 4, 5 and 6. On the other hand, the technological and skill considerations outlined above which give rise to external economies mean, too, that there are substantial continuing long-term benefits to be gained from trying to develop a critical mass of technology-intensive and skill-intensive industries. For once established, a sequence of related industries can evolve from such an industrial structure.

B. Entry Barriers and Structural Change in Individual Industries

As well as external economies, which can create difficulties in developing groups of industries, there are other factors which can create entry barriers for late-developers in individual engineering industries and they, too, often change in importance during an industry's lifetime (see Bain, 1962; Porter, 1980). Entry barriers, or barriers to entry, are structural features of an industry which give established firms inherent competitive advantages over potential newcomers, thus deterring new entrants; such barriers take various forms, as discussed below. This has important implications concerning the types of industry in which indigenous firms in a country like Ireland can best compete.

Some of these other factors have already been touched on in discussing the forces underlying external economies. First, as was already mentioned, *technological capabilities* are often important for competitive success, particularly in newly evolving industries, and this can create barriers to entry independent of the effects of external economies. If the important technological capabilities are possessed by a relatively small number of people, of if the technology is proprietary and restricted to a small number of firms, new entrants into the industry may face substantial R & D costs before they could compete on equal terms and there is also the risk that the existing firms will have made further technological advances while the newcomer is trying to catch up. The necessity for substantial R & D expenditure may arise either in developing products or production processes, or both.

Industries differ in the extent to which R & D costs pose such barriers since the level of R & D expenditure varies depending on how far the commercial benefit from technological development can be privately appropriated by the firm and on the degree of "technological opportunity", i.e., the relative ease of achieving new developments for a given R & D expenditure. But, in general, technological capabilities and the R & D effort are particularly important for competitive success in the early stages of development of new industries (or where new technologies are being introduced in older industries). Thus R & D expenditure accounts for 11.7 per cent of net sales in the computers and office equipment sector of electronics in the USA, but only 1.1 per cent in the more mature consumer electronics sector and only 0.4 per cent in textiles and clothing (Freeman, 1982). Access to technology would accordingly present a significant entry barrier to new Irish entrants in most of computers and office machinery, whereas the necessary technology for consumer electronics or textiles is more readily available, whether embodied in capital equipment which can be purchased or through purchasing of licences.

Second, formal R & D tends to be important in industries where significant technological advances can be made at some degree of remove from the actual production process, and where these advances can be codified, taught and learnt (Nelson, 1980). But there is another type of "know-how" acquired in a less formal or organised way, which can be important for competitive success. This also presents a type of barrier to entry, arising from *learning or experience economies* — which mean that production costs decline and quality improves as engineers, technicians and skilled manual workers accumulate practical on-the-job experience. This effect is related to the cumulative increase in output and it imposes higher costs and initial losses on newcomers as compared with experienced firms, thus deterring new entrants. The impact is greater the more complex and intricate are the tasks involved. In aircraft manufacture, for example, it has been found that average hours of direct labour needed per airframe can fall by about 20 per cent with each doubling in cumulative output of a given type of plane (Pratten, 1971, Ch. 15). Learning economies can apply not only in manufacturing, but also in other activities such as marketing.

Third, a common source of barriers to entry is *economies of scale* (or increasing returns to scale), which arise when a company's average costs per unit decline as the scale of production per period of time increases. This creates entry barriers because large existing firms have already achieved low costs due to a large scale of operation, so that newcomers would have to enter on a similarly large scale to be competitive. But newcomers may have little hope of capturing a sufficiently large market share to cover their investment costs quickly and therefore they risk going through a period of chronic losses. Alternatively, if they try to enter on a small scale, they must accept persistently higher average costs than large established competitors, which is also an unattractive option. Economies of scale, in the broadest sense of advantages of large size, are very common, arising not only in the manufacturing process, but also, and often to a greater extent, in purchasing, R & D, marketing, operating after-sales service networks, distribution and raising finance.

An impression of the general importance of economies of scale can be gained by looking at the structure of existing successful industries in advanced countries. Where one finds that an industry has become highly concentrated in a relatively small number of large firms, one can take it that there are probably significant advantages in a large scale of operation (for the firm, but not necessarily for society — Prais, 1976, Ch. 7), since the process of competition has squeezed out smaller firms and favoured larger ones. In the USA, for example, the *Census of Manufactures* distinguishes 174 different metals and engineering industries, and in 98 of these the largest eight firms accounted for over half of shipments in 1977. These 98 highly concentrated industries together accounted for a substantial majority of US engineering output. To put these figures in perspective, one must remember that the USA is an exceptionally large economy. If the top eight firms produce over half of output in a US industry, on average each one produces more than 6 per cent of US output, which would usually be a very large scale of production compared with the market size in most countries. For example, a company producing 6 per cent of output in a US industry would typically be capable of supplying roughly the equivalent of two-thirds of the Canadian market for the products concerned and twelve times the amount required by the Irish market.[2]

The importance of economies of scale, however, varies considerably between different types of industry. Table 2.2 gives one indicator of the types of industry which are most and least affected, by ranking the six major groupings of metals and engineering industries in the USA

2. These figures are no more than approximate indications of orders of magnitude based on the assumption that a US industry typically produces about enough to supply its home market and that market size for a typical industry in each country is proportionate to GDP.

according to the proportion of their output (value-added) which is accounted for by the highly concentrated industries within them. (For this purpose, highly concentrated industries are those in which the top eight firms account for at least half of shipments). Concentration data, however, show only part of the picture and another type of indicator which complements these data is the proportion of each industry's sales accounted for by large establishments with over 500 workers. In the USA, the percentages of sales recorded from such large

Table 2.2: *Relative Importance of Highly Concentrated Industries,* by Industry Group, USA, 1977*

Major Industry Group	*Number of Industries in Group*	*Number of Highly Concentrated Industries*	*Concentrated Industries' Share of Group's Value-Added (%)*
Transportation Equipment	18	14	96.0
Primary Metals	26	16	70.9
Electric & Electronic Equipment	37	27	66.0
Machinery, except Electrical	44	23	58.5
Instruments & Related Products	13	5	49.9
Fabricated Metal Products	36	13	25.5

**Note:* Highly Concentrated Industries are defined here to be those in which the top eight companies account for at least half of shipments.
Source: Derived from US *Census of Manufactures, 1977, Concentration Ratios in Manufacturing.*

establishments (which are bigger than virtually all Irish-owned firms in Metals & Engineering) are 87.9 per cent in Transportation Equipment, 66.5 per cent in Primary Metals, 64.6 per cent in Electric and Electronic Equipment, 61 per cent in Instruments, 54.7 per cent in Machinery and 29.3 per cent in Fabricated Metal Products. This is almost the same rank order of industry groups as the concentration data in Table 2.2. Both indicators suggest that economies of scale are least important in Fabricated Metal Products. Since other types of entry barriers besides those arising from a large scale also tend to be of limited importance in most of this group of industries, it would be no accident that (as is shown in Chapter 5) this is the only type of metals and engineering industry which native Irish firms have developed to a level comparable with other EEC countries. Of course, it is usually still possible for small firms and newcomers to find *limited* niches even in the most highly concentrated large-scale industries, for example, by focusing on specialised segments of the market or on selling in particular geographical areas. But there would tend to be only limited opportunities of this type in the highly concentrated industries while the major activities in them are dominated by large established companies.

Economies of scale are often not so significant in new industries, since rapidly evolving experimental product designs and small demand for the initially expensive new products allows rather little scope for the mechanised or automated production techniques which are a major source of economies of scale. But as sales grow over time and the technology becomes more settled and mature, greater economies of scale can arise in production, and also in marketing. For marketing also often becomes a more significant factor for competitive success in mature industries, both in order to realise the potential advantages of larger scale production by increasing sales, and because more mature products no longer sell themselves on the basis of novelty, new technological features or unique performance. Hence there is frequently a process of concentration, whether through mergers, acquisitions or a "shake-out" of weaker firms, after the early developmental phase and during the period of growth and transition to maturity (Porter, 1980; Dosi, 1981; O'Brien, 1985). Such a process of concentration into larger firms, squeezing out small firms and raising scale entry barriers for newcomers, has occurred in a wide range of maturing industries from pins (Pratten, 1980) to cars, aircraft and commodity semi-conductors.[3]

A fourth widely recognised source of entry barriers is *product differentiation advantages,* which means that established firms have advantages of brand identification and customer loyalties stemming from past advertising, a record of customer service or high quality, or simply from being one of the first into the industry. Differentiation creates entry barriers by forcing new entrants to spend heavily to overcome established customer preferences, at a considerable risk of failure, and it tends to be most important in consumer products.

Capital requirements are a fifth important source of barriers to entry. In part, this arises from the large scale of capital equipment necessary for competitive production in many modern industries — a factor which caused little difficulty for the earliest industrialisers. Thus Hobsbawm (1969, p. 39) remarks that the production techniques used in Britain's pioneering industrial revolution:

> . . . required little initial investment, and their expansion could be financed out of accumulated profits. Industrial development was within the capacities of a multiplicity of small entrepreneurs and skilled traditional artisans. No twentieth-century country setting about industrialisation has, or can have, anything like these advantages.

3. The example of pins is of interest, if only as a matter of historical curiosity. For Adam Smith based some of his observations and concepts on pin manufacturing, at a time when it was a model of the economist's "perfect competition" with many small producers. But by 1980, pin manufacturing in the UK had become concentrated in only two firms, both subsidiaries of multinationals, while in the USA 61 per cent of needles, pins and fasteners were made by the top eight companies in 1977.

However, as Porter (1980) also points out, capital requirements can also create particularly difficult entry barriers in cases where large amounts of finance are required for working capital purposes, e.g., for investment in advertising, R & D or customer credit; such investments may not be recoverable in the event of failure, whereas plant and machinery at least have some resale value. Capital requirements present entry barriers even when capital is not generally in short supply, because financial institutions may be justifiably reluctant to take the risk of lending to new and unproven manufacturing ventures faced with strong established competitors.

Capital-intensive large-scale industries also have a tendency to deteriorate into low or negative profitability unless they enjoy monopolistic advantages, and such deteriorations can occur quite rapidly. Thus while established firms may have little option but to remain in the business in the hope of recovering their investment costs, and since their investments are already sunk costs, this can be (and probably more often should be) a major deterrent to newcomers. The reason for this tendency is because investments in new additions to productive capacity have to be large, they take a long time to complete, and decisions to invest have to be based on long-run expectations concerning demand. When demand turns out to be below expectations, as it periodically does, excess productive capacity develops with new capacity continuing to come on stream for some time, leading to cut-throat competition and widespread losses. Such events occurred in steel, for instance, after the early 1970s.

Further possible barriers to entry which apply in engineering industries include *customers' switching costs* which can deter buyers from switching to a new supplier, due to costs such as retraining employees to handle different machines, the need to change ancillary equipment, or the cost of testing and approving the new product. And *access to distribution channels* can present entry barriers too, since existing producers are well established with distributors whereas new firms must persuade them to accept new products through price concessions, favourable credit terms, etc., which reduce the prospects of making profits.

Although this section has tended to dwell on the fact that many industries are characterised by entry barriers giving advantages to established firms and advanced economies, it should also be mentioned that newcomers can have advantages over them in other ways. In particular, labour costs are generally lower in late-developing countries than in the most advanced economies, and newly emerging firms can sometimes have greater freedom than existing ones to utilise up-to-date technology so long as the technology is generally available, embodied in capital goods, for example. Thus many developing countries have, of course, become internationally competitive in certain industries.

Their advantages tend to be greatest, however, in sectors which have relatively low entry barriers since these can be most easily developed by new firms and late-industrialising countries. Such industries are relatively small in scale, characterised by relatively low-level skills and perform little R & D, e.g., industries such as clothing, footwear, furniture, leather and wood processing. Industries such as these, which are quite fragmented in structure, are less common in Metals & Engineering than in some other sectors but there are examples in metal fabrication, metal articles and various components.

If an easily-entered industry is also characterised by high transport or logistical costs in relation to the product's value, or by advantages of close contact with customers, it will be highly decentralised geographically as well. For companies can arise quite easily to serve limited local markets and there are advantages over more distant competitors in doing so. They are sometimes called sheltered or (more loosely) non-traded industries because little international trade in their products occurs. Examples are concrete products and printing, and — in Metals & Engineering — structural steel and other simple fabricated metal products.

To conclude, the pattern of evolution and structural change in many Metals & Engineering industries in the most advanced countries has created various types of barriers to entry for relatively late-developing countries such as Ireland, since the necessary characteristics for competitive success can often be difficult for newcomers to acquire. But the nature and degree of difficulty caused by these entry barriers varies considerably between different types of industry. The next chapter outlines the main structural characteristics and types of entry barriers existing in the principal branches of Metals & Engineering in advanced industrial countries. This is seen as essential for understanding why certain types of industry have developed fairly well in Ireland while others have not, when we come to look at the Irish Metals & Engineering sector in Chapters 4, 5 and 6.

Chapter 3

STRUCTURAL CHARACTERISTICS OF THE PRINCIPAL ENGINEERING INDUSTRIES

This chapter outlines the main structural characteristics and types of entry barriers in each of the principal branches of engineering in advanced industrial countries. The purpose of this outline is mainly to indicate the nature of international competition and hence the varying degrees of difficulty which have confronted Irish firms in developing the different industries. This should help to explain the structure of the Irish engineering sector and the trends in its different branches when they are considered subsequently in Chapters 4, 5 and 6.

The analysis of this chapter is at quite a highly aggregated level, differentiating between only a fairly limited number of major categories of industry. In principle, one could disaggregate a good deal further, down to the level of the business segments within which firms actually confront each other in direct competition, i.e., what Bain (1962) calls a "theoretical industry" as opposed to categories of industries as defined in official statistics. But such a lengthy and detailed analysis is not considered necessary for the limited purpose of providing some explanatory background as an aid to understanding the experience of Irish engineering.

A. Comparative Indicators of Industrial Structures

This section looks at various indicators of structural characteristics of the principal engineering industries in a comparative way. The next section then sums up their characteristics, taking the industries one by one, with some more qualitative discussion as well. First we consider the role of economies of scale.

Economies of Scale

Although detailed studies at the company level would give more reliable results, a more accessible indicator of the importance of economies of scale in an industry, in the broadest sense of advantages of large size, is the size of existing successful firms and the degree of concentration in large companies. The justification for this is that the industrial structure which has emerged has been shaped to a considerable extent by competitive forces. If the process of competition has produced an industry dominated by relatively large firms, it is likely that there are competitive advantages arising from a large scale of operation, i.e., there are significant economies of scale. To some extent, however, such an industry structure might result from random or institutional factors, rather than economies of scale, but this is unlikely to be the case if we find much the same pattern of industry structures across a range of countries.

Table 3.1: *Percentage of Each Sector's Employment in Establishments with over 500 Workers, Germany, France and UK*

NACE Code	*Sector*	*Germany*	*France*	*UK*	*Three Countries Combined*
221	Iron and Steel	96.2	95.5	84.8	91.7
364	Aerospace	86.3	86.0	89.5	88.0
35	Motor Vehicles and Parts	90.2	84.2	80.3	85.5
361	Shipbuilding	78.1	79.2	76.2	77.5
33	Office and Data Processing Machinery	82.9	80.4	55.6	71.6
34	Electrical Engineering	76.6	64.4	56.8	68.1
224	Non-Ferrous Metals	69.9	48.5	43.6	53.0
311	Foundries	52.0	51.5	30.0	45.1
32	Mechanical Engineering	53.7	28.1	37.2	43.3
37	Instrument Engineering	34.4	20.6	38.8	34.0
316	Tools, Finished Metal Goods	33.6	31.4	33.9	33.2
314	Structural Metal Products	33.4	10.0	22.4	25.8
	Total Engineering	63.6	55.4	52.2	57.7
	Total Manufacturing	52.7	42.9	43.0	46.8

Source: Derived from Eurostat, 1983, *Labour Costs 1978, Vol. 2, Results by Size Classes and by Regions.*

Table 3.1 shows the percentage of employment in each sector accounted for by large establishments with over 500 employees in Germany, France and the UK, the three most important manufacturers of engineering products in Western Europe. It can be seen at the bottom of the table that employment in engineering as a whole in each country tends to be more heavily concentrated in large establishments than in the rest of manufacturing, but there are major differences in this regard between the different sectors of engineering. It is worth noting, too, that the German engineering industry, both in total and in nearly all the individual sectors, is the most heavily concentrated in large establishments, which may partly explain Germany's greater competitive success in most branches of engineering if it means that greater advantage is being taken of economies of scale.

The sectors which have a greater than average proportion of employment in large establishments are much the same in all three countries, and there are only minor variations in the rank order. (The industries are ranked in the table according to the data for the three countries together). This gives some reassurance that this type of analysis is picking up the effects of common underlying forces generating economies of scale, rather than random factors or institutional characteristics which would be peculiar to individual countries. The sectors with a greater than average proportion of employment in large establishments in all three countries are iron and steel, aerospace, motor vehicles, shipbuilding, office and data processing machinery and electrical engineering — in roughly that order. There is a less than average proportion of employment in large establishments in non-ferrous metals (except in Germany), foundries, mechanical engineering, instrument engineering, tools and finished metal goods and structural metal products — again roughly in descending order. (Much the same picture emerges in US engineering in Table 2.2). Barriers to entry due to economies of scale would thus tend to be most prevalent in industries placed at the top of this list and least significant in those closest to the end of the list. It does not necessarily follow from this alone, however, that industries towards the end of the list are easily entered by relatively late developers since they may be characterised by other types of entry barriers.

Table 3.1, however, could understate the general importance of economies of scale and the resulting entry barriers because the data show the percentage of employment in large *establishments* or plants, whereas many firms own more than one establishment. Hence a greater percentage of employment is concentrated in *firms* or enterprises employing over 500 people than in establishments with employment of over 500. The data by establishment size would be a reasonable indication of the importance of economies of scale in production, but economies of scale can also arise in R & D, purchasing, marketing, distribution, after-sales service, raising finance and the use of top management resources. These factors can give further advantages to larger multi-plant firms and create greater entry barriers than those arising from economies of scale in production alone.

However, whether one looks at data by establishments or by enterprises, the ranking of industries according to the proportion of their employment in large entities comes out much the same. Table 3.2 ranks engineering industries according to the percentage of their employment in establishments with over 500 workers in Germany, France and the UK (Column 1), and Column 2 of the table shows the percentage of their employment in enterprises of this size in Germany, France, the UK and Italy. The figures differ, naturally, but there are only minor variations in the rank order. Similarly, looking at data on the percentage of employment in even larger establishments with over 1,000 employees in Germany (Column 3), the ranking of industries is very much the same. Thus since much the same ranking of industries emerges from various indicators of

Table 3.2: *Percentage of Each Sector's Employment in Large Entities*

Sector	*Establishments over 500, Germany, France, UK*	*Enterprises over 500, Germany, France, UK, Italy*	*Establishments over 1,000, Germany*
Iron and Steel	91.7	91.6	90.5
Aerospace	88.0	92.0	86.3
Motor Vehicles and Parts	85.5	88.8	84.9
Shipbuilding	77.5	80.2	72.9
Office and Data Processing Machinery	71.6	87.9	74.5
Electrical Engineering	68.1	74.0	67.2
Non-Ferrous Metals	53.0	70.0	49.5
Foundries	45.1	45.6	36.5
Mechanical Engineering	43.3	51.5	34.3
Instrument Engineering	34.0	43.0	21.4
Tools, Finished Metal Goods	33.2	33.0	18.1
Structural Metal Produces	25.8	27.6	26.0

Sources: Table 3.1 for Column 1. Eurostat, *Structure and Activity of Industry-Data by Size of Enterprise 1981*, Theme 4, Series C for Column 2. Eurostat, 1983, *Labour Costs 1978, Vol. 2, Results by Size Classes and by Regions* for Column 3.

scale, and from various countries or groups of countries, there is no great need for concern about what precise type of indicator to use in identifying relatively large and small-scale industries. Jacquemin and de Jong (1977, p. 44) also point out that in ranking industries according to concentration ratios (the proportion of an industry concentrated in the largest firms), the results are similar regardless of the number of top firms selected as the criterion.

It is worth noting, however, that even where the technical scope exists for significant advantage to be taken of economies of scale, the actual size of firms may be limited by the size of the market for their products. Thus in industries consisting of distinct specialised segments, the technical conditions may exist for efficiency to be improved through larger-scale production, but demand for the products may be too limited to allow very large establishments or firms to emerge. For example, it can seen in Table 3.1 that establishments tend to be a good deal larger in iron and steel than in non-ferrous metals, but US data suggest that this is mainly because demand for the non-ferrous metals is much smaller. Table 3.3 shows the share of US production accounted for by the top eight firms in these industries as well as the average employment in the top eight firms.

Table 3.3: *Concentration Ratios and Employment Size of Top Companies in US Metals Industries*

Industry	*Share of Shipments by Top 8 Firms (%)*	*Average Employment in Top 8 Firms*
Blast Furnaces and Steel Mills	69	36,450
Primary Aluminium	93	3,220
Primary Copper	100	1,640
Primary Lead	100	620
Primary Zinc	100	570
Other Primary Non-Ferrous Metals	76	790

Source: US Census of Manufactures, 1977, Concentration Ratios in Manufacturing.

The high degree of concentration of production in a small number of firms in the non-ferrous metal industries suggests that significant economies of scale probably exist since there is little or no room for small companies. But the existing companies are still far smaller than steel companies because their industries are much smaller. Although barriers to entry in these medium-scale industries would be lower than in ones where very large firms are dominant, due particularly to lower capital requirements, the barriers would still be greater than the absolute size of existing firms suggests. For these industries are highly concentrated or oligopolistic in structure and it appears that a new entrant would need to gain a significant share of large markets to be competitive, which could be a slow and difficult business. Furthermore, a new entrant of a competitive size would represent quite a substantial proportionate increase in the industry's capacity, possibly leading to significantly excessive supply, competitive cuts in prices and a threat to the profitability of all concerned, particularly the new entrant who has the additional problem of having to build up market share quickly, starting from scratch.

Thus the deterrent to entry posed by economies of scale, as manifested in a high degree of concentration, but not a very large size of existing firms, is greater than firm size alone suggests. This type of consideration also applies in branches of mechanical and instrument engineering where economies of scale may exist but firms are not very large primarily because they are in small specialised segments with limited demand.

Technological Intensity and R & D

To turn to the role of advanced technological capabilities, various types of data are available as indicators of the importance of this factor in different industries. Resources devoted to R & D are usually taken as a key indicator and it is clear that the engineering sector taken as a whole is relatively R & D intensive. In the five OECD countries which spend most heavily on industrial R & D — the USA, Japan, Germany, UK and France — 68 per cent of R & D spending by business enterprises is accounted for by engineering industries, although they account for only 42 per cent of manufacturing value added. Table 3.4 shows the share of various engineering industries in total business enterprise R & D.

Table 3.4: *Percentage Share of Engineering Industries in Business Enterprise R & D, 1979*

Industry	*USA*	*Japan*	*Germany*	*France*	*UK*
Aerospace	22.3	n.a.	5.8	19.9	18.3
Electrical	7.3	10.1	25.2	3.4	4.0
Electronics	12.8	13.2		18.6	20.1
Instruments	5.4	2.9	1.9	1.1	1.5
Machinery	5.1	7.0	14.8	7.8	4.7
Computers	9.5	2.8			6.2
Motor Vehicles	11.7	14.0	12.6	11.8	5.6
Shipbuilding	n.a.	2.5	0.1	0.1	0.8
Other	0.4	0.2	0.1	0.3	n.a.
Total	74.5	52.6	60.5	63.0	61.1

Note: The definition of Engineering here differs somewhat from the EEC's NACE system.
Source: OECD (1984), Table 2.39.

Table 3.4 shows which industries tend to spend most on R & D, but since the industries vary in size it does not show which are the most R & D or technology "intensive". Table 3.5 shows that the most R & D intensive engineering industries in relation to sales or value added are generally aircraft, space vehicles and missiles, office and data processing equipment, telecommunications equipment, electronic components and professional and scientific instruments. Electrical engineering, motor vehicles and machinery generally have somewhat lower R & D intensities, with shipbuilding, metals and metal fabrication having the lowest intensities (see also National Science Board, 1983). Another indicator of technological intensity is the proportion of scientists and engineers in each industry's employment which, as seen in Table 3.5, gives much the same ranking of industries. The most R & D intensive industries toward the top of Table 3.5 tend to be those where advanced technological capabilities within the firm are most important for competitive success and where R & D costs would pose the greatest entry barriers for newcomers.

An important aspect of technological entry barriers is the extent to which R & D expenditure is heavily concentrated in a small number of large firms and governmental institutions. The US Department of Defense alone accounts for

Table 3.5: *US Resources for R & D by Industry, 1978*

Industry	*R & D as per cent of Net Sales*	*R & D Scientists and Engineers per 1,000 Employed*
Aircraft and Missiles	12.3	87
Office, Computing Equipment	11.7	76
Communication Equipment	7.7	46
Electronic Components	6.6	51
Optical, Medical, Photographic Instruments	6.2	43
Scientific Instruments	5.8	47
Other Electrical	5.3	32
Motor Vehicles	3.3	24
Non-electrical Machinery	2.1	38
Other Transport Equipment	1.4	14
Radio and TV	1.1	14
Fabricated Metal Products	1.1	11
Non-ferrous Metals	.9	13
Ferrous Metals	.5	5
Total Manufacturing	3.1	28

Source: Freeman (1982), Table 1.3a.

10 per cent of all R & D expenditure in the developed market economies (the OECD), and the top ten spending bodies in the OECD account for about 30 per cent. They include four US federal agencies, three US multinational companies and three European government agencies.

Among business enterprises, a high proportion of R & D is similarly concentrated in a small number of large firms. More than half of industrial R & D in OECD countries is undertaken by just 40 companies (OECD, 1982). Such firms engage in R & D projects on a scale which cannot possibly be matched by small or medium-sized firms or new firms. Table 3.6, for example, lists the R & D expenditures of the top twenty American and Japanese manufacturing companies (i.e., ranked in terms of R & D spending). The table shows that the scale of spending by individual large companies commonly exceeds that of *all* firms in countries such as Denmark and Finland and is many times greater than total expenditures of firms in Ireland. In industries where such a level of R & D expenditure is necessary to be competitive (e.g., cars, aircraft, major office and data processing machines, major telecommunications equipment), often backed by massive government funding or purchasing, the technological entry barriers for native firms in small or late-developing countries such as Ireland are overwhelming, at least in the main activities within such industries. Only very big established firms with a large dependable cash flow can undertake

Table 3.6: *R & D Expenditure of Top 20 US and Japanese Companies, 1979*

	USA			*Japan*		
Rank	*Firm*	*Million Dollars*	*Ratio to Sales (%)*	*Firm*	*Million Dollars*	*Ratio to Sales (%)*
1	General Motors	1,949	2.9	Toyota Motors	419	3.7
2	Ford Motors	1,719	3.9	Hitachi	397	5.8
3	IBM	1,360	5.9	Nissan Motor	362	3.3
4	AT & T/Bell	980	2.2	Toshiba	278	4.8
5	General Electric	640	2.9	Matsushita Elect.	201	2.9
6	United Technologies	545	6.0	Nippon Electric	173	6.0
7	Boeing	525	6.5	Mitsubishi Elect.	173	4.0
8	Eastman Kodak	459	5.7	Mitsubishi Heavy Ind.	154	2.8
9	IT & T	436	2.5	Honda Motor	153	3.6
10	Du Pont	415	3.3	Sony	132	7.0
11	Exxon	381	0.5	Fujitsu	123	6.1
12	Xerox	376	5.4	Nippon Steel	109	1.0
13	Chrysler	358	3.0	Toyo Kogyo	83	2.5
14	Spessy	280	5.9	Nippondenso	83	4.5
15	Dow	269	2.9	Takeda Pharmaceut.	81	4.8
16	3M	238	4.4	Fuji Photo Film	76	6.0
17	Honeywell	234	5.6	Isuzu	75	2.9
18	International Harvester	218	2.6	Bridgestone	72	4.1
19	Hewlett-Packard	204	8.6	Kobe Steel	71	1.7
20	Procter & Gamble	203	2.2	Tokyo Elect. Power	61	0.7

Total Business Enterprise R & D, million dollars

Finland	222
Denmark	213
Ireland	43

Source: OECD (1984), Tables 1.6 and 2.34.

such R & D expenditures, which will only pay back a return over many years.

The OECD (1984, p. 20) reaches a similar conclusion:

> Certain types of R & D are, in fact, so expensive that the minimum entry cost is too high for all except the very largest countries (e.g., high energy physics or space where even the largest European countries have to group their efforts in CERN and the European Space Agency).
>
> Not all R & D is as expensive as high energy physics or launcher development but the smaller the country the lower the number of fields or

industries in which it can hope to undertake R & D and the higher the number of those in which the minimum entry cost will become a barrier to entry.

Finally, it should be mentioned that the amount of resources devoted to R & D is not a comprehensive indicator of technology intensity. Expenditure on R & D is a measure of formally organised inputs into the innovative process, but innovation can also occur outside the formal R & D system. The relevance of the R & D data here is as indicators of a particular type of cost which acts as an entry barrier but they do not necessarily show the full extent to which technological capabilities may be important for competitive success. It may well be that practical experience and technological capabilities gained by engineers and others on the job in some industries, such as Mechanical Engineering, is an important requirement for "informal" invention, so that learning or experience economies would give advantages to existing firms over potential new entrants.

External Economies

Next we consider the extent of geographical concentration and the incidence of external economies in the main branches of engineering. Some industries, as was discussed in Chapter 2, operate most efficiently when centralised in large agglomerations due to advantages of external economies, although this factor is not very significant in others. From the point of view of less-developed regions or countries, the advantages of external economies enjoyed by established large industrial centres represent a competitive disadvantage to some degree, because they do not have the benefit of these advantages which existing competitors have. Thus they are less likely to develop the industries concerned.

One can judge the relative importance of external economies in an industry from the pattern of location of existing producers. If an industry is exceptionally highly concentrated in certain areas and absent from or very weak in less-developed areas — despite generally cheaper labour and government incentives for investment in the latter — one can take it that there are probably significant external economies underlying this pattern. Conversely, if an industry is not particularly highly concentrated anywhere and is reasonably well developed even in the least industrialised areas, the advantages of external economies could not be very significant and would not present appreciable difficulties for newcomers. Of course, there might also be general defects in the infrastructure, institutions or culture of less-developed areas which would partly explain their under-development, but such *general* conditions could not explain why some industries have developed there to a greater extent than others. This *difference* between the locational pattern of various industries, therefore, is a reasonable indication of the extent to which external economies influence their development.

EEC regional statistics can be used to analyse patterns of industrial location. The data used here are for regions of Germany, France and Italy, as defined by the EEC "Level II" classification, which distinguishes 31 separate regions in Germany, 22 in France and 20 in Italy, giving a total of 73 regions in the three countries combined.[4] These regions on average are about one-fifth the area of the Republic of Ireland. Table 3.7 (Column 1) shows the percentage of each sector's employment in the three countries combined

Table 3.7: *Regional Concentration of Engineering Industries in Germany, France and Italy, 1982*

NACE Code	*Sector*	*(1) Percentage of Sectoral Employment in Top 8 Regions*	*(2) Percentage of Total Industrial Employment in Same 8 Regions*	*(3) Index of Regional Concentration (1) ÷ (2)*
22	Metals	53.9	22.5	2.4
33	Office & Data Processing Machinery	60.0	25.4	2.36
35	Motor Vehicles & Parts	48.8	21.9	2.23
36	Other Means of Transport	43.6	20.7	2.11
37	Instrument Engineering	44.9	25.1	1.79
34	Electrical Engineering	42.7	25.3	1.69
32	Mechanical Engineering	40.4	30.5	1.32
31	Metal Articles	40.6	31.3	1.3

Note: The Top Eight regions are defined as those with the greatest employment in the sector concerned.
Source: Derived from Eurostat, 1985, *Yearbook of Regional Statistics*.

accounted for by the eight regions with the greatest employment in the sector concerned; thus the top eight regions referred to in the table are a somewhat different group for each sector. Since regions vary in size, population and level of economic activity, Column 1 of Table 3.7 could give a somewhat misleading impression of the relative concentration of the different sectors, so Column 3 of the table shows an index of regional concentration, calculated as the ratio of the top eight regions' share of employment in the sector concerned to their share of total industrial employment. Ranking sectors according to this index, as is done in the table, gives an indication of which sectors are most highly centralised relative to industry in general.

A significant aspect of external economies and centralisation in Metals &

4. UK data are not available from the source referred to here.

Engineering industries, too, is the importance of close inter-relationships between different sectors, which has the result that regions which are strong in one sector are also often among the strongest regions in other sectors as well. For example, in listing the top eight regions in the eight main branches of engineering, there is a total of 64 observations. And 48 of these observations (or three-quarters of them) occur in just twelve different regions which are listed in the top eight in at least two sectors. Table 3.8 illustrates this concentration in regions which are listed at least twice.

It can be seen from Table 3.8 that the largest concentrations of individual industries are often found clustered together in the same regions as the largest concentrations of other industries. In addition the regions concerned are mostly clustered together geographically, creating large agglomerations of engineering production. This reflects the pattern of evolution discussed in Chapter 2, by which a critical mass of skills and technological know-how developed in one industry often provides the basis for development of another while there is also often a need for continuing close contact between suppliers, purchasers and technologically related industries.

But Other Means of Transport (NACE 36) and, to a lesser extent, Metals (NACE 22) are somewhat exceptional to this general pattern since five of the top eight regions and three of the top regions in these sectors, respectively, are not among the top eight in any other sector (and hence are not included in Table 3.8). In other words, in these two sectórs the local linkages with other branches of engineering tend to be relatively weak. In Other Transport Equipment, this is mainly because shipbuilding is often located in places which are not major centres of other engineering industries. Aerospace, the other main component of this sector, does in fact tend to be clustered with large concentrations of industries such as Office and Data Processing Machinery, Instrument Engineering, Mechanical Engineering and Motor Vehicles. Shipbuilding, of course, has to be mainly located in coastal areas so it is isolated from most of the major engineering centres. It has also proved not to be a very prolific generator of other industries itself so large concentrations of other industries have not necessarily developed around it. This is of interest because it suggests that shipbuilding might not be a particularly useful industry to concentrate on in a development strategy, at least not from the point of view of aiming to generate skills, technological know-how and a structure of sub-suppliers from which a sequence of related industries would evolve. On the other hand, since it does not appear to depend on close contact with large concentrations of other industries, shipbuilding might be relatively easy for a newly industrialising country to develop.

Similarly the case of Metals is also significant, because it is clear that some regions have stong engineering industries without a substantial Metals industry

Table 3.8: *Regions Listed Among the Top 8 in Germany, France and Italy in More than 1 Branch of Engineering*

Region	Sector (NACE Code) 22	31	32	33	34	35	36	37
Nordrhein-Westfalen								
Düsseldorf	•	•	•					
Arnsberg	•	•	•					
Southern Germany								
Stuttgart		•	•	•	•	•		•
Darmstadt			•	•	•	•		•
Oberbayern					•	•	•	•
Karlsruhe					•			•
Freiburg				•				•
France								
Ile-de-France		•	•	•	•	•	•	•
Franche Comté						•		•
Nord-Pas-de-Calais	•	•						
North-West Italy								
Lombardia	•	•	•	•	•		•	•
Piemonte	•	•	•	•		•		

Source: Derived from Eurostat, 1985, *Yearbook of Regional Statistics.*

(e.g., the Southern German cluster of regions in Table 3.8), while other regions which have a strong Metals industry are relatively weak in other branches of Metals & Engineering. Thus the development of a Metals sector does not appear to have been either necessary or sufficient for more broadly based engineering development.

From the point of view of a relatively late-developing economy such as Ireland, the main reason for being concerned with external economies and geographical concentration is because these factors can create a form of entry barrier. From this angle, it seems more important to consider which sectors have generally proved slowest to develop in the regions which are *weakest* in engineering, rather than simply drawing conclusions by identifying those which are most highly centralised in a small number of the *strongest* regions. After all, Germany, France and Italy have *many* highly developed regions with a good environment of external economies for industry, so an industry might be fairly decentralised among quite a large number of regions while still being unable to operate very successfully in the weakest regions.

Table 3.9 (Column 1), therefore, shows the percentage of each sector's employment in Germany, France and Italy accounted for by the eight regions which have the lowest level of employment in the sector concerned. Again, as in Table 3.7, Column 3 of Table 3.9 shows an index of regional concentration, calculated as the ratio of the eight weakest regions' share of employment in the sector concerned to their share of total industrial employment. The sectors are ranked according to this index, indicating that the effect of external economies

Table 3.9: *Percentage of Employment in Engineering Industries in Weakest Regions of Germany, France and Italy, 1982*

NACE Code	*Sector*	*(1) Percentage of Sectoral Employment in 8 Weakest Regions*	*(2) Percentage of Total Industrial Employment in Same 8 Regions*	*(3) Index of Regional Concentration (1) ÷ (2)*
31	Metal Articles	2.8	7.97	.35
22	Metals	1.4	7.32	.19
34	Electrical Engineering	.88	5.37	.16
36	Other Means of Transport	.6	5.18	.12
32	Mechanical Engineering	.88	7.14	.12
35	Motor Vehicles	.52	6.15	.08
33	Office & Data Processing Machinery	.36	6.06	.06
37	Instrument Engineering	.13	4.56	.03

Source: Derived from Eurostat, 1985, *Yearbook of Regional Statistics*.

in inhibiting development is probably most marked in sectors at the bottom of the table and least important in those at the top.

Not surprisingly, the rapidly evolving high-technology sectors of Instrument Engineering and Office and Data Processing Machinery are proportionately least developed in these regions, since they lack the concentration of specialised technologists, skills, suppliers and services which are conducive to the successful emergence of such industries based on the latest technologies. In fact, employment in each of these sectors in the eight weakest regions combined is numbered only in hundreds although the regions concerned have over a million people in industrial employment. Thus the lack of appropriate external economies in the weaker regions seems to create significant barriers to development in these sectors.

Although this problem is somewhat less in evidence in the other sectors, most of them are still very much under-represented in the weakest regions compared with industry in general, suggesting that external economies in some form is a particularly significant feature of engineering. The Metal Articles sector, however, stands out as rather exceptionally well developed, even in the regions which have least employment in that sector. And although it does not come out in Table 3.9, more detailed observation reveals that Metals is also a relatively well developed industry in a number of the least industrialised regions which are weak in engineering generally. Five regions of Southern Italy and the island of Sardinia, for example, whose engineering industries are disproportionately small, account for a greater share of Metals employment in Germany, France and Italy than their share of total industrial employment. There are also similar examples in France and Germany of relatively underdeveloped regions being disproportinately strong in shipbuilding.

To sum up, it seems that barriers to development resulting from the effects of external economies are of least significance in Metal Articles since this sector is least highly centralised and even the weakest regions have developed it to a considerable degree. Metals and shipbuilding, although highly centralised in their main centres of production and very underdeveloped in many regions, differ from the usual pattern, too, in so far as they are sometimes highly developed in areas which are otherwise relatively lacking in industry, particularly other engineering industries. And in contrast to the common pattern as well, they are often virtually absent from strong centres of engineering. Thus they can operate in some degree of isolation from other engineering sectors, whereas the major concentrations of most of the other sectors tend to be clustered together more. And most of these other sectors, particularly the modern high-technology sectors, are usually much less developed in weaker regions than industry in general, suggesting that forces of external economies act as a barrier to their development in less-developed or late-industrialising areas.

Skills

Finally, it was suggested in Chapter 2 that learning or experience economies give advantages to existing firms over potential new entrants in industries involving specialised complex and intricate tasks, whether managerial, technical or manual in nature. One indicator which should give some impression of the industries most affected is skill-intensity, or the proportion of skilled white-collar workers and craftworkers in each industry's employment. Table 3.10 shows such data for the UK.

As the table shows, white-collar skill-intensity tends to be greatest in the most technology-intensive sectors — Office and Data Processing Machinery, Instrument Engineering, Aerospace and Electrical Engineering (which includes Telecommunications Equipment). Manual skill-intensity is highest in Railway Equipment, Mechanical Engineering and Aerospace again. It is worth noting here that in the high-technology, white-collar skill-intensive

Table 3.10: *Skilled Workers as a Percentage of Total Employment, UK 1983*

NACE Code	*Sector*	*White-collar Workers* as per cent of Total*	*Craftsmen as per cent of Total*	*All Skilled as per cent of Total*
22	Metals	24.8	12.3	37.1
31	Metal Articles	25.1	15.3	40.4
32	Mechanical Engineering	35.3	27.0	62.3
33	Office & Data Processing Machinery	69.7	4.0	73.7
34	Electrical Engineering	41.4	10.3	51.7
35	Motor Vehicles	23.0	15.8	38.8
362	Railway Equipment	20.0	47.7	67.7
364	Aerospace	48.3	28.6	76.9
37	Instrument Engineering	48.8	13.1	61.9
	Metals & Engineering	36.5	18.6	55.1

**Note:* White-collar includes Managerial, Administrative, Technical and Clerical.
Source: Engineering Industry Training Board, published in UK *Annual Abstract of Statistics*, 1986.

industries, apart from Aerospace, there is typically a rather low level of manual skills. Much of the actual production process involves low-skilled assembly work. This means that in large multi-plant or multinational firms, it can be relatively easy to separate parts of the production process from the core of the firm's activities and relocate them in underdeveloped regions or countries with low labour costs or other attractions. Consequently, as we shall see in Chapter 6, electronic and electrical engineering, which have low manual skill-intensity, are over-represented among multinationals in developing countries, whereas the skilled manual labour-intensive industries are not. Thus direct investment by foreign multinationals provides a relatively easy but only partial form of access for developing or newly-industrialising countries into the modern high technology industries, despite the prominent entry barriers for newcomers. But it also raises issues about the long-term implications of such development, which we return to in Chapter 6.

B. Structural Features of Individual Sectors

This section sums up the characteristics of the various sectors, taking each sector in turn. It also refers to the implications for Ireland, pointing out where one would expect the Irish engineering industry to be most or least successful in its development up to the present. In this way it offers some initial observations which should help to explain the structure and trends in the Irish engineering industry which are examined subsequently in Chapters 4, 5 and 6.

Production and Preliminary Processing of Metals (NACE 22)

The main branches of the Metals sector are mature industries, possessing characteristics that are commonly portrayed as typical of the mature phase of the industry life-cycle. Thus they are characterised by a relatively low rate of technical change, substantial economies of scale and hence concentrated or oligopolistic industry structures, a range of quite standardised products, generally weak growth in demand and a high degree of capital-intensity. In the older industrial countries, these industries generally arose in the same locations as ore deposits because of the influence of transport costs at a time when transport conditions for bulk shipments were poor. Areas without substantial ore deposits usually did not develop large competitive metals industries until more recently. But the development of cheaper bulk transport has enabled them to grow successfully in countries which are poor in resources, e.g., Japan.

The main source of barriers to entry in Metals is not in external economies, product differentiation, technological capabilities or specialised skills. The technology can often be purchased embodied in process plant or under licence. But major entry barriers result from economies of scale and capital requirements. These barriers have been successfully overcome by some large newly industrialising countries, which can attain a sufficient scale with the aid of protection of their substantial domestic markets and can obtain international loan capital for finance. Some of these countries, such as South Korea, Brazil and Argentina have thus emerged as major producers of steel, exacerbating a situation of apparently chronic excess productive capacity and resulting in widespread losses or low profitability.[5]

For Ireland, with a small domestic market and a policy of free trade, however, one would expect the entry barriers to impose a serious constraint on the development of an indigenous Metals industry. Of course, as in any large sector, there are activities which are exceptions to any generalisations such as those made above, so the industry is not *completely* ruled out for Ireland, but one would expect it to be relatively small. Apart from indigenous firms, however, another route to industrialisation is through the attraction of multinational companies to Ireland. Since large firms have emerged in this sector, one might expect to find some multinational investment in Ireland. But this would be relatively limited since most companies in the developed world have been rationalising or cutting back productive capacity rather than expanding in recent times.

5. Peter Bruce, "The Rise and Rise of the Third World", *Financial Times*, 22/11/83.

Manufacture of Metal Articles (NACE 31)

Although this sector includes a diverse range of activities, a valid generalisation for most of them is that barriers to entry tend to be lower than in the other branches of Metals & Engineering. Economies of scale tend to be relatively insignificant, so most firms are only small to medium-size and industry structures are generally quite fragmented. Technologies are either relatively simple and easily mastered, or else embodied in capital equipment which can be purchased. Skill levels are low and the forces of external economies and centralisation present relatively few difficulties for late-developing areas in some of the main product groups in the sector. Indeed, some product groups have both low entry barriers and a degree of natural protection against distant competitors because there is a need for close contact with local customers and flexibility of response to diverse local demands; these types of activities are thus sheltered or virtually "non-traded".

Structural metal products (e.g., metal barns and sheds, metal doors, window-frames, staircases) and other simple metal fabrication (tanks, gates, etc.) are generally numbered among the sheltered industries, which would be expected to have developed in Ireland in step with domestic demand. And many standardised finished metal articles (cutlery, pots and pans, buckets, etc.) also have low entry barriers although they could not be regarded as sheltered. The main area where difficulties could arise for a late-industrialising country like Ireland is in sub-supply industries (castings, forgings, stampings, metal treatment, etc.). In these activities there are often significant external economies since they may need to be in close contact with their customers which are principally other engineering industries. Thus such activities could be relatively underdeveloped in Ireland compared with other countries which have much larger concentrations of established engineering industries. Since firms in Manufacture of Metal Articles tend to be rather small, there has been relatively little development of multinational companies in this sector, so it could hardly be a major area for foreign investment in Ireland.

Mechanical Engineering (NACE 32)

This sector produces a very diverse range of productive machinery and equipment and consequently it is difficult to generalise on its characteristics. Some branches are dominated by very large firms, e.g., tractors, bulldozers and combine harvesters, but for the most part firms in the industry are not particularly large. However, many segments of this sector are quite concentrated or oligopolistic in structure and the main reason why the companies concerned are not very large is because of limitations of demand for their specialised products. Thus entry barriers caused by economies of scale and the necessity to gain a significant market share to attain an efficient scale of production are often greater than firm size alone would suggest.

Although Mechanical Engineering is not a particularly technology-intensive sector, it is skilled manual labour-intensive. There also appear to be quite significant external economies since established centres of the industry, with a pool of specialised engineering and labour skills and a structure of sub-suppliers and related industries, have continued to be the principal locations for this industry. Thus, for example, the owner of one machine tool company explains why his firm decided to remain in Bridgeport, Connecticut, a traditional centre of his industry, despite the very high wage levels:

> . . . there is a culture of mechanical skills and the kind of mental skills you don't get in the agricultural areas. Here we have the resources in terms of very high quality sub-contractors, industrial suppliers, steel distributors and good communications.
> It's very difficult to take a guy out of the cornfields and make a toolmaker out of him.[6]

Although such forces of external economies are not so strong as to make Mechanical Engineering exceptionally highly centralised in a small number of regions, it does remain relatively undeveloped in regions which are generally weak in engineering. Thus one would expect this factor to have proved a constraint on its development in Ireland. As always, there are exceptions to such a generalisation, but one could expect Mechanical Engineering to be relatively small in Ireland compared with advanced industrial countries.

Office and Data Processing Machinery (NACE 33)

Much of this sector is composed of big firms, it is one of the most R & D intensive of all industries, and there seem to be significant external economies since it is highly centralised in advanced regions and virtually absent from many less-developed areas in industrialised countries. Thus in several important respects there are high entry barriers for indigenous firms in Ireland, in the main activities in this industry, so one would expect to find only limited indigenous development.

But since many firms in the industry have grown large, substantial multinational companies have emerged and unskilled labour-intensive activities have been located in developing countries. And because growth rates in this relatively new industry have been very high, significant opportunities have also arisen to attract expanding multinational companies to Ireland. *A priori,* however, one would expect the most R & D intensive and technologically demanding activities to remain concentrated in advanced industrial areas, so

6. "Profitable Niche in the Machine Tool Market", *Financial Times* survey of Connecticut, 15/1/86.

that mobile multinational plants in Ireland could generally be expected to carry out operations which are rather less demanding technologically than those remaining in more advanced industrial areas.

Electrical Engineering (NACE 34)

Much of this sector, again, is composed of large firms, e.g., in the major domestic electrical appliances, telecommunications equipment and basic electrical machinery, so there are entry barriers arising from economies of scale in much of the industry, but there are also some exceptions. Technological entry barriers, too, are sometimes substantial, with large R & D expenditures being necessary in much of telecommunications equipment in particular. However, other areas such as consumer electronics, electrical appliances and insulated wires and cables are mostly technologically mature with quite low R & D intensities. Most of the sector would not be easy for Irish firms to succeed in, but there are some activities with low barriers to entry.

However, there would be quite significant opportunities to attract multinational investment since there are many large firms which have been able to expand due to quite high growth in demand.

Motor Vehicles including Parts and Accessories (NACE 35)

The Motor Vehicles industry is very highly concentrated in giant firms since there are substantial economies of scale. In the United States, for example, the top four firms in "Motor Vehicles and Car Bodies" accounted for 93 per cent of sales and had average employment of over 75,000 each in 1977 *(US Census of Manufactures, Concentration Ratios in Manufacturing).* In Western Europe, six companies, each making over a million cars a year, accounted for 85 per cent of car production in 1978 while five other companies accounted for a further 14 per cent (Jones, 1981, Ch. 1). Although this sector is not exceptionally R & D intensive in relation to sales, companies' R & D expenditures tend to be very large in absolute terms, creating additional major entry barriers. Thus one would not have expected many Irish indigenous firms to prosper under free trade conditions in this industry. The possible exceptions, constituting a small minority of the sector as a whole, would be in special-purpose vehicles which form small specialised segments where no company can take much advantage of economies of scale, as well as in truck bodies and some parts and accessories.

There would be opportunities to attract some foreign investment in this industry since major multinational companies exist and growth rates are quite healthy. But the large integrated plants generally prefer to locate close to large centres of engineering since they depend on a very wide range of suppliers of components and there are advantages in close contact between them.

Consequently Motor Vehicles tends to be one of the least developed sectors in regions with relatively weak engineering industries.

Other Means of Transport (NACE 36)

This sector is comprised of three main branches, aerospace, ship (and boat) building and railway equipment, which have rather diverse characteristics. Entry barriers of nearly all types are very high in aerospace, making it an unlikely industry for successful Irish indigenous development. And both its skilled labour-intensity and the importance of preferential state purchasing from domestic producers in much of the industry often tend to restrict its choice of location to the major advanced countries, so that foreign investment in Ireland would tend to be rather limited.

Shipbuilding shares some of the characteristics of the steel industry — technological maturity, large scale, limited technological linkage with other major branches of engineering and hence considerable freedom to develop outside major established engineering centres. Thus for much the same reasons as in the case of steel, it has been successfully developed by large newly industrialising countries with the initial aid of protection — from Japan some decades ago to South Korea and Taiwan more recently. In view of these developments, combined with weak demand, there has been chronic excess capacity for some time, with widespread losses. One would expect the scale entry barriers to have restricted the development of this industry by Irish indigenous firms, while the poor market climate and excess capacity would have meant poor prospects in recent times for investment in Ireland by expanding multinational companies. However, small boat building, which is fragmented among many quite small firms, might offer opportunities for Irish indigenous firms.

Railway equipment is mostly quite highly concentrated in large firms indicating that economies of scale are probably significant. In the USA, for example, the top eight firms accounted for 65 per cent of sales in 1977 and employed an average of 4,200 people each. The entry barriers due to economies of scale would thus tend to have restricted development by private indigenous firms in Ireland. In this industry, too, preferential public sector purchasing from domestic producers tends to limit export opportunities, so the industry could scarcely have grown very large in Ireland, and Ireland would not be a particularly attractive location for multinational firms.

Instrument Engineering (NACE 37)

As in Mechanical Engineering, many firms in this sector are not particularly big and there is room for quite a large proportion of small to medium-sized firms. Again, however, some individual segments are quite concentrated or oligopolistic in structure, so one reason why the companies are not very big is because demand for their specialised products is limited. Thus the constraints imposed on new entrants by the necessity to gain a significant market share in order to attain an efficient scale of operation are sometimes quite important.

Much of Instrument Engineering is also particularly R & D intensive, more so than Mechanical Engineering, so there are probably appreciable technological entry barriers. And there appear to be quite significant external economies since the industry scarcely exists in many of the regions which are weakest in engineering generally in industrialised countries. Thus despite the relatively small size of many firms in this sector, there appear to be quite significant barriers to entry which one would expect to have restricted the development of Irish indigenous firms.

Although most firms in Instrument Engineering are not very large there are still quite a number of substantial firms. For example, among the 13 branches of the American Instrument Engineering industry, the top eight firms in each branch typically employ an average of 2,000-4,000 people and account for about 50 per cent of sales. So it has been possible for multinational firms to emerge and, with quite high rates of growth in demand, they have expanded quickly and provided significant opportunities for Ireland to attract foreign investment in this sector.

Having outlined the structural characteristics of the main branches of engineering in advanced industrial countries with which Ireland has had to compete, we can now turn to examine the growth and development of the Irish Metals & Engineering sector, which has occurred in this international context.

SECTION II

ENGINEERING INDUSTRIES IN IRELAND

Chapter 4

THE DEVELOPMENT OF ENGINEERING INDUSTRIES IN IRELAND

A. Background — Irish Engineering before the 1960s

In outlining the early evolution of engineering industries in advanced countries in Chapter 2, it was pointed out that they tended to develop initially in close proximity to their customers in increasingly concentrated industrial centres, the principal customers at first being industries such as textiles, mining and firearms. There also tended to be advantages in increasing specialisation within engineering. Since large industrial centres with a large mass of industries purchasing machines were able to generate the greatest demand for engineering products, they could achieve the greatest degree of specialisation within engineering. And this in turn meant that their engineering industries were the most efficient and turned out high quality products, so that the industrial centres which grew relatively large at the earliest date tended to be the most competitive, both in engineering and in the "leading" sectors which used the machinery and equipment concerned.

This development of competitive advantages in large integrated industrial centres was a dynamic and cumulative process giving increasing advantages to the larger industrial centres as time went on. To be competitive at any one time, it was important to have a scale of production and a degree of specialisation comparable to the best practice of the time. This made it increasingly difficult as time went on for late developing regions or countries to compete effectively with the more advanced areas, and consequently some form of policy intervention, such as protection against advanced competitors, was commonly used by relatively late developers.

In general, unprotected industries could not and did not develop smoothly from relatively small beginnings after the start of mechanisation elsewhere into successful large-scale producers. Rather the strongest centres of an industry, which made the earliest start on the largest scale, tended to gain increasing market shares during the nineteenth century, disposing of lesser competitors as they did so.

Since Ireland was in a relationship of free trade with Great Britain after the early nineteenth century, and since Britain was the world's leading industrial economy from the beginning of the Industrial Revolution up to the 1860s, there were thus considerable obstacles in the way of a successful Irish industrial revolution, quite apart from any domestic inadequacies. It was not that industrialisation completely passed Ireland by, but it occurred on a rather small scale and relatively late in the day in most of Ireland, at least by comparison with

Britain. Thus as time went on, the Irish industrial revolution faltered and eventually turned into industrial decline, with the notable exception of Belfast and the surrounding area.

As was noted in Chapter 2, in the absence of significant mining and firearms industries, the textiles industry appeared to provide the best prospect as a "leading" sector which might have generated the demand to create engineering industries in Ireland. Quite a substantial textiles sector did emerge in Ireland, in fact, and as late as the Census of 1841, 700,000 people were reported to be engaged in it. Linen was much the strongest branch, with a large established export trade before the process of mechanisation began. At that stage, before mechanisation began, it employed many people right across the northern half of the country, but the weaving and finishing stages were concentrated in the northeast while spinning gave work to large numbers of people, mostly women, as far afield as Mayo and Galway. The woollen and cotton industries were also well established in the home market in the late eighteenth century when the industrial revolution was getting under way, but they exported little and were a good deal smaller than British competitors.[7]

Beginning in the 1820s, both the cotton and woollen industries went into long-term decline. The contraction of the cotton sector, as Dickson (1978) concludes, may be regarded as:

> . . . only one aspect of the general concentration of the industry on Lancashire and Glasgow, in the second generation of industrialisation.

Cullen (1976) similarly remarks that the decline of the Irish woollen industry was comparable to the decline of smaller British woollen centres such as Norwich and the southwest of England in the face of the growing dominance of Yorkshire.

The Irish linen industry fared much better, however, which was consistent with the fact that it was larger than its British counterparts at the time when mechanisation began. After a process for powered spinning of fine linen yarn was perfected in the 1820s, the spinning stage of the industry in Ireland was transformed from a decentralised rural cottage industry into a factory-based activity concentrated in Belfast. As outlined in Chapter 2, centralisation generally accompanied the introduction of machinery into an industry, and Belfast was the natural location for the growth of a linen-spinning and textile machinery complex in Ireland, since the main concentration of skilled weavers and linen finishing trades were already based in the surrounding area. In due course, as was also mentioned in Chapter 2, a series of related engineering

7. See O'Malley (1981) for a somewhat more detailed discussion of these historical developments and references to some of the relevant literature.

industries developed in the Belfast area, starting with textile machinery, and Belfast emerged as the predominant centre of linen manufacturing in the world, gradually squeezing out its English and Scottish rivals.

For the rest of Ireland, however, the nineteenth century turned into a period of industrial decline as production became increasingly concentrated in specialised factories in large industrial centres elsewhere. Engineering activities which had existed in the early stages of the industrial revolution mostly failed to achieve an adequate scale or degree of specialisation to survive into subsequent generations in the absence of a large concentrated demand from local industries.

In steam engine construction, for example, Dublin rather than Belfast had been the main centre of production up to the 1820s. At that time:

> . . . any large engineering firm would have been prepared to undertake the construction of all types of machinery, including steam engines, if they could secure designs or machines to copy, for specialisation did not become general until the second half of the nineteenth century (Coe, 1969, p. 39).

But as specialisation, and hence a large local demand, became increasingly important for survival, Belfast with its rapidly growing and mechanising linen industry generated sufficient demand to support competitive steam engine manufacturers while Dublin did not. Similarly, ironfounding was a larger industry in the south than in the north in the first half of the nineteenth century. But the south's industry was largely general and non-specialised ironfounding, producing a diversity of products, whereas the north's ironfounders were focused more on producing specialised parts for machinery being made locally. In the second half of the century, this left the southern industry vulnerable to increasingly specialised and large-scale British competition, while Belfast's expanding engineering industries generated sufficient demand for specialised castings to allow northern ironfounding to continue growing (Coe, 1969, Ch. 3).

The outcome of such developments was that metals and engineering in the south declined, and due to the consequent scarcity of skills and technical knowledge acquired through experience, it became increasingly unlikely that new generations of products would be made here on a substantial scale. By 1929, only about 10,700 people were recorded as employed in Metals & Engineering in the Irish Free State, which was just 17 per cent of manufacturing employment and 0.8 per cent of the total labour force.[8] Much of this

8. Census of Industrial Production (CIP), 1929. The figure of 10,700 includes 6,909 in all Metals & Engineering sectors except railways and tramways plus an estimate of about 3,800 engaged in manufacturing and repairing of railway and tramway equipment; this estimate is based on the proportion of output of the railways and tramways sector accounted for by manufacturing and repairing, as opposed to construction and other work, since employment is not broken down in this way whereas output is.

employment was in a handful of quite large establishments — railway workshops and the Ford factory in Cork (see Jacobson, 1977, for an explanation of Ford's decision to establish a factory in Ireland). The remainder was largely confined to very small-scale manufacture of metal articles, with virtually no involvement in metals, mechanical engineering or electrical engineering except for repair and maintenance work.

When protection against imports was introduced in the early 1930s, however, foreign competition was substantially restricted, and industrial production and employment began to expand quite rapidly despite the world depression at that time. Metals & Engineering shared in this growth, although the greatest expansion occurred in consumer goods industries, and engineering's share of manufacturing employment declined slightly. Industrial growth was interrupted during the Second World War because of the difficulty of importing necessary inputs but it resumed after the war even more rapidly until the prolonged recession of the 1950s. By 1951, about 22,000 people were employed in Metals & Engineering which represented 15.7 per cent of manufacturing employment.[9]

It appears, therefore, that the protectionist policy encouraged industrial growth during the 1930s and 1940s. It might be said that the theory of comparative advantage shows that free trade promotes the greatest efficiency in allocation of productive resources, whereas protection leads to inefficiency in allocation and lower economic welfare than would otherwise be attainable. But whether the conclusions of the theory hold in a particular case at a particular time depends on whether the assumptions underlying it actually apply, and specifically on whether full employment of productive resources prevails. If there is full employment, international competition under free trade promotes efficiency in allocation of resources to the benefit of the trading partners, but if there is not then international competition would cause the weaker trading partner to suffer disproportionately from unemployment. Since there was, of course, high unemployment worldwide in the 1930s, and since Ireland had a record of unemployment and/or emigration for a long time previously, protection was not necessarily an inefficient strategy and certainly the initial phase of the protectionist policy was a time of industrial growth such as had not occurred for a long time past.

However, a basic long-term weakness in this strategy became evident in the 1950s. Protection had encouraged production for the domestic market but it did nothing to promote exports, and it may even have discouraged exporting

9. CIP, 1951. Although it appears from the data that employment in engineering more than doubled in the 1930s and 1940s, this probably overstates the rate of growth to some extent since the Census increased its coverage during this period. Nevertheless, it is clear both from the Census of Population and from the large number of new firms established in the 1930s and 1940s (Kennedy, 1971, Ch. 2) that there was substantial growth in manufacturing and, no doubt, in Metals & Engineering.

by giving producers good reason to concentrate on the home market where competition was less demanding. Thus, although the economy and the industrial sector in particular were growing, exports fell from £132 million in 1929 to £82 million in 1951, in constant (1953) prices *(Trade and Shipping Statistics, 1961)*. And as industrial production for the home market increased, without export growth, the proportion of manufacturing output going for export fell, with only 6 per cent of output (excluding Food, Drink and Tobacco) being exported in 1951 (CIP and *Trade and Shipping Statistics*).

At the same time, although import bills were initially cut quite substantially by the process of import substitution during the 1930s, there were still many goods which were not produced in Ireland, including many industrial inputs of fuel, materials and machinery. This was because of a lack of some raw materials, weaknesses in engineering technology and the constraint imposed by a small market on development of large-scale or specialised industries. Hence, as demand for those imports which had not been substituted by domestic production increased with economic growth, the import bills eventually, by the late 1940s, grew to exceed the cost of imports before the process of import-substitution began. With a continuing failure to achieve significant growth of exports, balance of trade deficits became increasingly threatening. In the absence of major capital inflows, this led to prolonged recession since further increases in imports, which necessarily accompanied growth, were no longer possible without increased export earnings.

Between 1951 and 1958, industrial output grew by little more than 1 per cent a year and manufacturing employment declined. In Metals & Engineering, employment stagnated throughout the 1950s, and the level reached in 1951 was not exceeded until 1960.

B. The Development of Irish Engineering since the 1950s

During the 1950s and early 1960s, there were fundamental changes in policy aimed at overcoming this impasse. New grants, tax concessions and advisory services were introduced in the 1950s to promote exports, and legislation was changed to encourage investment in export industries by foreign multinational firms, which had been actively discouraged from investing in Ireland since the 1930s. And in the 1960s steps were taken to dismantle protection and to return to free trade, mainly through the Anglo-Irish Free Trade Area Agreement, signed in 1965. The free trade relationship was further extended to all EEC countries after Ireland joined the EEC in 1973.[10]

These policy changes made Ireland an attractive location for multinational companies, particularly those aiming to export to the UK and later to the rest of

10. The intention to adopt these major changes in policy and the rationale for doing so were outlined and explained in *Economic Development* (1958) and the first *Programme for Economic Expansion* (1958). O'Malley (1980) contains an account of the steps by which the policy changes were implemented.

the EEC. They also improved access for Irish agricultural and food exports to major attractive markets. Consequently, with an inflow of foreign capital for industrial investment and rising export earnings, from both industry and agriculture, the balance of payments constraint was relaxed and economic and industrial growth resumed in the 1960s and 1970s. In this new phase of increasingly export-oriented industrial growth, engineering was the most important growth sector, unlike the import-substituting phase. Within engineering, however, as in industry generally, much of the growth was due to new multinational investment while many formerly protected Irish firms had difficulties in coping with the free trade environment. The rest of this chapter, however, concentrates on describing developments in engineering at an aggregate level without regard to distinctions of nationality of ownership. The aim here is mainly to demonstrate the key role played by this sector in Ireland's industrial development since the 1950s, without attempting to explain the trends, which can only be done when Irish firms are separated from the multinationals, as is done in the following two chapters.

Table 4.1 shows average annual rates of growth of the volume of production and employment in Metals & Engineering and in all manufacturing for various periods between 1953 and 1985. As the table shows, following the recession of the 1950s, the rate of growth of output and employment rose substantially during the period 1958-73 in both Metals & Engineering and total manufacturing. This growth was interrupted by the international recession of the mid-1970s, but after that growth rates rose again in the second half of the 1970s. In the first half of the 1980s, however, output growth slowed again in most industries and employment fell quite sharply, although in Engineering the rate of growth of output accelerated; but since there was also very rapid growth

Table 4.1: *Average Annual Percentage Growth Rates, 1953-85*

Period	*Volume of Output, Metals & Engineering*	*Volume of Output, All Manufacturing*	*Employment, Metals & Engineering*	*Employment, All Manufacturing*
1953-58	4.4	1.2	1.0	-0.2
1958-73	8.2	6.7	5.3	2.4
1973-76	0.5	1.6	0.5	-1.0
1976-79	7.2	7.6	6.8	3.2
1979-85	10.1	4.0	-1.3	-3.2
1958-85	7.7	5.7	3.9	1.0

Note: There was a change in the industrial classification system from SIC to NACE in 1973, but Metals & Engineering covers substantially the same activities under both systems. Employment data for 1985 are the average of the first three quarters.

Source: Census of Industrial Production, and monthly inquiries for 1985.

in labour productivity, engineering employment fell somewhat at the same time. Thus after the late 1950s there was generally quite a strong expansion of industrial output and employment, at least until the 1980s. Metals & Engineering played a very important part in this expansion and accounted for a growing proportion of Irish industry, as Table 4.2 shows. By 1982, engineering employed 66,000 people, as compared with 24,000 in 1960. In fact, the increase in Metals & Engineering employment between 1960 and 1982 was equivalent to about two-thirds of the increase in total manufacturing employment.

Table 4.2: *Percentage share of Metals & Engineering in Manufacturing Employment and Output, 1960–82*

	1960	*1970*	*1980*	*1982*
Percentage Share of Employment	16.0	19.6	29.0	30.7
Percentage Share of Net Output	15.1	18.5	26.7	29.1

Source: Census of Industrial Production.

Within the engineering sector, however, there has been a good deal of diversity in the experience of different branches. Table 4.3 illustrates this by showing the changing composition of the sector between 1973 and 1985.[11]

Table 4.3: *Sectoral Composition of Metals & Engineering, 1973 and 1985*

Sector	*Employment 1973 (%)*	*Employment 1985 (%)*	*Net Output 1973 (%)*	*Net Output 1982 (%)*
Metals	8.3	2.9	7.5	2.5
Metal Articles	23.3	21.1	21.5	16.1
Mechanical Engineering	11.3	13.9	11.7	9.5
Office and Data Processing Machinery	2.0	13.2	3.6	27.6
Electrical Engineering	22.8	24.9	20.7	21.7
Motor Vehicles and Parts	15.5	5.5	14.0	4.8
Other Means of Transport	11.9	6.7	10.2	5.3
Instrument Engineering	4.9	11.8	10.8	12.5
Metals & Engineering	100	100	100	100

Note: Employment data for 1985 are the average of the first three Quarters.
Source: Census of Industrial Production, and monthly inquiries for 1985.

11. Owing to reclassification from the SIC system to NACE in 1973, it is not possible to extend the comparison at this industry branch level back beyond 1973.

Metals, Motor Vehicles and Other Means of Transport all declined substantially in importance and, in fact, they all had an absolute decline in employment. At the same time, there was particularly rapid expansion in Office and Data Processing Machinery and Instrument Engineering, both in absolute terms and relative to the rest of Metals & Engineering. Since these are generally regarded as high-technology and high-growth industries internationally, these trends might be seen as fairly typical of western European experience. However, when we come to examine the trends in more detail in Chapters 5 and 6, distinguishing between indigenous and foreign-owned firms and tracing the impact of the removal of protection, it will be apparent that the Irish experience and the forces behind it are rather different in important respects from the experience of more advanced industrial countries.

A further important aspect of the development of the Irish Metals & Engineering industry was the particularly rapid growth of exports, which was, of course, an important policy goal in view of the potential for a balance of payments constraint to restrict the growth of such a small and open economy. Exports accounted for only 12.4 per cent of the gross output of Metals & Engineering in 1960, which was considerably less than the figure of 19.3 per cent for all manufacturing, suggesting that the large majority of Irish engineering industries at that time could not match internationally competitive standards and depended a good deal on protection to ensure their survival. By 1973, however, exports had risen to 31.4 per cent of engineering gross output, which almost equalled the figure of 33.4 per cent for all manufacturing (*Review of 1973 and Outlook for 1974*, Table (i)). And the proportion of the sector's output going for export continued to increase rapidly, to 52 per cent in 1978 and about 69 per cent by 1982.[12] Metals & Engineering now exports a substantially greater share of its output than the rest of industry. Whereas engineering products had accounted for only 8 per cent of manufactured exports in 1960, they increased to 35 per cent by 1983. Thus the Metals & Engineering sector was well to the fore in the expansion of Irish industrial exports, as in other aspects of the country's industrial development since the 1950s.

Although this rapid growth of Irish engineering exports could be partly attributed to relatively strong growth in world demand and international trade in these products, a good deal of the growth in Ireland's exports was due to a marked increase in the country's share of world markets. Ireland's share of Metals & Engineeering exports from all Developed Market Economies increased six-fold, from 0.07 per cent in 1965 to 0.41 per cent in 1982 (UN *International Trade Statistics Yearbooks*).

12. The 1978 figure comes from data supplied by the Department of Industry, Commerce and Tourism for Blackwell, Danaher and O'Malley (1983). The 1982 figure is the sum of SITC categories 67, 68, 69, 7, 81 and 87 as a percentage of Metals & Engineering gross output in the 1982 CIP.

In one important respect, however, the growth of Metals & Engineering has contributed rather less to Ireland's economic development than it might appear from some of the data presented above. For engineering industries, and especially the fastest growing ones, have tended to import a relatively high proportion of their inputs and, in the case of foreign-owned multinational companies, to repatriate much of their substantial profits.

Thus the proportion of their output accounted for by value-added and retained in Ireland is lower than in many other industries. Table 4.4, Column 2, shows the "Irish economy expenditures" of engineering industries as a percentage of sales, meaning the amount spent on wages, salaries, and Irish materials and service inputs, expressed as a percentage of sales.

In Metals & Engineering as a whole, and particularly in the fastest growing sectors placed at the top of the table, these Irish economy expenditures are a good deal lower than in all manufacturing. It is very likely, therefore, that the growth of engineering industries has contributed proportionately less to the economy than growth of most other industries.[13]

Table 4.4: *Growth Rates and Irish Economy Expenditures in Engineering Industries*

Sector	*Annual Average Output Growth (%) 1973-85*		*Irish Economy Expenditure as % of Sales, 1983*
Office and Data Processing Machinery	39.4		25.2
Instrument Engineering	6.8	Instrument Engineering	35.0
		Healthcare Products	36.2
Mechanical Engineering	6.3	Mechanical Engineering	63.6
		Precision Toolmaking	71.7
Electrical Engineering	4.8		42.0
Metal Articles	1.1		53.4
Other Means of Transport	0		28.7
Metals	- 0.2		84.5
Motor Vehicles and Parts	- 9.2		44.7
Metals & Engineering	7.0		38.3
Total Manufacturing	4.6		49.0*

**Note:* This is the figure for Non-Food Manufacturing.

Sources: Column 1 from Census of Industrial Production and monthly inquiries.
Column 2 from IDA (1985, Appendix V).

13. Note, however, that Irish economy expenditures are not the same as value-added in the economy since there are secondary leakages, in the sense that material and service inputs purchased in Ireland contain some imported inputs. But Irish economy expenditures give an indication of the *relative* contribution to the economy of different sectors.

The data suggest that as Metals & Engineering has become increasingly important in the industrial sector over the past 25 years, the contribution to economic growth arising from a given increment to total industrial output would, therefore, probably have tended to decline somewhat. And, furthermore, the composition of Metals and Engineering itself has been changing so that the fastest growing branches, which have become increasingly important, tend to be those with the lowest Irish economy expenditures. This suggests that the contribution to economic growth arising from a given increment to the output of Metals & Engineering has probably been declining, because most of the growth has come in sectors with low Irish economy expenditures.

On the more positive side, Irish economy expenditures *per employee* in engineering are quite close to the average for non-Food manufacturing, and higher in Office and Data Processing Machinery, although they seem low when expressed as a percentage of sales. And despite the relatively low Irish economy expenditures of engineering industries as a percentage of sales, and the substantial outflows of profits and payments for imported inputs, they would still be net contributors of foreign exchange to the Irish economy because they export such a high proportion of their output. In fact, exports accounted for over 95 per cent of sales in the fastest growing sectors. So although their imported inputs and outflows of profits look very high — as much as a possible 75 per cent in Computers and Office Machinery — the value of their exports was even greater. Thus not only does Metals & Engineering now generate sufficient foreign exchange earnings to pay for its own imports, but it also has a surplus which helps to relax the foreign exchange constraint for the rest of the economy.

Finally, despite the rapid expansion of Irish engineering since the 1950s, it is still a relatively underdeveloped industry here by the standards of advanced industrial countries. Table 1.1 in the introductory chapter showed that it accounted for 30 per cent of Irish manufacturing employment in 1983, compared with 49 per cent in the EEC. Given that Irish industry as a whole still lags behind most of the EEC in its development, we would not be too far off the mark if we said that Metals & Engineering is no more than half as large in Ireland, in proportion to the size of our economy and labour force, as it is in the advanced economies. A further indication of this relative weakness by international standards is the fact that Ireland's imports of Metals & Engineering products still exceeded exports by 19 per cent in 1984.

To conclude, starting almost from scratch the Irish Metals & Engineering industry has grown substantially since the foundation of the State. In several respects it is now Ireland's most important manufacturing sector. This growth occurred in two main phases — under a protectionist policy in the 1930s and 1940s and under a free trade, "outward-looking" policy since the end of the

1950s. The nature of growth, and the type of firm and type of product involved, differed in these two phases in ways which left their mark on later developments. The next two chapters go into these matters in more detail, analysing patterns of change since the 1950s distinguishing between indigenous and foreign-owned firms. A major issue to be considered is how the industry could grow so strongly under a free trade, outward-looking policy since the 1950s, despite the fact that it had largely failed to compete internationally at all times during the previous 100 years, and despite the barriers to entry faced by late developers which were discussed in Chapters 2 and 3.

The reason for distinguishing between indigenous and foreign-owned firms in the next two chapters is because the two groups have rather different characteristics and have behaved differently. In particular, indigenous firms, as latecomers, have been impeded by barriers to entry while the foreign-owned industries are generally branches of relatively strong established companies. In the circumstances one cannot really analyse the comparative advantage or competitive advantage of a country such as Ireland adequately in terms of product or industrial categories without distinguishing between indigenous and foreign firms. Since competitive advantage to a great extent resides in specific firms, many of which are multinational firms, rather than in the country as such, one could not understand the pattern of industrialisation on the basis of factor endowments, resources or skills present in the country, without making a distinction between the type and origin of the firms involved. Similarly, in seeking to develop the country's competitive advantage further, it is necessary to make this distinction because the new industries which might be most successfully developed by Irish firms may be quite different to those which are most likely to be established by foreign multinationals. Just because industry X is well developed here by multinationals, it should not be presumed that Irish firms can succeed in the same industry. But we return to this issue in Section III.

Chapter 5

IRISH INDIGENOUS ENGINEERING INDUSTRIES

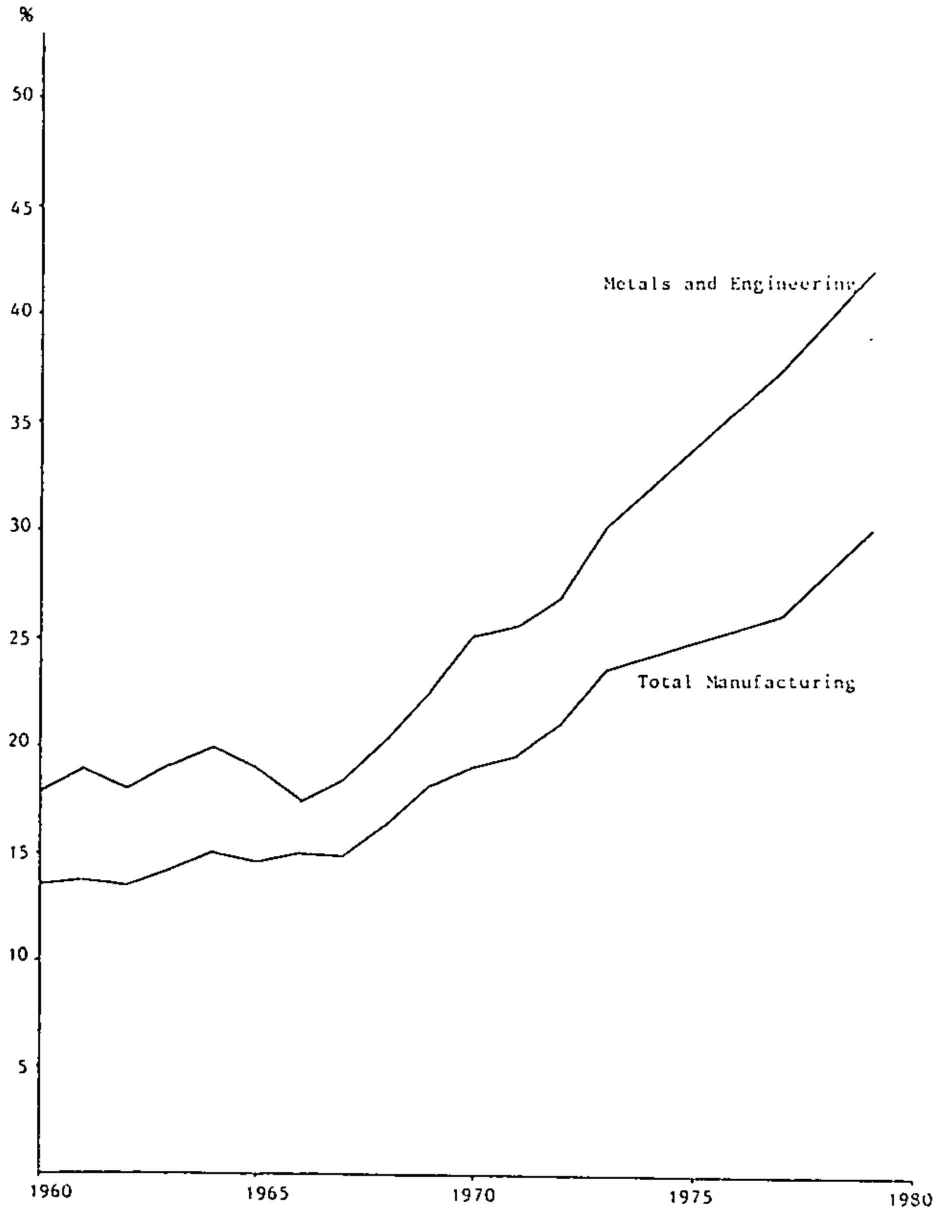
It has been shown in Chapter 4 that the Metals & Engineering sector expanded rapidly after the 1950s, with particularly strong growth of exports. This was in contrast to its previous persistent failure to meet international competition successfully, and it may also appear to be at odds with the evidence of relatively high barriers to entry for late developers which was outlined in Chapters 2 and 3. In fact, as will be shown below, most of the growth in engineering, as in industry in general, was due to the establishment of branches of foreign multinational firms, which would not be constrained by the problem of entry barriers, while Irish indigenous firms which do face this problem did not fare so well. Thus the break with past experience after the 1950s was primarily in the development of Ireland as an attractive site for mobile multinational companies. There was a substantial degree of continuity with historical experience in the performance of indigenous firms, at least in the sense that they have not proved very strong in competing internationally.

A. General Trends since the 1950s

The policy of protection against imports had continued during the first half of the 1960s until the Anglo-Irish Free Trade Area Agreement was signed in 1965, so that tariffs began to come down by 10 annual cuts of 10 per cent each, starting in 1966. Reflecting this change, the share of "competing" imports of Metals & Engineering products in the Irish market had fluctuated between 17.4 per cent and 19.9 per cent during the period 1960-66, with no discernible upward trend, but competing imports then gained an extra 2.3 per cent of the market per annum in the period 1967-79 (see Figure 5.1)[14]. A similar, although somewhat less severe increase in competing imports occurred for industry as a whole at the same time, with manufactured competing imports gaining a 1.2 per cent increase in market share per annum during the period 1967-79. It was mainly the native Irish firms who lost ground to the rise in competing imports because the new foreign-owned firms which have come to

14. Data on imports classified as competing directly with Irish producers are derived from the annual *Review and Outlook* for 1960-73; from *Trade Statistics of Ireland* for 1973-77, by summing up import items classified as "competing" according to a list provided by Alan Matthews of Trinity College, Dublin; and 1977-79 data were provided by the Department of Industry, Commerce and Tourism for Blackwell, Danaher and O'Malley (1983). These three data series differ somewhat in classification, but they are joined together in Figure 5.1 by applying the proportionate increase in later periods to the level reached at the end of the preceding period.

Figure 5.1: *Competing Imports' Share of Irish Market, 1960-79*



Source: As explained in footnote 14.

Ireland since the late 1950s have always been very highly export-oriented; in the Metals & Engineering sector, 85 per cent of their output was exported in 1973 (McAleese, 1977, Table 4.2).

At the same time as the rise in import penetration, there was apparently little or no compensating increase in shares of export markets held by indigenous firms. Metals & Engineering firms other than new grant-aided foreign-owned firms exported only about 9-11 per cent of their output in 1960 and this increased very little to 13 per cent by 1973[15]. This was still well below the average of 26 per cent of output exported by all industries other than new foreign-owned ones in 1973, and it represented a fall in share of world Metals & Engineering exports. The figures just quoted refer to all Metals & Engineering firms other than the new foreign-owned ones established with grant-aid since the 1950s, and hence they include some older foreign firms as well as indigenous Irish-owned companies. But indigenous firms accounted for the bulk of this group, with 78 per cent of its employment in 1973, so there is a fairly strong indication that the indigenous industry did not experience any significant improvement in its export performance up to 1973 at least (see Appendix 2 for a note on data sources).

There are no precisely comparable data for more recent years, but it seems reasonably clear that, despite some prominent exceptions, the overall export performance of indigenous engineering remains quite weak. Telesis (1982, p. 88) reported that the Metals & Engineering, Chemicals and Miscellaneous industries combined accounted for less than 20 per cent of Irish indigenous manufactured exports (whereas they accounted for 25 per cent of indigenous employment, and Metals & Engineering alone accounted for 19 per cent of this employment). Telesis (1982, p. 113) also reported that only about one-sixth of the hundreds of new indigenous engineering firms established since 1967 were exporting anything at all:

> The dramatic increase in employment in the [Irish indigenous] metals and engineering sector has mostly come from domestic demand. Since 1967, more than six hundred firms have been created in the sector and 110 are registered by CTT as exporting. Their overall exports, however, amounted to only £11 million in 1979, about 2 per cent of total indigenous manufacturing exports and less than one tenth of one per cent of total Irish exports.

15. The 1960 estimate assumes that new grant-aided foreign firms accounted for between 10 and 30 per cent of Metals & Engineering exports at that time. This is a very broad "guesstimate" but, since total engineering exports were so small in relation to output, even this degree of imprecision allows the estimate given in the text to be placed within a narrow margin of error. The 1973 figure is derived by subtracting data on new foreign firms, in McAleese (1977), from national totals.

Another piece of evidence here is the fact that exports of the Manufacture of Metal Articles sector amounted to just 29 per cent of gross output in 1979. Foreign-owned firms accounted for 28 per cent of employment in this sector, and presumably at least as great a share of output since their output per worker is generally higher than in indigenous firms. If even two-thirds of their output was exported, and 80 to 90 per cent would be more typical of foreign-owned engineering firms, then the indigenous firms in Manufacture of Metal Articles were exporting something less than 15 per cent of their output. And since over half (54 per cent) of indigenous Metals & Engineering employment was in this sector, this would be representative of much of Irish engineering.

Despite these difficulties in successfully meeting international competition, at home or abroad, indigenous engineering, unlike most of Irish indigenous industry, did have quite a substantial increase in employment until reaching a peak in the early 1980s, and there was also almost certainly a fairly large increase in output at the same time. But there is no proper series of data on output distinguishing indigenous from foreign-owned industries. Furthermore, a majority of employment, and hence most likely also a majority of output, in Metals & Engineering is now in foreign-owned firms, so the *Census of Industrial Production* data on output give no indication of what has been happening to levels of production in the indigenous branch of the industry. In Manufacture of Metal Articles, however, indigenous firms accounted for 70 per cent of employment in 1973 rising to 77 per cent in 1985, so that the output trend there would largely reflect indigenous activity. And, as was mentioned above, such a large proportion of indigenous engineering employment is in that sub-sector that it is an important example of the experience of indigenous firms. In Manufacture of Metal Articles, output grew by 7.0 per cent a year in the period 1973-80, which was greater than the average industrial growth rate of 4.3 per cent, but it then fell by 6.5 per cent a year in 1980-85, giving an average growth rate of only 1.1 per cent for the years 1973-85.

It is possible to present a more complete picture of trends in employment in indigenous engineering firms. It is clear that, unlike most of indigenous industry, they had quite a substantial increase in employment until reaching a peak in the early 1980s, although most of the overall increase in Metals & Engineering employment occurred in foreign-owned firms. In firms other than new grant-aided foreign firms, i.e., in indigenous plus older foreign companies, employment grew by about 9,000 from 1960 to 1973[16]. After

16. This calculation is based on an estimate for 1960 derived from the *Census of Industrial Production* figure minus an estimate of about 1,000-2,000 for new foreign firms at that time (as suggested by O'Hearn, 1987), while the 1973 figure comes from the IDA's employment survey which began in that year.

1973, the employment data allow separation of all foreign-owned firms from indigenous Irish-owned ones, and employment in indigenous engineering increased from 24,000 in 1973 to a peak of 31,000 in the years 1980-82 before falling back to 26,000 by 1985 (Table 5.1 and Figure 5.2).

Table 5.1: *Metals & Engineering Employment*, 1973-85

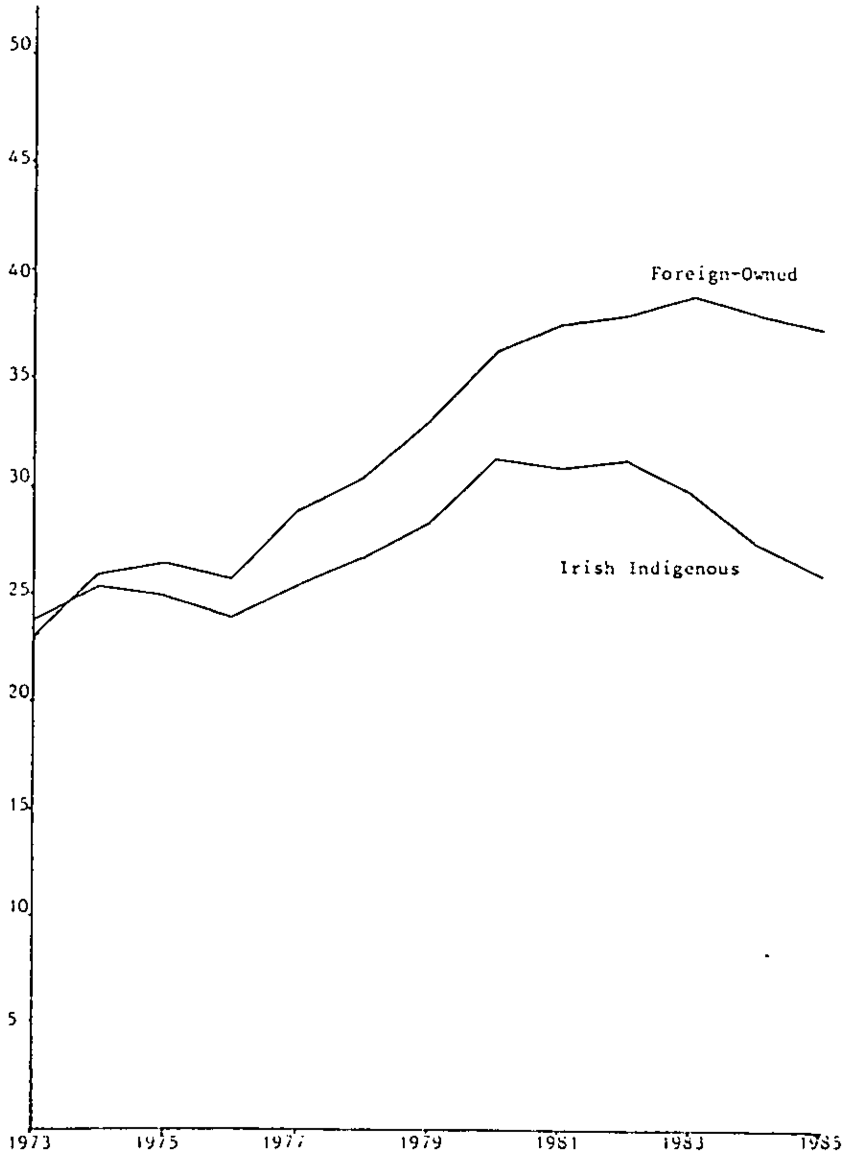
	1973	*1980*	*1985*	*Change 1973-1985*
Indigenous	23,800	31,300	26,000	+ 2,200
Foreign-owned	22,900	36,300	37,400	+14,500
Total	46,700	67,600	63,400	+16,700

Source: IDA Employment Survey.

It is clear that most employment growth in engineering has occurred in foreign-owned firms but, nevertheless, there was quite strong employment growth in indigenous companies too, until 1980. In fact, employment grew by over 30 per cent in indigenous Metals & Engineering in the period 1973-80, while it did not grow at all in the remainder of indigenous industry. This relatively strong growth in employment in 1973-80 occurred despite the fact that the rise in competing import penetration was more severe in engineering than in industry in general, and despite the fact that indigenous engineering firms appear to have had a weaker export performance than indigenous industry as a whole. This is explained by the fact that there was particularly strong growth in domestic demand for the products of indigenous engineering in 1973-80 and, similarly, the fall in its employment in the 1980s has been largely a reflection of weaker domestic demand. In a context of low export-orientation and rising import penetration, strong domestic demand has been a necessary condition for growth in indigenous engineering.

In the 1970s, the domestic demand situation was particularly favourable for the mainly local market-oriented indigenous engineering firms. As Telesis (1982, p. 113) pointed out, most of the growth in indigenous Metals & Engineering in the 1970s occurred in small-scale general metal fabrication operations, "which typically serve a very local market", and in structural steel products "where the economics also favours local suppliers". These activities, which are mostly in the Manufacture of Metal Articles sector, are thus relatively sheltered from foreign competition, or virtually non-traded, so that they were almost guaranteed strong growth under good domestic demand conditions. In the 1970s, they were stimulated by high rates of investment in new plant construction, in agriculture (e.g., tanks, farm gates, metal farm buildings) during the boom resulting from accession to EEC membership, and in building (structural metal products). But this changed in the first half of the

Figure 5.2: *Metals and Engineering Employment, 1973-85 (thousands)*



Source: IDA Employment Survey.

1980s with a weakening of agricultural investment, cuts in the public capital programme and general conditions of recession.

In general, therefore, the pattern in indigenous engineering to date has been one of increasing import penetration under free trade conditions and a relatively weak export performance, implying a poor performance by internationally traded activities. The local market-oriented, virtually non-traded activities, however, were able to expand when domestic demand conditions were favourable but similarly they have been forced into decline as demand weakened.

Consistent with this generalisation about weakness in internationally traded activities, there has been a very marked change in the size structure of indigenous Metals & Engineering, such that larger establishments have declined rapidly while the proportion of employment in small establishments increased, as is shown in Table 5.2. Larger firms are generally more likely to be involved in internationally tradable activities whereas small firms are often in sheltered, local market-oriented industries. Thus Kennedy and Healy (1985, p. 41) find that over two-thirds of Irish manufacturing firms with less than 50 employees had no exports at all, compared with only 30 per cent of firms with over 100 employees, and they say that a similar pattern holds for most other countries.

Table 5.2: *Percentage Distribution of Irish Indigenous Metals & Engineering Employment, by Establishment Size*

Employment Size	*Percentage of Employment 1973*	*Percentage of Employment 1984*
Over 200	32.0	12.2
101-200	20.9	12.8
51-100	10.9	17.9
Under 50	36.3	57.1
	100	100

Source: IDA Employment Survey.

This is largely because the market area which can be serviced competitively by a firm is influenced by the combined effects of economies of scale (in production, marketing, etc.) and transport or logistical costs. For any given rate of transport or logistical costs in relation to a product's value, the size of the market area which can be serviced competitively depends partly on the scope for economies of scale. If little advantage can be taken of economies of scale in an industry, then small firms supplying the local market are large enough to be of an efficient size and can thus be more competitive in their local market than distant firms, in view of the additional transport or logistical costs faced by more distant potential competitors. But if there are substantial economies of scale in an industry, larger firms are most efficient and they have an advantage over smaller firms which can outweigh the effect of transport costs over a large area. Hence, other things being equal, the large-scale industries tend to be internationally traded, while small-scale fragmented industries are often local market-oriented or virtually non-traded. Of course, transport or logistical costs in relation to each product's value are not equal in all industries so that the "tradability" of an industry is largely determined by a trade-off between these costs and economies of scale, rather than economies of scale alone. But it is still true to say that a greater proportion of small-scale industries than large-scale industries have advantages of natural protection against imports.

The same logic dictates that many small-scale industries cannot sell competitively in distant markets and hence do not export. Thus one indication that most of the small indigenous engineering firms which emerged in Ireland were in non-traded industries is the fact that only about 17 per cent of those established in 1967-80 were exporting anything at all by the end of the period, as mentioned above. Thus at a time when small indigenous engineering companies were thriving in the home market, that success was not in evidence in export markets. They must, therefore, have had advantages in the home market which did not apply elsewhere — in other words they were naturally sheltered non-traded industries.

A further indication of this point is the fact that the growth which occurred up to the early 1980s took the form primarily of establishment of many new small firms rather than expansion of existing companies. This reflects the fact that growth was occurring mainly in industries where there is little advantage in economies of scale, so that duplication of small firms, serving limited local markets, is more efficient than expansion of existing firms. Inevitably, such industries are virtually non-traded. Thus between 1973 and 1982, according to the IDA Employment Survey, the number of indigenous establishments in Metals & Engineering increased by 99.9 per cent, from 802 to 1,603, while employment grew much more slowly at 31.6 per cent. Growth evidently occurred through the establishment of hundreds of new small enterprises. Average employment per establishment thus fell from the already low level of 30 to just 20 between 1973 and 1982.

Meanwhile, the large establishments which had existed in 1973 were generally in serious decline, and only two new or small ones grew to employ over 200 people by 1985. Indigenous establishments with over 500 workers in Metals & Engineering employed 2,263 people in 1973, but only 610 by 1985. Those with over 200 workers employed 7,126 in 1973, but only 1,845 by 1985. And the number of indigenous establishments with over 200 workers fell from

19 to 5 in this period[17]. The large companies which existed in the early 1970s were generally engaged in activities with quite significant economies of scale, as indicated by their own relatively large size by Irish standards, but in many cases they were too small in scale to compete successfully against imports from even larger firms elsewhere as the trade barriers were dismantled. Thus it was no accident that, among companies already existing in 1973, it was the largest firms which declined most during the 1970s as import penetration increased (see Table 5.3).

Table 5.3: *Employment in Irish Indigenous Metals & Engineering in Plants Established before 1973*

Employment Size	*1973*	*1980*	*Percentage Change*
Over 500	2,263	923	-59.2
201-500	4,863	3,309	-32.0
101-200	4,653	4,473	- 3.9
51-100	2,428	2,491	2.6
Under 50	8,081	9,147	13.2
	22,288	20,343	- 8.7

Source: IDA Employment Survey.

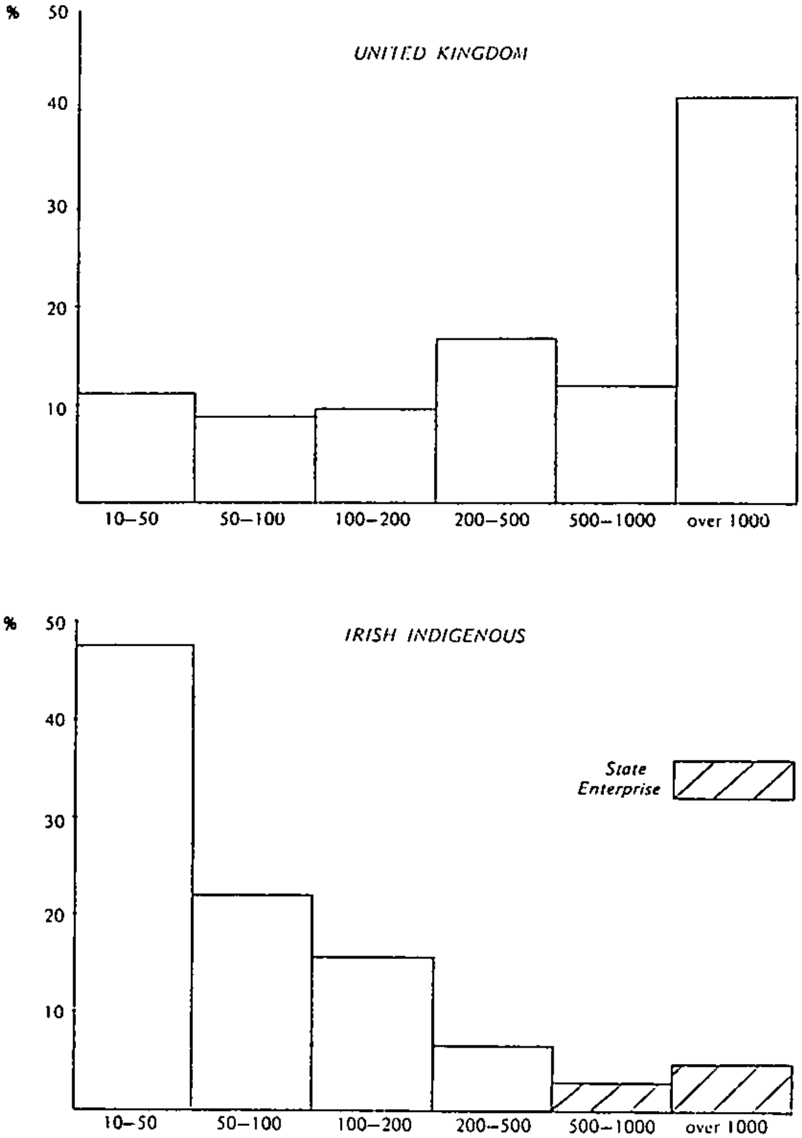
By now, Irish indigenous engineering firms are very highly concentrated in small size categories by comparison with more advanced industrial countries. Reflecting this fact, the Sectoral Consultative Committee (1983) remarked that:

> . . . a particular problem is seen in the plethora of small low technology firms . . .

In effect, the types of engineering industry which have to be large in order to be internationally competitive are almost entirely missing from Irish indigenous industry, so that what remains is necessarily confined to small size categories. The principal exceptions are state enterprises, which effectively underlines the general rule that, under the normal operation of market forces, Irish firms have not succeeded in large-scale engineering industries. Figure 5.3 shows the contrast between the distribution of engineering employment by size of establishment (measured in terms of employment) in the UK and in Irish indigenous industry. And as was seen in Table 3.1, British engineering is somewhat less concentrated in large establishments than in France or Germany.

17. These figures do not include companies predominantly engaged in other sectors, such as Aer Lingus and CIE, which can be large employers of metal and engineering workers, particularly in repair and maintenance work.

Figure 5.3: *Percentage Distribution of Metals & Engineering Employment by Size of Establishment, UK and Irish Indigenous*



Sources: IDA Employment Survey, 1983 for Irish Indigenous. Eurostat, 1983, *Labour Costs 1978, Vol. 2, Results by Size Classes and by Regions* for UK.

Figure 5.3 refers to "establishments" rather than whole companies, some of which own more than one establishment. At company level, there may be an even greater disparity between the size structure of Irish indigenous industry and more advanced economies since there are few substantial Irish multi-plant firms in engineering. In contrast, Belgium and Denmark, to take two small advanced economies, each had 17 indigenous companies employing over 1,000 people in engineering in 1979 (Telesis, 1982, Exhibit 3.56). The scarcity of large firms in Irish indigenous engineering has implications for the development of some important types of small firms too, since there is limited demand from large customers for the smaller sub-suppliers and sub-contracting companies.

In Chapter 3, it was suggested that industries characterised by substantial economies of scale present barriers to entry to new or small firms and that consequently Irish indigenous companies would probably not do well in large-scale activities under free trade conditions. The trends outlined above are certainly consistent with this suggestion, although this issue is examined in more detail later in this chapter. It was also pointed out that technology-intensive industries pose entry barriers too, which again would mean that Irish indigenous firms would have difficulties in developing such industries. Research and Development expenditure is a useful indicator of technology intensity, and in 1984 indigenous companies in Metals & Engineering spent £9.4 million on R & D, or £345 per employee. This was a good deal higher than the figure of £150 per head for all indigenous manufacturing, but it was less than the figure of £460 for foreign-owned firms in engineering and much less than the £1,260 per head (in Irish pounds) spent by engineering industries in the UK in 1983[18].

Thus it seems that indigenous engineering firms are engaged in technology-intensive industries to a greater extent than other Irish firms, but to a lesser extent than the multinational subsidiaries here and much less than engineering industries in the UK and no doubt in other advanced industrial economies as well. A qualification to this, however, is that R & D data are not totally reliable to the extent that they do not include design work and that some small firms may carry R & D as non-reported overheads. But this is unlikely to invalidate the general argument. The technology intensity of the Irish firms may be increasing but it is still low by international standards. One problem is that firm size and technology-intensity are positively related since larger firms are better able to carry substantial overhead costs such as R & D. Since Irish

18. Irish R & D figures are as supplied by the NBST. The UK figure is derived from the *Annual Abstract of Statistics*, 1986, Tables 6.2 and 11.9. The data refer to R & D performed within industry. If the UK figure for 1983 is inflated in line with the retail price index and adjusted for the 1984 exchange rate, it comes to £1,340 (in Irish pounds) in 1984, almost four times the level in Irish indigenous engineering.

engineering firms tend to be so small by international standards, they cannot undertake the large R & D programmes necessary to engage in many of the more technology-intensive industries.

The small size of most firms also makes it difficult for them to finance the introduction of Advanced Manufacturing Technologies (AMT) based on new developments in electronics (Casey, 1986). Consequently, they can have difficulties in developing in industries which are technology-intensive in this sense too, even if no great R & D effort is required. Thus the Sectoral Development Committee (1985, pp. 73, 79) concluded that indigenous engineering firms lag behind those in other countries in the use of technologies such as computer-aided design and manufacture, CNC machines, robotics, and information and control systems. The Committee also pointed out, in referring to company failures in indigenous electronics, that companies must have sufficient resources to fund new product development and design, as well as marketing, and information and market intelligence. Thus they concluded that small size was often a factor in explaining the lack of growth of companies or their failure in technology-intensive areas.

To conclude this section, Irish indigenous engineering, for the most part, has had a weak record in competing internationally. When growth has occurred it has been mainly in naturally protected industries stimulated by domestic demand while internationally traded industries have generally declined. As might be expected in the indigenous industry of a relatively newly industrialising country, there has been a particular weakness in the large-scale and technology-intensive industries, since the greater size and technological capabilities of established firms in more advanced economies create entry barriers for new or small firms in a country such as Ireland. Within this general picture, there is some diversity in detail and there are some exceptions to the general experience. The next section briefly examines the situation of the different sectors.

B. Sectoral Development

The Irish indigenous Metals & Engineering industry is still relatively underdeveloped. It was seen in Table 1.1, for example, that engineering accounts for 49 per cent of manufacturing employment in the EEC, whereas even at the peak level of Irish indigenous employment in this sector in 1982, it accounted for just 21 per cent of Irish indigenous manufacturing employment. Thus, by the standards of advanced economies, Metals & Engineering remains a disproportionately small sector of indigenous industry, which is itself rather underdeveloped by European standards. This is true of all the main branches of engineering except one. Table 5.4 shows the proportion of total manufacturing employment accounted for by the main branches of the sector in the EEC countries, by comparison with the proportion of indigenous manufacturing employment accounted for by branches of the industry in Ireland.

Table 5.4: *Percentage Shares of Engineering Industries in Manufacturing Employment in the EEC and Irish Indigenous Industry, 1982*

Sector	*(1)* *EEC Countries*	*(2)* *Irish Indigenous*	*(3)* *Irish/EEC Relative Size* *(2) ÷ (1)*
Production and Preliminary Processing of Metals	4.72	0.67	0.14
Manufacture of Metal Articles	9.62	11.36	1.18
Mechanical Engineering	10.73	2.12	0.2
Office and Data Processing Machinery	0.99	0.3/0.4	0.3/0.4
Electrical Engineering	10.58	2.74	0.26
Motor Vehicles and Parts	6.75	1.36	0.2
Other Means of Transport	3.87	1.74	0.45
Instrument Engineering	1.76	0.25	0.14
Metals & Engineering	49.02	20.81	0.42

Source: Eurostat, *Employment and Unemployment* (1985) for Column 1 and IDA Employment Survey for Column 2, with Office & Data Processing Machinery adjusted as explained in Appendix 2.

The third column of the table, by dividing Column 2 by Column 1, shows an index of relative concentration in each branch in Irish indigenous industry compared with the EEC. An index greater than 1 would mean that the sector concerned accounts for a larger proportion of Irish indigenous manufacturing employment than of industrial employment in the EEC, and conversely for indices less than 1. Note that an index greater than 1 does not mean that the Irish industry is stronger or more highly developed than in the other countries, since their industry as a whole is obviously more highly developed than Irish indigenous industry. Thus an average Irish industry, with an index of 1, would be less well developed than its EEC counterpart. However, a low index would mean that the Irish industry is relatively underdeveloped. Admittedly, this comparison is not entirely valid since the EEC data in Column 1 of the table include European subsidiaries of non-EEC companies and not just indigenous EEC industries. But this would distort the comparison with Irish indigenous industry only to the extent that such non-EEC subsidiaries are both disproportionately concentrated in certain sectors and form a large proportion of the sectors concerned. Thus as a means of judging whether Irish indigenous industry is relatively well developed or relatively underdeveloped in the different sectors by the standards of advanced industrial countries, the data in Table 5.4 are unlikely to be seriously misleading, at least if they are regarded as approximate rather than precise indicators.

It is clear at any rate, from Table 5.4, that Manufacture of Metal Articles stands out as being by far the largest sector of indigenous engineering in absolute terms (Column 2), as well as being relatively well developed by European standards — being of much the same proportions as in the EEC countries (Column 3). All the other sectors are disproportionately small. This pattern can be explained by reference to the structural characteristics of the different sectors in advanced competing countries and the consequent competitive difficulties of new or small Irish firms.

It was suggested in Chapter 3 that various factors creating entry barriers for newcomers would tend to constrain Irish indigenous development, in different ways in different industries. Quantitative indicators of the prevalence of entry barriers relating to economies of scale, skill-intensity, external economies and R & D intensity in the main engineering sectors in advanced economies were also presented in Chapter 3 and some of these are drawn together in Table 5.5. The data indicate that barriers to entry are generally a

Table 5.5: *International Indicators of Scale, Skill-Intensity and Influence of External Economies*

Sector	*Percentage of Employment in Large Enterprises**	*Percentage White-Collar Employment*	*Percentage Craft Employment*	*Index of Concentration in weak EEC Regions*
Metals	77.0	24.8	12.3	0.19
Metal Articles	33.4	25.1	15.3	0.35
Mechanical Engineering	51.5	35.3	27.0	0.12
Office and Data Processing Machinery	87.9	69.7	4.0	0.06
Electrical Engineering	74.0	41.4	10.3	0.16
Motor Vehicles	88.8	23.0	15.8	0.08
Other Transport	86.3	42.4	31.4	0.12
Instrument Engineering	43.0	48.8	13.1	0.13
Average	67.7	38.8	16.2	0.14

**Note:* Large enterprises are those employing over 500 people; the data are for Germany, France, UK and Italy combined.

Sources: Eurostat, *Structure and Activity of Industry*, Theme 4, Series C for Column 1. Table 3.10 for Columns 2 and 3. Table 3.9 for Column 4.

good deal less significant in Manufacture of Metal Articles than in the other branches of Metals & Engineering, so that Metal Articles could be much more readily developed by Irish firms. Compared with the other engineering industries in advanced economies, Metal Articles has the lowest level of concentration in large firms, it is the most highly developed in underdeveloped regions and it has close to the lowest level of white-collar skill-intensity and a little below average manual skill-intensity. Also, although the categories are not exactly comparable, Table 3.5 showed that it has a low level of R & D intensity. In the other sectors, in contrast, one or more of these sources of entry barriers is significant, creating difficulties for development by new or small Irish firms. In Metals the problem is primarily economies of scale, while the data in Table 5.5 for each of the other sectors indicate above average entry barriers from at least two sources.

Thus it seems reasonable to conclude that the principal strength and many weaknesses of Irish indigenous engineering can be explained by reference to the structural characteristics and competitive economics of the different sectors in advanced economies with which Ireland has to compete. There are, of course, other factors having a more general influence on Irish industrial performance, such as exchange rate movements, the impact of taxation, labour costs and cultural factors influencing entrepreneurial initiative. But these have a general or macroeconomic impact, bearing on all sectors of industry in much the same way, so they would not explain why some industries are much better developed than others by Irish firms. If the strength of different sectors varies so much in a given macroeconomic environment, then clearly the effect of industry-specific factors which can account for this, must have a considerable influence on industrial development.

Although indigenous engineering remains relatively underdeveloped, there has been employment growth in most sectors since 1973, and their performance in this respect has been better than indigenous industry as a whole (see Table 5.6). The nature of the trends in each sector is very briefly outlined below.

Production and Preliminary Processing of Metals (NACE 22)

This sector of indigenous engineering consists of Irish Steel Ltd., a state enterprise which accounts for two-thirds of employment in the industry, and 27 much smaller companies employing only a few hundred people between them. Clearly, Irish firms, with the exception of Irish Steel, are only very marginally involved in the industry. This is not surprising since there are major entry barriers arising from economies of scale in the principal activities, as was noted in Chapter 3 and earlier in this chapter.

In addition, the Metals industry internationally has experienced significant

Table 5.6: *Employment in Indigenous Metals & Engineering by Sector, 1973-85*

Sector	*1973*	*1980*	*1985*	*Percentage Change per annum, 1973-85*
Office & Data Processing Machinery	147	604	1,247	19.5
Instrument Engineering	268	274	455	4.5
Mechanical Engineering	2,106	3,450	3,034	3.1
Other Means of Transport	1,801	1,985	2,409	2.5
Metal Articles	12,071	17,411	13,300	0.8
Electrical Engineering	3,527	3,793	2,972	-1.4
Motor Vehicles & Parts	2,280	2,405	1,611	-2.9
Metals	1,643	1,416	963	-4.4
Metals & Engineering	23,843	31,338	25,994	0.7
Total Indigenous Industry	155,754	163,741	132,159	-1.4

Source: IDA Employment Survey.

upheavals for more than the past decade. The volume of world production of Basic Metal Industries (ISIC 37)[19] fell by 1 per cent in the decade 1973-83, but in the Developed Market Economies it fell by 18 per cent while at the same time it rose by 73 per cent in the Developing Market Economies (UN *Industrial Statistics Yearbook 1983).* Thus, in general, there has been very weak demand, significantly growing competition from newly-industrialising countries (for reasons mentioned in Chapter 3) and consequent chronic excess capacity in the developed countries leading to widespread losses. This in turn has led to exceptional protectionism in the developed economies, rationalisation and major cuts in employment, and the imposition of national quotas for steel for EEC members. For all these reasons, the international environment has been exceptionally poor for this industry, so that the weak performance of the Irish indigenous Metals industry was probably inevitable, and large commercial losses occurred too. The particular situation of Irish Steel is referred to briefly below in discussing the largest Irish companies.

Manufacture of Metal Articles (NACE 31)

This sector is by far the largest in Irish indigenous Metals & Engineering, as noted above, and it is relatively well developed by European standards. This is explained by the general insignificance of entry barriers here and also by the fact that much of the sector has a degree of natural protection against distant competitors because there is often a need for close contact with local

19. This is a slightly different classification to NACE 22, but they are very largely the same.

customers and flexibility of response to diverse local demands. A corollary of this is that companies in this sector generally export little, as was noted earlier in this chapter.

Since much of this sector is virtually non-traded, its fortunes depend heavily on domestic demand which grew strongly in the 1970s but weakened subsequently as noted above. Accordingly, indigenous employment in Metal Articles grew very rapidly from 1973 to a peak in 1980 but dropped between then and 1985, as seen in Table 5.6. And by 1983, profits were only 1 per cent of sales (IDA survey data).

Two other features also reflect the fact that Irish firms in this industry are generally in activities with low entry barriers. First, it was seen above that a relatively small proportion of the industry is concentrated in large firms in the four major EEC countries compared with other engineering sectors, but nevertheless there are some fairly large-scale activities so that 28.5 per cent of UK employment, for example, is in establishments with over 500 workers and 48.6 per cent is in those with over 200. But there are no Irish firms engaged in large-scale activities and the largest establishment employs just over 200. And second, it was suggested in Chapter 3 that the sub-supply industries within this sector might be relatively underdeveloped by Irish firms, because such industries mostly tend to be located in close contact with large concentrations of other engineering industries, which are relatively lacking in Ireland. In other words, forces of external economies would constrain the development of sub-supply industries in Ireland. Accordingly the sub-supply industries — Foundries (NACE 311), Forging, Pressing and Stamping (NACE 312) and Secondary Transformation, Treatment and Coating of Metals (NACE 313) — accounted for just 13 per cent of employment in Manufacture of Metal Articles in Ireland in 1982, compared with 40 per cent in the UK.

Mechanical Engineering (NACE 32)

This sector of Irish indigenous industry is entirely concentrated in small establishments, with the two largest employing just over 100 people and only seven more employing over 50. It was shown above that Mechanical Engineering is not an exceptionally large-scale industry in advanced industrial countries, but nevertheless 58 per cent of its employment in the UK is in establishments with over 200 workers, compared with none in Ireland. Thus while the industry internationally includes a very diverse range of activities which vary quite considerably in scale, it appears that the larger ones are absent from Irish indigenous industry.

It is also noticeable that there is no pattern of strong geographical concentration in the location of Irish Mechanical Engineering firms, despite the fact that this is typically the case in more advanced economies. The nine largest Irish establishments, with over 50 employees each, are located in eight different counties. Thus the Irish industry would not appear to have acquired much benefit from external economies and, on the contrary, it seems that it must have developed primarily in activities where external economies are not very important, which excludes it from many branches of the industry. This structure of small-scale, geographically scattered enterprises suggests, in fact, that the industry is mainly engaged in virtually non-traded local market-oriented activities.

Much of this sector makes agricultural machinery and equipment, for example, and in Ireland this is largely a small-scale local-oriented industry. Telesis (1982, Exhibit 3.39) show that 39 per cent of indigenous employment in this industry is in companies with no exports, and a further 40 per cent is in companies which export only as far as Northern Ireland, and these exports only amount to 8 per cent of the sales of the firms concerned.

Reflecting this largely local-oriented, virtually non-traded structure, employment in indigenous Mechanical Engineering grew quite strongly in the 1970s and declined again in the 1980s in step with domestic demand, as was seen in Table 5.6. On the more positive side, however, is the fact that the long-term trend has been upwards, with employment in 1985 still over 40 per cent (or 900 jobs) greater than in 1973. This growth occurred in incremental fashion as the number of enterprises doubled, rather than by expansion of existing ones, which is similar to Manufacture of Metal Articles and again suggestive of concentration in sheltered local-oriented activities. Thus it seems that Irish enterprises have been getting into the available small-scale niches, particularly in sheltered activities, at quite a rapid rate. And they have been quite successful in commercial terms, with profits at 15 per cent of sales in 1983 (IDA survey data). This at least suggests that there is a spirit of active entrepreneurship and an ability to take advantage of the more obvious and accessible opportunities, although the industry's development would inevitably remain relatively stunted unless some larger-scale activities can be established.

Office and Data Processing Machinery (NACE 33)

In some respects, the indigenous Office & Data Processing Machinery industry shows similarities to the Mechanical Engineering sector. It is again exclusively concentrated in small firms, none of which employ over 100 people[20]. Thus the larger-scale activities which are more typical of this industry internationally are absent. It has also grown incrementally, by an increase in

20. This is leaving out two larger companies which are included in this sector in IDA data but actually seem to belong in Electrical Engineering (see Appendix 2). But other employment figures referred to here follow the IDA classification.

the number of small enterprises, rather than expansion of existing ones. As a result, average employment per establishment has changed little from 21 in 1973 to 18 in 1985. This is very different from the type of exponential growth at very high rates seen in many new US companies in the leading centres of the industry (see O'Brien, 1985, Table 6.12). Thus Irish firms have succeeded in entering small-scale niches, showing an ability to take advantage of the more accessible opportunities and making good profits at 25 per cent of sales. But substantial entry barriers arising from economies of scale, technology intensity and external economies seem to preclude wider development in the major activities internationally.

Employment in this industry has grown continuously at a very high rate, as was seen in Table 5.6, but this was starting from a virtually non-existent base, and the rate of growth must almost inevitably slow down if it continues to be incremental or additive in nature.

Electrical Engineering (NACE 34)

Electrical Engineering, along with Motor Vehicles, is one of the principal sectors in which there used to be relatively large protected indigenous firms which declined rapidly under the impact of competing imports. Four large establishments, with over 300 workers each, employed a total of 2,100 people in 1973, or 60 per cent of indigenous employment in this sector at that time. Three of these, which were engaged in radio and television assembly, electric lamps and telecommunications equipment, have closed down since then, although the other one, engaged in domestic electrical appliances, continued successfully in operation under new ownership after declining substantially during the 1970s. The decline of such relatively large-scale industries under free trade was not entirely unexpected since the Committee on Industrial Progress (1971) noted that large-scale production was an increasingly significant feature of much of the industry internationally, which would "undoubtedly create serious difficulties for those Irish firms which are dependent on the limited home market".

At present, the electrical appliances establishment referred to above — Basic Engineering, a branch of the Glen Dimplex group — is the largest indigenous Metals & Engineering establishment in the private sector. Two others in telecommunications equipment have over 100 employees and they are to a great extent spin-offs from public sector purchasing, so that non-market forces were at work in helping them to get established. In the rest of the industry, the pattern is the familiar one of small firms, local market-orientation, and growth of employment through establishment of additional small enterprises in conditions of strong domestic demand in the 1970s followed by decline when demand weakened in the 1980s. Thus the number of establishments more than doubled between 1973 and the end of 1981 while average employment fell from 54 to 26. The overall growth of this sector in the 1970s was rather weak and the subsequent decline in employment quite marked, as was seen in Table 5.6. This performance, weaker than Mechanical Engineering or Metal Articles, was primarily due to the greater influence of the continuing decline of larger existing firms. In terms of profitability, too, indigenous Electrical Engineering seems to have fared worse, recording losses amounting to 3 per cent of sales in 1983, by which time the overall downturn in employment had begun.

Motor Vehicles and Parts (NACE 35)

The Motor Vehicles sector is something of a special case since car assembly, which was the major part of it, continued to benefit from a form of protection under both the Anglo-Irish Free Trade Agreement and the terms of accession to the EEC until the end of 1984. It was generally understood that the Irish car assemblers (although large companies by Irish standards) were too small and too diversified to survive open competition in this exceptionally large-scale activity, and it was hoped that this transition period would allow them time to rationalise production or to substitute alternative related industries. Thus whereas one would have expected a sharp drop in employment under true free trade, it held up fairly well in the 1970s, but with the subsequent disappearance of car assembly indigenous employment fell by one-third in 1980-85 (Table 5.6).

At the same time new companies have appeared in other activities. These include special-purpose vehicles where no company can take much advantage of economies of scale, e.g., ambulances and fire tenders; commercial vehicle bodies and trailers; and various parts and accessories. The largest of these companies, which produces ambulances, employs just over 300 people and exports most if its output to the UK. All the others employ less than 100, the average employment is again very small at 14, and most firms serve the local market. The low-value-added, assembly-type nature of the industry is shown by the fact that material inputs, almost all imported, amounted to 84 per cent of the value of sales of indigenous firms in 1983, compared with a maximum of 54 per cent in other engineering sectors (IDA survey data).

Other Means of Transport (NACE 36)

Employment in this sector of indigenous industry has grown fairly steadily without suffering a cyclical downturn in the 1980s, as seen in Table 5.6. Also, this sector is relatively well developed by Irish firms. This may not be very clear from the data in Table 5.4 above since employment in manufacture and repair of railway rolling stock (NACE 362) in CIE is not included in the IDA employment survey, although it is conventionally classified as a manufacturing activity and is included in the Census of Industrial Production. If we include this employment in CIE, the Other Means of Transport sector accounted for 2.82 per cent of indigenous manufacturing employment in 1982, compared with 3.87 per cent in the EEC, giving an "Irish/EEC relative size index" of 0.73 which would rank it a clear second in Table 5.4. Thus this sector of engineering is relatively well developed by Irish firms despite the indications of particularly strong barriers to entry seen above.

This is not attributable to private sector firms and market forces, however, since 89 per cent of indigenous employment in the industry is in Aer Lingus (in overhaul and maintenance of aircraft and aircraft engines) and in CIE. These two employ over 1,500 people each in indigenous Metals & Engineering activities. The other indigenous enterprises in this sector are all very small since none employs over 50 people and their average employment is just 7; many of these are involved in small boat-building. Thus among the private sector firms, it is very much a case of involvement in small-scale, probably sheltered "niches", no doubt reflecting the entry barriers due to scale and technology intensity which characterise most of this sector. Indeed, even Aer Lingus and CIE are obviously involved in relatively marginal ways and are not in the mainstream of the industry internationally. We return to these companies below.

Instrument Engineering (NACE 37)

Instrument Engineering is a very small sector of indigenous industry which has grown at a respectable rate since 1973, but this was starting from a very small base. There were no large existing companies in this sector at the start of the period to share in the general decline of larger firms, so the familiar pattern of incremental growth by establishment of new small enterprises produced quite a strong upward trend although the total employment is still less than 500. The largest establishment employs less than 40 people and the average size is 9, down from 19 in 1973. So again it is very much a case of involvement in an increasing number of small-scale niches. It is not clear to what extent Irish firms in this industry are involved in exporting. Very small companies of this size usually export little or nothing, but since Instrument Engineering is finely segmented into specialised activities, even such small firms may sometimes be serving a wider market than that of Ireland alone.

C. Large Irish Companies

It should be clear by now that there are few large Irish engineering companies and that the indigenous industry is very highly concentrated in small firms. This is in marked contrast to the situation in most of Europe, North America or Japan, where large Metals & Engineering firms typically constitute a major component of the "commanding heights" of industry. Irish indigenous engineering effectively has no commanding heights. However, there are some companies which are relatively large by Irish standards. This section presents a very brief profile of four of the five Irish-owned companies which employ over 500 people in Metals & Engineering. These include three state enterprises, Aer Lingus and CIE, each of which employs 1,500-2,000 people in engineering although engineering is only ancillary to their main activities, as well as Irish Steel in the 500-1,000 size category. In the private sector, the Glen Dimplex group, which is owned and controlled in Ireland, employs close to 1,000 people in Ireland as well as a considerably greater number abroad. The fifth large company, Unidare, is not discussed here as an example of indigenous development since it was originally foreign-owned and has been taken over only very recently by Irish owners.

Aer Lingus

Aer Lingus was established in 1936 as a commercial airline. It was founded as a state enterprise because it was considered unlikely that private capital in Ireland at that time would be attracted to the barely proven business of commercial air travel. It had grown to become one of the largest companies in the country by the end of the 1960s and it had begun to diversify by both forward integration (e.g., package tours and hotels) and backward integration (e.g., aircraft maintenance and overhaul, passenger reservations, catering, etc.). In this latter type of activity, the airline was increasingly carrying out functions previously contracted out and, in the process, building up skills and organisational structures which could be turned to providing contract services to customers outside the company (see Brophy, 1985, Ch. 7).

When the fortunes of the company began to decline in the 1970s as a result of more intense competition on North Atlantic routes in particular and massive fuel price increases, the profitability of the air transport business came under serious threat and the management responded with a programme of greater diversification. One area of emphasis in this programme was an increase in aircraft maintenance and overhaul work, technical training and engineering services for other airlines. These activities generated £85 million in revenue by 1984/85 (Aer Lingus/Aer Linte Eireann Report and Accounts, March 1985). A related development was the establishment of a large jet engine overhaul facility in Airmotive Ireland, which gains 70 per cent of its revenues from foreign-based operators in 25 different countries. These activities are profitable and indeed Aer Lingus says they constitute one of the most profitable commercial businesses owned in Ireland. The Oireachtas Joint Committee on State-Sponsored Bodies (1982) accepted that the company's aviation-related ancillary activities have produced "very good profits", but noted that the actual *rate* of return on capital employed would not be very meaningful because much of the capital equipment employed was acquired for Aer Lingus's own use rather than specifically bought for outside contract work.

In this diversification of Aer Lingus, we have an exceptional example of successful development of a large-scale, highly-skilled, export-oriented indigenous engineering industry. It is worth noting the key features of the process by which entry barriers were overcome. The initial demand was generated in-house by the large parent company in a non-market situation, the quite substantial amounts of capital required were provided by or borrowed by the large parent company, and skill resources were developed and progress made along the "learning curve" in this relatively sheltered situation. Ultimately a competitive and profitable enterprise resulted, but it is not something that could be easily repeated by new firms or the small enterprises which characterise most of indigenous engineering. However, there may be lessons here for future industrial development strategy.

CIE

The manufacture and repair of railway equipment in CIE employs almost as many people as engineering activities in Aer Lingus, but in other respects the two are quite different. Railway equipment is among the oldest engineering industries in Ireland since it developed in tandem with the railways, and at the time of the foundation of the state it was the only substantial indigenous engineering industry. When the railways were nationalised under CIE, the engineering activities associated with the railway were taken over too.

At present this industry is almost entirely confined to serving CIE's own needs. Exports of railway equipment amounted to just 3 per cent of output in 1982 and there are no significant customers for this equipment in the country other than CIE. Thus the industry basically grew up as part of the business of running the domestic railway system and this remains the case. The main activity, accounting for 84 per cent of output in 1981, is repair and maintenance, while manufacture of rolling stock accounted for 7 per cent and manufacture of parts of rolling stock accounted for the remaining 9 per cent. Much of the equipment needed for a railway, such as locomotives which are typically made by large-scale firms, is generally imported since CIE would not have sufficient demand itself to justify making it. Evidently a major difference between the engineering activities of CIE and Aer Lingus is the fact that CIE sells little outside the company. This is understandable since there are effectively no other customers in the Irish market for railway equipment or for its repair, and the logistics of bringing in locomotives or rolling stock from other countries for repair and maintenance work in Ireland would obviously be very different from the case of aircraft and very likely prohibitive in cost. There might possibly be scope, however, for building on the skills and resources in CIE to develop related activities.

It is not known if CIE's engineering activity is profitable since it is not distinguished separately in the company's accounts. But in any case, the concept of profitability might not be very meaningful here since this type of engineering is basically a necessary part of the cost of running a railway and, since all "sales" are within the company, "prices" could be set and "profits" recorded to give differing results.

Irish Steel

Irish Steel became a state enterprise when the assets of the failed Irish Steel Ltd were taken over in 1947. It developed initially as a protected industry but it has experienced major commercial difficulties for most of the time since 1974 for a variety of reasons, so that large losses have occurred and employment has been cut back substantially. Without state support it would almost certainly have been forced to close down some time ago.

Steelmaking is a very large-scale industry for the most part and Irish Steel, although large by Irish standards, is in fact a mini-steelworks. Unlike the larger works which comprise the mainstream of the industry internationally, it reprocesses scrap metal using electricity as an energy source, rather than processing ore with a coke-fired blast furnace. Thus the price of scrap is an important element in its cost structure, as is the price of electricity (Irish Steel Limited, *Annual Reports*). Since Irish Steel differs from the large integrated steelworks, its smaller scale does not make it inherently uncompetitive. Mini-steelworks:

> . . . can be profitable in the right circumstances, though they need alert managements capable of making rapid decisions. They can be crippled economically if the price of scrap rises or if the cost of electric power increases drastically (Alexander and Street, 1982, p. 143).

With losses at over 90 per cent of turnover in 1982/83 and still at 35 per cent of turnover in 1984/85, although a small profit was recorded in 1985/86, Irish Steel could have been described as "economically crippled" in recent years. Part of the explanation is increases in electricity prices following rises in fuel prices, and increases in scrap prices as international demand from new electric furnaces grew.[21] In addition, major capital investments were undertaken in the late 1970s and early 1980s to re-equip the plant and high interest charges added further to the difficulties. At the same time, there have

21. Peter Bruce, "The Remarkable Boom in Scrap", *Financial Times*, 18th July 1984.

been major difficulties on the demand side. As was mentioned in Section B above, world demand stagnated between 1973 and 1983 while new capacity continued to come on stream, particularly in developing countries, and this created chronic excess capacity. The EEC resorted to protectionism, planned rationalisation and closures, and national quotas. This international environment has a major effect on Irish Steel since it exports most of its output (69 per cent of sales in 1984/85), and has to do so to utilise its capacity. Thus weak international demand has created problems in utilising capacity sufficiently to cover the heavy fixed capital costs resulting from the recent major investment programme.

Irish Steel probably could be commercially viable, given more favourable market conditions combined with lower electricity and scrap prices, which would enhance its competitiveness relative to many other steelmakers using different processes. But whether such conditions will occur for a sustained period remains to be seen.

Glen Dimplex

The Glen Dimplex group is a relatively new creation although most of the companies within the group are not. The original company, Glen Electric, was established across the border in Northern Ireland in the early 1970s by former employees of AET, a company based in Dunleer, Co. Louth, which was one of the large formerly protected firms still existing at that time in electrical engineering (Brophy, 1985, p. 84).

Glen made electric heaters and became quite successful. In 1977, Glen took over Dimplex, an English manufacturer of electric heaters which was in receivership. A year later Glen Dimplex returned to its starting point in taking over AET, which had been in trouble for some time past, and the group headquarters was established in Dunleer. Since then the Dunleer subsidiary has been renamed Basic Engineering and it has concentrated mainly on domestic heaters.

Five more companies were acquired in the UK and France between 1980 and 1985, nearly all of them involved in small domestic electrical appliances including heaters, kettles, other kitchen appliances, light fittings and hair care appliances[22]. And a major takeover of an American company in the same type of business followed in 1986. A new plant, smaller than Basic Engineering, had also been opened in Co. Louth to make a range of electrical appliances. Thus the Glen Dimplex group has become a substantial enterprise with about 4,000 employees and a range of related products, and it is vertically integrated from design through to metal fabrication and manufacturing. It uses agents for

22. Susan O'Keeffe, "Martin Naughton's Empire", *Business and Finance*, 31st October 1985.

consumer distribution, however, having found by trial and error that its strengths do not lie in that field. Rather the strengths of the group are mainly in design, manufacturing (with a range of related products with a good "fit"), and in recognised and accepted brand names such as Dimplex, Morphy Richards and Vidal Sassoon. In its own field it is now relatively large — for example, it claims a 38 per cent share of the UK market for electric heaters — and this gives advantages of scale in manufacturing. Evidently, this is an exceptional example of business success for an Irish-owned engineering company. Much of this success must be attributable to good management since several of the group's subsidiaries were failed or failing companies which have been turned around successfully. Key strategic issues were probably in the choice of product areas, the assembly of a range of related products with a good strategic fit, rationalisation of product lines, and recognition of the importance of design and marketing in this consumer-oriented industry.

Although Glen Dimplex has been an exceptional success, the nature of its path to success in a sense highlights some factors militating against development of this type of industry in Ireland by new or small firms. For the fact is that this was primarily, although not exclusively, expansion by acquisition of established companies, mostly located abroad. Only about a quarter of the group's employment is in the Republic of Ireland. The management must have judged, no doubt correctly, that this would work better than building up a similar type of company manufacturing in Ireland. The logic of this is clear enough; it avoids start-up costs and the period of initial losses commonly experienced by new ventures getting off the ground, it avoids the costs and delays involved in assembling a sizeable competent and experienced workforce and, perhaps most important in this industry, it provides instantly a range of recognised and accepted brand names. The importance of brand names and marketing is indicated by the fact that £2.5 million was to be spent on advertising the Dimplex and Morphy Richards brands alone in 1986, out of an expected group turnover of about £100 million. How much more would have to be spent to establish similar recognition and market shares for new brands, and how would this be financed by a new or small venture with a smaller initial cash flow? Thus the acquisitions road seems to be a quicker and more logical way to rapid expansion.

This is not to say that the contribution of Glen Dimplex to Irish industrial development has been insignificant. In Basic Engineering, it maintains the largest indigenous private-sector establishment in Metals & Engineering, having rescued it from failure, and the strength of the group brought about by expansion probably enhances the strength of the Irish establishments. But at the same time, further development of manufacturing in Ireland would be preferable from the point of view of the Irish economy, although it makes less sense from the point of view of the company and might be very difficult to achieve.

Conclusion

To conclude this chapter, it has been shown that most of the growth in Metals & Engineering since the 1950s was due to foreign-owned multinational companies rather than Irish indigenous firms. Nevertheless, indigenous employment in the industry grew quite strongly up to 1980 although it has declined considerably since then. The available data on output of indigenous firms indicate a similar trend. At the same time, there was a substantial increase in import penetration, beginning in the mid-1960s with the coming of freer trade, as well as a relatively weak export performance since the 1950s, implying a poor performance by internationally traded activities generally. The local-oriented virtually non-traded activities were able to expand in the 1960s and 1970s, however, when domestic demand conditions were favourable, but similarly they have been forced into decline in the 1980s as demand weakened. The relatively weak performance of internationally traded activities displays a substantial degree of continuity with earlier historical experience.

Consistent with the prevalent weakness of internationally traded industries, larger firms mostly declined while growth, when it occurred, was chiefly in small-scale firms serving the domestic market. By now indigenous engineering is very heavily concentrated in small firms, while the types of industry which have to be large in order to be internationally competitive are almost entirely absent. By international standards, there is also a marked scarcity of technology-intensive industries in indigenous engineering. It appears that barriers to entry arising from economies of scale, technology and external economies (among other things) have constrained the development of many types of industry by Irish firms, with the result that all sectors of indigenous engineering, except for Manufacture of Metal Articles, are relatively underdeveloped compared with other EEC countries.

On the more positive side, the number of small firms has grown rapidly, indicating considerable entrepreneurial initiative and an ability to take increasing advantage of the more accessible opportunities. The gap in the industry's development is therefore in larger-scale activities where entry barriers are more significant. The principal exceptions are state enterprises, so that non-market forces were at work in these cases. The development of indigenous engineering will probably remain rather stunted unless some more larger-scale industries can be established.

The next chapter focuses on the development of foreign-owned engineering industries in Ireland.

Chapter 6

FOREIGN-OWNED MULTINATIONAL INDUSTRIES

It was seen in the last chapter that foreign-owned multinational companies have accounted for most of the growth in the engineering industry in Ireland since the 1950s, as they have in manufacturing in general. They have established many new enterprises in the type of high-technology and/or large-scale industries in which indigenous firms are weakest, thus widening considerably the range of activities operating in Ireland. To a great extent the multinationals in engineering and other industries have been responsible for Ireland's transformation from a predominantly agricultural country to what is now conventionally recognised as a developed industrial country.

A. The Scale and Growth of Foreign Industry

By 1985, foreign-owned companies employed 37,400 people in Metals & Engineering, or 59 per cent of total employment in the industry, and they almost certainly accounted for an even larger share of output since sales per employee were higher than in indigenous firms in 1983 (IDA survey data). Even more striking has been the contribution of foreign firms to exports. The new grant-aided companies which have started up since the 1950s have always been very highly export-oriented, with 85 per cent of the output of those in Metals & Engineering being exported in 1973, for example (McAleese, 1977, Table 4.2).

Table 6.1 shows the sectoral distribution of employment in foreign industries in Ireland compared with that of indigenous industry, demonstrating a striking difference between the two. Foreign industries are much more heavily concentrated in sectors which have a relatively high proportion of technically advanced and large-scale activities, particularly Metals & Engineering and Chemicals which account for nearly 60 per cent of their employment. The proportion of their employment in engineering, at almost half, is much the same as in the industry of other EEC countries, so in this respect the composition of foreign industry in Ireland is similar to that of advanced industrial economies and quite different to that of Irish indigenous industry. Whereas indigenous industry has been impeded by barriers to entry from developing most modern large-scale activities, the multinationals are engaged in such industries and they have acted as a substitute for Irish firms in at least partially filling this gap in the country's industrialisation. Whether they are ultimately an adequate substitute is an issue which arises below under a number of headings.

Table 6.1: *Sectoral Distribution of Employment in Foreign and Indigenous Manufacturing, 1984 (per cent)*

Sector	*Foreign*	*Indigenous*
Non-Metallic Mineral Products	3.4	9.2
Chemicals	11.5	3.4
Metals & Engineering	47.7	19.9
Food	8.4	28.4
Drink & Tobacco	4.9	4.5
Textiles	5.8	5.1
Clothing, Footwear & Leather	8.3	8.7
Timber & Wooden Furniture	1.2	8.1
Paper & Printing	2.2	9.2
Miscellaneous	6.7	3.4
Total	100	100

Source: IDA Annual Report 1984.

Within Metals & Engineering there is a similar contrast in the composition of foreign-owned and indigenous industry. As much as 51.2 per cent of employment in indigenous engineering is in Manufacture of Metal Articles, the sector with the least significant entry barriers, whereas only 10.7 per cent of employment in foreign-owned engineering is in that sector, with the remainder in the others which have considerably greater barriers to entry. This means that 42.6 per cent of employment in *all* foreign-owned industries is in engineering sectors other than Metal Articles, compared with 9.7 per cent of employment in all indigenous industries. This is not really surprising since much the same forces which impede development of new or small indigenous firms in such industries with significant entry barriers gave rise to the development of large firms in advanced economies in the first place, and hence to their ability to undertake foreign direct investment. Indeed, much of the international literature on foreign direct investment by multinationals explains the phenomenon precisely in terms of factors associated with barriers to entry, oligopoly or "imperfect" competition. As Lall (1979) puts it:

> It now seems to be widely accepted in the empirical literature on trade and investment that enterprises need some form of "monopolistic advantage" to compete in the highly imperfect markets for products and factors that characterise modern industry. Studies of the patterns of comparative advantage and of direct investment flows, starting from different premises, have come increasingly to converge on a set of explanatory factors that are practically identical with the "barriers to

> entry of new competition" which have been identified by the industrial organisation literature to lead to the growth of large firms, and to the emergence of concentrated market structures, within the advanced countries. Thus, the forces that lead to successful growth at home also seem to provide the leading firms with the edge that they need to sell their products abroad or to set up foreign affiliates and serve overseas markets by producing abroad.

Thus, the international empirical literature would have led one to an *a priori* expectation that foreign investment in Ireland would tend to be concentrated in the same types of industry that indigenous firms are largely excluded from.

Most foreign-owned engineering industries in Ireland, like the foreign-owned industries in general, can be roughly classified into three types, according to the period when they were established, their motivation for investing here and the nature of their products. First, those established up to the 1950s were motivated mainly by a desire to sell to the Irish market. Since the policy of protection against imports at that time made it difficult for them to export to Ireland they overcame the protectionist barriers by setting up production here. The majority of them were British firms involved in industries such as motor vehicle assembly, radio and TV assembly, bicycles and batteries and they have mostly declined under freer trade conditions. By 1980, they employed about 5,000 people or about one-sixth of the total in foreign engineering industries[23].

Second, from the late 1950s to about the end of the 1960s, new foreign engineering investment in Ireland was largely in relatively labour-intensive industries with quite mature technologies for *export* markets. The industries concerned included consumer electronic and electrical goods, toolmaking and other light mechanical engineering. As Vernon (1966) suggested at around this time, such mature industries, with fairly standardised products, were most capable of locating in industrially undeveloped countries because they no longer depended on the specialised technologists, skills, suppliers and services found in advanced industrial centres. And since they were generally quite labour-intensive they had a motivation to move to relatively low-wage locations once they were sufficiently "mobile," or free from the need for close contact with advanced industrial areas. The international dispersal of such industries occurred quite early in relatively low-income countries on the periphery of the developed world, such as Puerto Rico and Ireland. Then, from about the mid-1960s, such mobile multinational industries increasingly

23. This was the number employed in foreign-owned firms which had not received a New (or Small) Industry grant under the scheme first introduced in the 1950s.

went to poorer less-developed countries with much lower wages[24]. Grants and tax concessions which were often introduced in the host countries (including Ireland) added to the attraction of low wages.

The third type of foreign industry to come to Ireland, from about the late 1960s (partly overlapping in time with the second group) has involved newer, more technologically advanced products, particularly computers, telecommunications equipment and other electronics, and medical instruments and equipment, again primarily for export. Typically these industries involve only certain *stages* of production which are usually not the most demanding on local technological inputs, skills and high-quality suppliers. Again, there is some parallel here with the type of mobile industry which has been able to go to less developed countries since the late 1960s (Helleiner, 1973), although the industries coming to Ireland include some more highly skilled activities, particularly in electronics, even if they have usually lacked the key technological and business functions of the firm. The majority of them are American-owned companies aiming to produce primarily for European markets and they have selected Ireland as a suitable relatively low-cost, virtually tax free site within the EEC.

While the first group of formerly protected foreign industries has declined under free trade since the mid-1960s, largely because they were sub-scale operations set up to serve the small domestic market, the other two groups of new export-oriented firms contributed substantially to employment growth. By 1973, new grant-aided foreign engineering industries established since the 1950s employed over 13,000 people, which was 28 per cent of total engineering employment at that time. And as was seen in Figure 5.2 and Table 5.1, employment in foreign-owned engineering continued to grow rapidly up to 1983 although it then fell slightly.

Unfortunately, there is no regular data series on industrial output distinguishing foreign from indigenous firms. It is possible, however, to gain an impression of output trends in most of foreign-owned engineering by examining the data on sectors which are mainly composed of foreign firms. Table 6.2 lists these sectors, showing the percentage of their employment accounted for by foreign companies as well as estimates of the percentage of sales accounted for by them. The sectors in the table account for 86 per cent of employment in all foreign-owned Metals & Engineering. The growth of output in these predominantly foreign-owned sectors is shown in Table 6.3. For the most part, the growth rates remained quite high in the first half of the 1980s despite the general recession, except in Motor Vehicles, where car assembly was collapsing for reasons mentioned in Chapter 5. At the same time, however,

24. Teeling (1975, Ch. 1) found that the composition of all new foreign industries in Ireland up to 1971 bore a close resemblance to those found in more conventionally recognised Less Developed Countries.

Table 6.2 *Predominantly Foreign-Owned Engineering Sectors*

Sector	*Foreign Employment 1985*	*Foreign as per cent of Total Employment 1985*	*Foreign Sales as per cent of Total Sales, 1983*
Office & Data Processing Machinery	11,020	90	98
Electrical Engineering	8,610	74	74
Instrument Engineering	7,060	94	99
Mechanical Engineering	3,310	52	73
Motor Vehicles and Parts	2,210	58	55

Note: The last column is estimated by taking data on sales per employee from an IDA survey of firms with over 30 workers and multiplying by employment data from the IDA Employment Survey to get estimates of sales of Irish and foreign-owned firms respectively.

Source: IDA Employment Survey and a 1983 IDA survey of sales and costs, reported in IDA (1985).

Table 6.3: *Average Annual Percentage Growth of Output in Predominantly Foreign-Owned Sectors, 1973-85*

Sector	*1973-80*	*1980-85*
Office & Data Processing Machinery	42.8	34.9
Electrical Engineering	4.7	5.0
Instrument Engineering	4.6	10.0
Mechanical Engineering	6.4	6.2
Motor Vehicles and Parts	-3.5	-16.7

Source: Census of Industrial Production and monthly inquiries.

employment in foreign-owned Metals & Engineering, which had grown at an average annual rate of 6.8 per cent in 1973-80, slowed down to 0.6 per cent per annum in 1980-85, and it actually declined between 1983 and 1985. In fact, there was little growth or a decline in employment in much of foreign-owned engineering between 1980 and 1985, except for electronics (Office & Data Processing Machinery and part of Electrical Engineering) and, to a lesser extent, Instrument Engineering. Thus there appeared to be a changing relationship between output and employment since there was a considerable difference between the trends recorded in these two variables. The implications of these trends for the Irish economy are discussed below, but first we consider the factors which motivate foreign direct investment.

B. Factors Influencing Foreign Direct Investment

In order to understand the behaviour of foreign industries in Ireland, it is useful to begin with some consideration of the factors which are thought to influence foreign direct manufacturing investment in general. A basic point which should be recognised at the outset is that manufacturing industries do not generally move freely around the world to take advantage, say, of cheap labour or government incentives. Rather, there are factors influencing their choice of location, such that only certain types of industrial activity locate outside advanced industrial areas. This means that late-industrialising countries, such as Ireland, which seek to attract foreign industrial investment, are competing for shares of a rather limited amount of it which is sufficiently mobile. Furthermore, most foreign industries aim to produce primarily for the host country's domestic market, having been induced to invest by a large market size and/or protection. This means that latecomers seeking export-oriented foreign manufacturing investment as Ireland does, are competing for only a segment of those foreign industries which are sufficiently mobile to locate outside an advanced industrial environment.

The strong attraction, for many industries, of an advanced industrial environment and large local markets is reflected in the fact that the bulk of foreign direct manufacturing investment has gone to advanced countries, not the low-income less-developed countries. The rapid growth, since the Second World War, of such investment flowing between advanced industrial countries has been explained as part of the process of increasingly oligopolistic competition. Hirsch (1976) points out that there is particularly wide scope for interpenetration of high-income foreign markets by advanced country firms in industries characterised by firm-specific assets, such as proprietary technology and marketing stength. These high-technology, product-differentiated industries are generally ones where concentrated, oligopolistic structures prevail, e.g., pharmaceuticals, instruments, computers, cars, cosmetics, etc. In such industries, as Hymer (1972) argues, there are large overhead costs such as R & D, design, marketing and capital equipment, which must be covered by a high volume of sales. Consequently the successful firms are large and have become intense rivals for market shares since the loss of market shares can lead to cumulative decline, given the advantages of large size. Once such large oligopolistic firms had developed a national (or continental) scale of operations, the dynamics of competition pushed them on to a wider multinational scale, selling their products in other countries.

In many cases direct foreign investment, rather than exporting, was the means chosen to penetrate foreign markets. In most cases, the decision to produce abroad is apparently influenced rather little by considerations of transport costs and relative labour costs in the two countries concerned. This may be deduced from the fact that most foreign direct manufacturing investment has gone to advanced countries, which are generally neither the most distant markets from the home base of the firms involved, nor the sites with lowest wage costs. The concentration of foreign investment in advanced countries points to the importance, as factors facilitating direct investment, of a large local market, political "reliability", and an advanced industrial environment capable of supplying specialised inputs, services and skills. It seems, too, that foreign direct investment in advanced countries is often motivated by the need to compete more effectively with rival firms based in the host country, as well as by the existence or possibility of protectionist measures against imports (Hymer, 1972). Due to the importance of these considerations in motivating local market-oriented foreign direct manufacturing investment, most less-developed countries (LDCs) have proved less attractive as sites, although strong protection against imports has proved to be something of a substitute for a large local market as an inducement to foreign direct investment. However, an industrially undeveloped environment remains a constraint on the types of industry which will go even to protected LDCs.

Although it is somewhat dated in other respects, as acknowledged by Vernon (1979), Vernon's (1966) analysis of the product life-cycle is useful in clarifying the issues raised here. He points out that most product innovations occur in the most advanced industrial countries (or specifically the USA at his time of writing), and that the inputs, production techniques and final specifications of a new product may vary quite widely for some time. This means that it must be produced in a location which offers flexibility in the choice of inputs and productive equipment, swift and easy communication with the firm's technical development base, and similar ease of communication with customers in a substantial market who will give feedback on the most desirable product specifications. Consequently, such a product will tend to be produced in, or close to, a major advanced industrial centre. Later, as the product matures somewhat and as the existence of a market abroad is established, it will be feasible to produce it in other advanced countries offering similar conditions. But it is only when the product is more standardised and the production process more settled and mature that it will be possible to establish the industry in an industrially undeveloped country.

The same constraints just referred to are relevant to the type of export-oriented foreign industries which can be set up in industrially undeveloped countries. Thus Vernon's (1966) analysis proceeds to suggest that as products become fully standardised, with mature production processes, their production comes to depend less on the external economies of advanced industrial centres. At the same time, their sales come to depend more on price and less on novelty, product differentiation or strong marketing. At this point, the low cost of labour in less-developed areas would prove to be an attraction for relocation of production (even though the target markets may be in developed countries), especially for relatively labour-intensive products where labour costs substantially affect the price. But Vernon also stressed that only a limited range of industries meet these requirements sufficiently.

> Manufacturing processes which receive significant inputs from the local economy, such as skilled labour, repairmen, reliable power, spare parts, industrial materials processed according to exacting specification, and so on, are less appropriate to the less-developed areas than those that do not have such requirements. Unhappily, most industrial processes require one or another ingredient of this difficult sort.

Helleiner (1973) writing some years later, adds two other categories of export-oriented foreign investment which would be possible in less-developed or newly industrialising countries. In addition to technically mature, unskilled labour-intensive final products which mostly fall within the same category that Vernon discusses, Helleiner includes basic processing of local raw materials, and more importantly, relatively simple or labour-intensive activities or processes which are only part of a longer production process. In this last category, which showed rapid growth from the mid-1960s, the *final* product may be relatively new, unstandardised and the product of advanced technology, but one or more *stages* of its production would be technically simple and relatively labour-intensive and hence suitable for LDCs. Dunning (1979) describes this type of foreign investment as "vertical" specialisation by location, as opposed to "horizontal" specialisation where the whole production process for each product made by the firm is concentrated in a particular place. Examples of "vertical" specialisation now occur in a wide range of industries including electronics, vehicles, chemicals and electrical machinery and much foreign investment in engineering is of this type. In this type of activity, the organisational capability of multinational companies enables them to relocate certain parts of the firm's production, or to sub-contract parts to local firms in places far distant from the base of the firm's operations. The organisation of the operation as a whole may still be subject to external economies, so that company headquarters, R & D and often much of the production process remains located in or close to large industrial centres. But certain stages of production no longer are subject to this constraint since the company's large size and organisational ability, together with improving communications and transport, enable it to "internalise" the external economies.

Helleiner (1973) also makes some suggestions about the factors which influence the particular choice of countries as sites for export-manufacturing of this type:

> . . . the important factors in a foreign investor's selection of a country are low labour costs, limited distance, special concessions (which may offset the labour cost and distance factors) and political "reliability" or "stability".

The attraction of Taiwan, South Korea, Hong Kong, and Singapore could be explained by the combination of low labour costs (in the early 1970s) and political reliability, while Mexico's attraction, despite somewhat higher labour costs, Helleiner suggested, showed the influence of distance costs (for exports to the USA). He also mentions that Spain, Portugal, Ireland and Greece have played a similar role in Europe, presumably subject to similar factors influencing the choice of country. Finally, Helleiner warns that the local linkage and learning effects and other "dynamic" benefits for the host countries in this type of export manufacturing may be very small and of little help to long-term development. Nayyar's (1978) analysis confirms Helleiner's on a number of points. He too mentions, as important categories of export-manufacturing by multinational companies in LDCs, simple labour-intensive final products and specialised processes in the manufacture of components and in assembly operations which are part of a larger production process, and he also expresses doubts about the benefits for long-term development.

C. The Nature of Foreign Engineering Industries in Ireland

The nature of foreign direct investment in engineering in Ireland can now be considered in the light of the discussion of the last section. The first significant wave of foreign involvement in manufacturing in Ireland occurred during the protectionist phase of Irish policy which began in the 1930s, as was mentioned above. The fact that this foreign investment occurred in a period of high protection, and the fact that the overall level of exports remained very low, indicates that this was essentially local market-oriented foreign investment induced by protection. Much of it occurred in the 1930s and 1940s, which was relatively early by most international comparisons. But since most of it was by British firms accustomed to regarding Ireland as a local market and with relatively small logistical difficulties in operating an Irish plant, this was scarcely surprising. It seems clear that these foreign engineering plants were generally engaged in final phase and assembly-type activities. These types of operation are commonly referred to in the literature as characteristic of local market oriented foreign investment in LDCs. Those which would have depended on the high level skills, close linkages with related industries and the other external economies of advanced industrial centres were not much in evidence.

From the 1950s onwards, however, there began a substantial inflow of highly export-oriented foreign manufacturing investment, and in due course these new exporting foreign firms came to employ far more people than the older, formerly protected ones. Although these new industries include many advanced high-technology categories, it will be clear from the discussion above that this in itself does not necessarily mean that the activities located in Ireland are very highly skilled, high technology activities, since low-skilled activities within such industries are commonly located in LDCs by multinationals. Thus the nature of such industries in Ireland requires further investigation.

First, let us consider the industrial composition of the foreign firms in Ireland. Table 6.4 shows that Metals & Engineering as a whole has accounted for a growing share of foreign manufacturing firms' employment, which is in line with the changing pattern of multinational investment in LDCs. For increasing "vertical" specialisation in such industries has enabled parts of them to go to LDCs, following after the earlier established mature industries such as clothing, textiles and footwear. Thus the proportion of American multinational manufacturing firms' capital expenditures in LDCs accounted for by Metals & Engineering industries increased from 47 per cent in 1977 to 61 per cent in 1984, while it remained stable at 57 per cent in the developed countries (US Department of Commerce, *Survey of Current Business*). On this basis, one could see the trend in Ireland as similar to LDCs, although at the same time it must be noted that the pattern of foreign investment in LDCs, by broad industrial category, has become very similar to that of developed economies.

Table 6.4: *Percentage Share of Engineering Industries in Foreign-Owned Manufacturing Employment, 1973 and 1985*

Sector	*1973*	*1985*
Office & Data Processing Machinery	5.1	14.1
Electrical Engineering	7.2	11.0
Instrument Engineering	4.5	9.0
Manufacture of Metal Articles	8.2	5.1
Mechanical Engineering	3.1	4.2
Motor Vehicles & Parts	5.6	2.8
Metals	0.2	1.0
Other Means of Transport	2.6	0.5
Metals & Engineering	36.5	47.7

Source: IDA Employment Survey.

Table 6.4 also shows that within Metals & Engineering the growth of foreign-owned industry was heavily concentrated in Office & Data Processing

Machinery and Electrical Engineering (which between them cover electronics, although much of Electrical Engineering is non-electronic), as well as Instrument Engineering. These sectors combined accounted for 72 per cent of foreign engineering employment in Ireland by 1985. The particularly rapid growth of these industries in Ireland was, of course, partly a reflection of their rapid growth internationally and the consequent increase in foreign investment worldwide. The first row of Table 6.5, for example, shows that US foreign investment in the world as a whole has grown much faster in Electric and Electronic Equipment than in all manufacturing. As the table also shows, however, American foreign investment in Electric and Electronic Equipment grew much faster in the LDCs than in the developed countries. It seems that parts of the Electrical and Electronic industries are particularly "mobile", or free from the ties of external economies in advanced industrial areas, since foreign investment in LDCs has become disproportionately concentrated in these sectors. For example, 21 per cent of all US manufacturing investment in LDCs was in Electrical and Electronic Equipment by 1984, compared with just 8 per cent of US manufacturing investment in the developed countries. As was noted in Chapter 3 and shown in Table 3.10, a relatively low level of manual production skills is required in Electrical, Electronic and Instrument Engineering, which facilitates the establishment of production units in less-developed areas. Thus, despite the high-technology nature of much of these sectors, when decomposed vertically by multinational companies they appear to generate many opportunities for direct investment in relatively simple processes in LDCs. Confirming this point, Shoesmith (1986) reports that electronics, with a predominantly unskilled labour force, is a major industry among foreign firms in the Free Trade Zones of Taiwan, the Philippines, Malaysia and Sri Lanka. Thus the growth of these industries in Ireland does not necessarily mean that highly skilled or high technology activities have been established here.

Table 6.5: *Average Percentage Growth Per Annum of Foreign Capital Expenditure by US Companies (in current dollars), 1977-84*

	Electric & Electronic Equipment	*All Manufacturing*
In All Countries (excl. USA)	11.0	4.2
In Developed Countries	7.9	3.6
In Less-Developed Countries	18.1	7.0

Source: US Department of Commerce, *Survey of Current Business*, October 1981 and September 1985.

To a certain extent, however, foreign investment in electronics in Ireland is concentrated in different products to the LDCs or newly-industrialising countries (NICs). Ireland was one of the world's top ten exporters of four categories of electronic products in 1983, all of them in the computers area. Among the NICs, Brazil and/or Spain were also ranked among the top ten exporters of these products as seen in Table 6.6. But other leading NICs, such as Singapore, South Korea and Hong Kong tend to be strongest in consumer electronics. This raises the possibility that Irish electronics might be more R & D intensive and skill-intensive than is typical of the NICs since computers tend to be a much more high-technology area than consumer electronics, in the world as a whole whatever about Ireland.

Table 6.6: *Ireland and the NICs Ranked Among the World's Top 10 Exporters of Selected Electronic Products, 1983*

Product	*Ireland*	*Spain*	*Brazil*	*Singapore*	*South Korea*	*Hong Kong*
Digital Computers	2	10	*	*	*	*
Digital Central Processors	7	*	8	*	*	*
Peripheral Units	8	10	9	*	*	*
Off-Line Data Processing Equipment	10	*	7	3	*	*
Calculating Machines	*	*	*	7	6	2
Colour TVs	*	*	*	4	3	*
Monochrome TVs	*	*	*	6	2	7
Car Radios	*	*	*	5	3	8
Portable Radios	*	9	*	3	4	2
Other Radios	*	*	*	4	2	3

Note: *Means not among the world's top ten exporters in this product category.
Source: UN *International Trade Statistics Yearbook 1983*, Vol. II.

The available information on this issue, however, suggests that the foreign-owned industries in Ireland are generally far less R & D intensive and also less skill-intensive than the industries of advanced industrial countries although they are probably more skill-intensive than in most of the NICs. Or to put it another way, Ireland, in this respect, looks like a leading NIC as much as an advanced economy. First, we may note the assessment by Telesis (1982) of electrical and electronic multinationals:

> Of the 60 companies surveyed, none have a truly stand-alone operation in Ireland, and only three have operations in Ireland which embody the key competitive elements of the company's business. All others are currently manufacturing satellites, performing partial steps in the manufacturing process. Skill development and linkages in Ireland have

> been limited. The electronics industry is a high-skilled industry worldwide, but the activities in Ireland's electronics industry do not now reflect this.

In a similar vein, Telesis commented on multinationals in mechanical engineering:

> Ireland's foreign-owned mechanical engineering companies consist mainly of sub-assembly and assembly shops of the sort commonly found in newly-industrialising countries . . . Of the 34 shops surveyed, about half had only one or two skilled blue-collar workers and one or two engineers.

And on medical instruments and supplies, or Healthcare Products[25], Telesis concluded:

> [The disposable medical products industry] is based on low labour costs with few, if any, skilled workers. The six companies we surveyed had less than 1 per cent of their workforce in managerial, engineering, technical and skilled blue-collar positions. [In medical appliances] with the exception of one company, the skill levels of the workforce, both blue- and white-collar, are relatively low, representing less than 5 per cent of total employees.

Telesis also noted that companies in Healthcare Products in Ireland are subject to intensifying competition from Asian NICs. On foreign-owned firms in general, they concluded:

> Foreign-owned industrial operations in Ireland with few exceptions do not embody the key competitive activities of the business in which they participate; do not employ significant numbers of skilled workers; and are not significantly integrated into traded and skilled sub-supply industries in Ireland.

To focus on the electronics industry, since it has played a key role in the growth of foreign-owned engineering, Table 6.7 shows the skill profiles of electronics in Ireland and a number of other countries.

25. "Healthcare Products" in the IDA Employment Survey is a distinct category which is not used in the NACE system. Throughout this paper the NACE system is used as far as possible and Healthcare Products is included in Instrument Engineering to this end; indeed it accounts for most of that sector's employment, but an indeterminate proportion of Healthcare Products belongs more properly in Processing of Plastics or elsewhere.

Table 6.7: *Skill Profile of Electronics in Selected Countries, c. 1980/81*

	Singapore	*Ireland*	*Scotland*	*UK*	*USA*	*Denmark*
Managerial, Administrative, etc.	n.a.	23	35*	34	24	29
Engineers/Professional/Technical	6	5	9	10	17	
Technicians		9	13	14	11	32
Craftworkers		3	8	8	10	
Non-craft Production Workers	c. 90	57	35	31	32	39
Other Workers		3	*	3	6	
Total	100	100	100	100	100	100

Note: Data on Hong Kong indicate a skill profile broadly similar to Singapore, but the categories are not strictly comparable so they are not included here.
* For Scotland, "Other Workers" are included with Managerial, etc.
Source: O'Brien (1985), Table 6.10.

The table shows that the level of technical skills in Irish electronics is considerably lower than in the more advanced countries with employment being more heavily concentrated in non-craft production work, but skills are also a good deal higher than in NICs such as Singapore, and probably Hong Kong. When R & D intensities are compared, the gap between Ireland and advanced countries looks considerably greater and South Korea comes out slightly ahead of Ireland, as shown in Table 6.8. As O'Brien (1985) points out, the total expenditure on electronics R & D in Ireland is less than that by many individual medium-size firms in other countries and less even than some firms in the NICs such as Samsung of South Korea. He reports too that R & D intensity in Irish electronics showed no change between 1977 and 1982 although the absolute amount of R & D expenditure did increase as the industry grew.

Table 6.8: *R & D in Electronics in Selected Countries as a Percentage of Sales*

UK (1981)	10.8
USA (1982)	8.1
Denmark (1979)	8.0
Finland (1981)	7.1
Japan (1982)	6.4
South Korea (1979)	1.3
Ireland (1982)	0.9
Taiwan (1981)	0.3

Note: About half of the UK figure is accounted for by firms on military projects.
Source: O'Brien (1985), Table 6.8

The proportion of professional and technical workers in the industry's employment has increased somewhat, however, in recent years. The proportion of Engineers/Professional/Technical Workers and Technicians rose to 16.6 per cent by 1985, compared with the figure of 14 per cent in 1980/81, shown in Table 6.7. And the proportion of Non-Craft Production Workers fell from 57 per cent in 1980/81 to 52.8 per cent in 1985[26]. It is possible, however, that the situation of over-supply of electronic engineers and technicians which developed during this period encouraged firms to employ such people in jobs for which they were really over-qualified and which would previously have been done by people with lower skills. At any rate, wage costs per employee were not particularly high in 1983 at £10,700 in foreign-owned Office & Data Processing Machinery and £8,100 in foreign-owned Electrical Engineering — compared with £9,700 in all foreign-owned industry and £10,000 in Total Manufacturing — suggesting that the average level of skills in these sectors was not very greatly different to the overall average (IDA survey data).

The data in Table 6.8 indicate that the electronics industry in Ireland has a much lower R & D intensity than in more advanced economies. This reflects the fact that it consists very largely of branch-plants of multinationals which do their main R & D elsewhere, so that high-technology products can be produced in Ireland without a major Irish technology input. The foreign-owned electronics industry is actually less R & D intensive than the much smaller indigenous industry. Thus the multinationals accounted for 59 per cent of R & D in Electronic Equipment in 1984 (NBST statistics), compared with about 81-90 per cent of electronics employment[27].

This relatively low level of R & D intensity among multinationals in Ireland is not unusual since such companies typically conduct most of their R & D in advanced centres of their industry in the home country, where the largest pools of the most experienced R & D workers are located. Advanced R & D is an activity that is very much subject to the influence of external economies. American multinational companies in all of manufacturing, for example, incurred only 8.6 per cent of their R & D expenditure outside the USA in 1977 although 26.6 per cent of their employment was located abroad. In electronics the gap was considerably greater since just 5.9 per cent of R & D expenditure was incurred outside the USA compared with 32.2 per cent of employment

26. The 1985 data come from a survey carried out under the direction of Professor M. E. J. O'Kelly at the Department of Industrial Engineering, University College, Galway.

27. The lower figure in the range comes from the IDA Employment Survey, using a loose definition of electronics as Office & Data Processing Machinery plus Electrical Engineering. The higher figure comes from the survey referred to in footnote 26, which adopted a more precise definition that excludes much of Electrical Engineering.

located abroad (O'Brien, 1985). This is consistent with Lall's (1979) finding that the propensity of US multinational companies to undertake R & D abroad in engineering industries is negatively correlated with the R & D intensity of the industries concerned. His explanation is that in engineering industries with the most rapid rate of product innovation:

> . . . the core of the innovative process is the improvement, "tailoring" and testing of new designs and it is more difficult [than in the case of process innovations or slow rates of product innovations] to separate such functions as exploring the needs of major customers, bringing scientific and technical skills to bear on these needs, getting rid of bottlenecks in successive stages of production, ensuring an adequate supply of new components of various kinds, marketing the product and reacting to "feed back" from the users. In other words, there is a closer need for continuous interaction between all the major functions and the procurement, production, management and marketing functions . . .[28].

No doubt for much the same reasons, when multinational companies do undertake R & D abroad, most of it is located in the large advanced countries, rather than in LDCs or NICs. American electronics multinationals, for example, incurred 62 per cent of their foreign R & D expenditure in Germany, France and the UK, although just 29 per cent of their foreign employment was in these countries. Given this order of things, it would be surprising to find a heavily R & D intensive electronics industry in Ireland.

It seems justifiable to conclude from the discussion of this section so far that the profile of most foreign-owned engineering industries in Ireland shows some similarities to those in the leading NICs. They are mostly examples of "vertical" specialisation by location, they are a good deal less R & D intensive than the same industries in advanced countries and they are export-oriented satellite plants. This is important because it suggests that Ireland has attracted mainly relatively "mobile" plants which might have been capable of selecting a location with an industrially undeveloped environment and a small local market. And this has implications which are discussed in Section D below, which deals with the future outlook.

One qualification, however, is that the stage of production conducted in Ireland by many firms in the "modern" sectors such as electronics involves final assembly, testing/quality control and packaging. Since testing and quality control in particular need skilled technicians and engineers, these activities are

28. As Lall points out, this analysis echoes that of Rosenberg on American engineering industries in the nineteenth century, which was referred to in Chapter 2 of this paper.

bigger employers of skilled and professional workers than the earlier (1950s/ early 1960s) generation of foreign export industry. And it also appears to be the case that Ireland has significantly more of this type of mobile foreign industry than most NICs and consequently has higher skill levels. This certainly puts the most recently established industries in Ireland in a more favourable light, but there are no really firm grounds for expecting further major "upgrading" of technology and skills in foreign-owned industry. For foreign firms have shown relatively little inclination to locate key functions such as advanced R & D in Ireland or other peripheral locations, while the rather routine nature of much of the skilled and professional work provided probably does relatively little to enhance Irish technological capabilities. And as Telesis (1982, Chapter 4) pointed out, Scotland has had a larger electronics industry than Ireland for a longer time, based on investment from outside, but "the majority of non-Scottish operations were established as manufacturing satellites, and few have progressed significantly beyond this role". They conclude that:

> Programs currently underway will substantially improve Ireland's physical infrastructure and its education and skill base for the electronics industry. This should mean that Ireland can achieve levels of integration as good as those in Scotland. This level of sophistication however is still considerably less than Ireland seeks . . .
> The ultimate limiting factor is the competitive economic dictates of the high technology multinational firms. Their business economics in most cases will limit the placing of key competitive activities in a small, relatively remote "foreign" country even with significant incentives.

Ireland's Advantage as a Location

If many foreign export-oriented engineering industries in Ireland are relatively "mobile" manufacturing plants of a type which is quite commonly located in NICs, the question arises why should so many of them choose Ireland rather than somewhere else with much lower labour costs? The factors usually mentioned as important influences on location decisions of mobile multinational production units are low labour costs, a docile or repressed labour force, ease of access to major markets, political "reliability", an acceptable infrastructure of transport and communications, and government incentives such as grants and tax concessions. In the 1950s and the first half of the 1960s, at least, Ireland would have ranked quite highly on most of these criteria — among countries which would have been seriously considered as potential sites. For few countries made strenuous attempts to attract mobile export-oriented multinational plants until around the mid-1960s, and in fact few in the Third World would have had the basic infrastructure and/or political reliability required to do so. The relatively low-wage countries on the periphery of the developed world, therefore, would have been rated quite highly as feasible sites, so it was possible for Puerto Rico and Ireland to emerge as forerunners in this activity.

By the late 1960s and early 1970s, however, a number of other countries, especially the Far Eastern NICs, were becoming acceptable sites of some importance, with much lower labour costs than Puerto Rico or Ireland. Against such competition, Ireland's continuing ability to attract substantial amounts of foreign investment would have to be put down mainly to advantages of proximity and access to major markets, if one sticks to the conventional influences on plant location mentioned above. Teeling (1975, Ch. 2) considers whether tariff-free access to a large market (the UK in this period) and transport costs differentials would account for the attraction of Ireland. He concludes that since Singapore and Hong Kong had similar rights of market access to the UK, and since the cost of transporting the relevant goods was generally small, these factors would not explain Ireland's attraction. There are, however, other advantages of proximity such as ease of communication (post, telephone, etc.), short delivery times and ease of travel for salesmen, repairmen and executives. For these reasons, the choice of location even *within* a country such as Britain can be influenced by ease of access to the major markets and service centres.

Teeling recognises that these aspects of proximity do matter but another factor which he stresses is no doubt significant too. He argues that information, uncertainty and risk are all important or perhaps vital variables in offshore investment decisions. Because of such factors as the relatively long and successful history of promoting foreign investment in Ireland, the experience and internationally recognised efficiency of the IDA, Ireland's proximity to advanced countries, and cultural ties with the USA and UK, "on each of these variables, Ireland was shown to have a comparative advantage over competing locations". Teeling's main evidence to support this is the fact that most foreign investors in Ireland were quite small and had little international experience, by the standards of most multinationals. This suggests that they would have high information costs and high perceptions of risk and uncertainty — particularly regarding more distant locations — compared with larger, more experienced firms. Over half of the firms he surveyed were undertaking their first foreign investment when they came to Ireland. In 1971, 46 per cent of the Irish subsidiaries had parent companies with sales of less than \$10 million, compared with only 6 per cent in Singapore. And whereas 30 per cent of the foreign firms establishing plants in Ireland in 1954-66 had more than 6 foreign subsidiaries, this proportion fell to 18 per cent in 1967-72; thus in the later period, Ireland's comparative advantage seemed to be shifting more towards small inexperienced multinationals while larger companies were prepared to go to the NICs. Teeling also refers to other studies which find that foreign firms in Puerto Rico and the Mexican border region are also relatively small and inexperienced, suggesting that they too are averse to risk and value the close contact with the USA, which is comparable to Ireland's position in relation to Europe. O'Loughlin and O'Farrell (1980), with data relating to 1976-77, confirm Teeling's earlier finding that foreign investors in Ireland tend to be relatively small and inexperienced multinational companies, probably with high information costs and high perceptions of risk and uncertainty.

Since 1973, Ireland has had the further attraction for export-oriented foreign investors of being a member of the EEC. There is no doubt that this has been very important. According to a survey of foreign firms in Ireland reported in the *Allied Irish Bank Review,* April 1981, two-thirds of them regarded a site within the EEC as an important or a necessary attraction, since their main purpose is exporting to Europe. Presumably this means that an even higher proportion of those which came to Ireland since 1973 were looking for a site within the EEC. Telesis (1982, Ch. 4) reached a similar conclusion, suggesting that most foreign companies in Ireland were looking for an EEC location and, within that constraint, chose Ireland as a relatively low-wage, tax-free location:

> Currently, most foreign-owned companies use Ireland as a convenient manufacturing satellite for sales in the EEC. Over 80% of the companies visited during our study came to Ireland primarily because it provided a tax shelter for penetrating the EEC. Fourteen per cent, epecially those who came in the 1960s or early 1970s, were attracted primarily by the relatively low wage rates. Today, Ireland still has the lowest average tax and wage rates of all EEC countries . . .
> In this sense, Ireland is similar to Singapore and Puerto Rico, which are both small tax havens used as satellite manufacturing locations for Asia and North America respectively. This contrasts with foreign company investments in Germany and the U.S., where firms seek access to large home markets or particular skills available in those countries.

Consistent with this view is the increased proportion of new foreign investment accounted for by firms based in countries outside the EEC, and the increased proportion of exports from Ireland going to other EEC countries besides the UK. Thus US firms accounted for 42.5 per cent of foreign Metals & Engineering employment in 1973, rising to 60 per cent by 1985, while other non-European countries accounted for 0.9 per cent in 1973 rising to 7.9 per cent by 1985. In all foreign-owned manufacturing, the share of US firms in employment rose from 24.2 per cent in 1973 to 48.1 per cent in 1985, and the share of other non-European countries rose from 2.3 per cent to 8.4 per cent. And in 1973, 55 per cent of Irish exports went to the UK and 21 per cent to the rest of the EEC, but in 1984, 34 per cent went to the UK and 34 per cent also to other EEC countries. These trends confirm that much foreign investment in Ireland in the 1970s and 1980s was by non-EEC firms selecting an attractive site within the EEC to produce for European markets, and this gives Ireland an advantage over low-wage NICs in attracting such firms.

In recent years too, it appears to be the case that American electronics firms have been attracted to Ireland partly by the ready availability of qualified engineers and technicians. This is not necessarily to say that the quality of skills in Ireland is at an unusually high level, and indeed there is clearly a dearth of experienced R & D scientists and engineers relative to the USA. But the Irish graduates are of good quality, if lacking in R & D experience, and they are in over-supply here while there has been a shortage of graduates relative to demand in America and some European countries.

D. The Secondary Effects and Medium-Term Outlook for Foreign Engineering

Some of the issues which arise in considering the secondary effects of foreign engineering industries on the domestic economy have already been touched on in the last section. This section looks further into these and other related issues. Under the heading of the secondary effects of foreign industries, three issues are discussed briefly — their "backward linkage" stimulus to the local economy by purchasing inputs, their effects on the balance of payments, and the extent of technology transfer.

Linkages

Compared to most industries, foreign-owned Metals & Engineering firms have tended to have lower than average expenditure in the Irish economy in relation to their sales or turnover. Table 6.9 shows the proportion of total expenditures of grant-aided "New Industries" spent in Ireland (in Column 1) and the proportion of their expenditures on material inputs spent in Ireland (Column 2) in 1973. It can be seen that engineering firms among these industries tended to have a lower than average Irish content in their expenditure and that foreign-owned firms tended to have lower Irish linkages than indigenous firms.

A more recent IDA survey in 1983 allows a more detailed break-down by sector, and data from this survey are presented in Table 6.10. Again it is clear, from Columns 1 and 2, that Metals & Engineering as a whole has a lower Irish

Table 6.9: *Expenditure on Irish Goods and Services by New Grant-Aided Industries, 1973*

Sector	*Irish Content of Total Expenditure (per cent)*	*Irish Content of Materials Expenditure (per cent)*
Metals & Engineering		
Foreign	40.2	8.4
Irish	46.6	17.2
Non-Food Manufacturing		
Foreign	47.1	11.7
Irish	55.0	24.2

Source: McAleese (1977), Table 5.4.

content in its expenditures than manufacturing in general, while foreign-owned engineering firms have a lower Irish content than total engineering. The sectors with the fastest growth in recent times — Office & Data Processing Machinery and Instrument Engineering — have the lowest proportion of Irish economy expenditures. Taken sector by sector, however, there is no clear tendency for foreign firms to have a lower proportion of Irish economy expenditures than their sector as a whole; in three sectors it is lower and in three it is higher. Thus much of the reason for the lower Irish content in expenditures of foreign-owned engineering as a whole is because of its sectoral composition, being relatively concentrated in the sectors with a low Irish content in their expenditures. Also, as Columns 3 and 4 of Table 6.10 show, in all sectors except one, the foreign firms spend more in Ireland *per employee* than the sectoral average, because even in cases where their Irish expenditures are below average as a percentage of sales, they tend to have above average sales per employee.

Since there does not appear to be a consistent tendency for foreign firms to spend less in Ireland than Irish firms in the same sectors, the attitudes or business practices which arise from foreign ownership as such are probably less significant barriers to developing further linkages than deficiencies in the range and quality of Irish supplier industries. Telesis (1982, p. 145) reached this conclusion:

> The foreign mechanical engineering industry in Ireland is hampered by a shortage of skilled workers and by the absence of a skilled infrastructure of suppliers in areas such as casting, toolmaking, precision plastics and machine sub-contractors. Cost penalties for foreign firms setting up in

Table 6.10: *Irish Economy Expenditures of Engineering Industries, 1983*

Sector	*Total Irish Expenditure as per cent of Sales*		*Irish Expenditure per Employee (£)*	
	Foreign Firms	*All Firms*	*Foreign Firms*	*All Firms*
Metal Articles	47.9	53.4	18,763	17,454
Mechanical Engineering	45.0	65.3	19,575	15,001
Office & Data Processing Machinery	24.3	25.2	31,609	29,841
Electrical Engineering	42.9	42.0	15,964	16,065
Motor Vehicles & Parts	53.9	44.7	14,894	12,834
Instrument Engineering	37.4	36.0	19,401	18,497
Metals & Engineering	33.5	38.3	21,164	18,876
All Non-Food Manufacturing	38.0	49.0	22,000	22,180

Note: As no foreign firms in Metals or Other Means of Transport were covered in the survey from which the data are derived, they are left out here. These sectors accounted for only 4 per cent of foreign engineering employment in 1983.
Source: Derived from data from the survey reported in IDA (1985).

> Ireland and importing these components are high . . . They would like to buy more, but the low quality and high cost of sub-suppliers prevents this.

Similarly, the Sectoral Consultative Committee — Engineering (1983, Section 7.2) reported:

> The Committee . . . considered that the main problem area lay with the sub-contracting companies . . .

The Committee found that there were deficiencies in the quality and reliability of delivery among existing supplier firms, and also that it can be difficult for a wider range of new suppliers to emerge.

> The development of an efficient sub-contracting industry typically suffers from a "chicken and egg" situation — where the volume of work is insufficient to support an efficient and profitable sub-contract industry and therefore contractors are at a serious disadvantage because there is not an efficient sub-contract industry.

Or, to put it another way, in the absence of sufficient local demand it is difficult for a wide range of specialised suppliers to develop, and their absence in turn hampers the development of the larger firms which would purchase from them. Established large centres of engineering abroad do not suffer from such problems and indeed the benefits of external economies which they enjoy put others at a competitive disadvantage. Relatively small domestic demand for specialised sub-supplies not only tends to limit the range of suppliers which can emerge, but could also at least partly account for low quality or slow deliveries among existing suppliers. For small demand means that supplier firms are small, and hence may lack the financial and managerial resources required for application of adequate quality control equipment or procedures. And a small volume of production and sales also means that firms may take quite a long time to benefit from learning economies which accrue in relation to the cumulative volume of output, in both management and production.

There are no really adequate data to assess what progress has been made in developing the backward linkages of foreign engineering firms over time, although the regular series of surveys initiated by the IDA in 1983 is beginning to provide such data. In foreign engineering as a whole Irish economy expenditures as a percentage of sales seem to have fallen between 1973 and 1983, from about 40 per cent (Table 6.9) to about 34 per cent (Table 6.10). These figures, however, are not really strictly comparable since Table 6.9 refers only to grant-aided "New Industries" whereas Table 6.10 includes older ones as well, but nevertheless it seems very likely that the declining trend indicated is correct. However, the reason is probably not that the proportion of Irish economy expenditures of each sector has fallen, but rather that the composition of foreign-owned engineering has changed quite rapidly so that the sectors with the lowest linkages have become increasingly important.

Table 6.11 gives an indication of the possible magnitude of the effect of this change in composition. Columns 1 and 2 of the table show the gross output, in constant 1980 prices, of the predominantly foreign-owned sectors in 1980 and 1985; the total gross output of these sectors increased by 109.9 per cent in volume terms, or by 16 per cent a year. Columns 3 and 4 show hypothetical estimates of the Irish Economy Expenditures of these sectors, again in constant 1980 prices, derived by assuming that Irish Economy Expenditures as a percentage of output in each sector remained constant between 1980 and 1985 at the rate recorded in the IDA's 1983 survey; on this assumption the total Irish Economy Expenditures would have increased by 72 per cent in volume terms, or by 11 per cent a year. This means that Irish Economy Expenditures as a percentage of sales of these sectors combined would have fallen from 42 per cent in 1980 to 34 per cent in 1985, even with no decline in the rate for each sector. This is not necessarily what actually happened, of course, since it is based on the assumption that Irish Economy Expenditures as a percentage of sales in each sector remained unchanged. But the point is that there could well

Table 6.11: *Estimated Gross Output and Irish Economy Expenditures of Predominantly Foreign-Owned Engineering Industries (constant 1980 prices)*

	Gross Output		Irish Economy Expenditures	
Sector	*1980*	*1985*	*1980*	*1985*
Mechanical Engineering	190.5	257.0	124.8	168.3
Office & Data Processing Machinery	331.3	1,481.9	81.9	366.2
Electrical Engineering	320.8	409.0	140.9	179.6
Motor Vehicles & Parts	183.2	73.6	85.5	34.4
Instrument Engineering	141.8	228.9	52.7	85.0
Total	1,167.6	2,450.4	485.8	833.5

Source: Census of Industrial Production 1980, for Column 1, increased in line with indices of volume of production for Column 2. Columns 3 and 4 are derived by multiplying Columns 1 and 2, respectively, by the "Irish Economy Expenditures as a Percentage of Sales" data from the 1983 IDA survey. Thus this assumes that the Irish Economy Expenditure proportions in 1980 and 1985, in each sector, were the same as in 1983.

have been some increase in the linkages of most individual sectors, consistent with an overall decline arising from changing sectoral composition.

Foreign Exchange Earnings

Most foreign-owned engineering firms are highly export-oriented and hence they would appear to be significant earners of foreign exchange for the economy. On the other hand, we have seen that their expenditures in the Irish economy are relatively low as a percentage of sales, which implies that there is a high import content in their products, so that their *net* foreign exchange earnings must be a good deal less than the value of their exports. Again the IDA survey of 1983 gives an indication of the magnitudes involved. Table 6.12 uses data on the predominantly foreign-owned engineering industries from this survey to show exports (calculated using data on employment, sales per employee and exports as a percentage of sales), and "potential" foreign exchange outflows. The potential foreign exchange outflows are calculated as the proportion of the value of a sector's sales not accounted for by Irish economy expenditures; thus they include principally the value of imported materials and services, and profits, as well as small amounts attributable to interest and depreciation. Since not all profits or interest payments necessarily leave the country, the foreign exchange outflow figures represent the maximum potential outflow and the net foreign exchange earnings in Column 3 are minimum estimates. As the table shows, these engineering industries are quite significant net earners of foreign exchange although such net earnings could amount to only about 26 per cent of the value of their exports if all profits were repatriated. By comparison, in the Rest of Manufacturing the minimum net earnings are 38 per cent of the value of exports.

Table 6.12: *Exports and Net Foreign Exchange Earnings of Predominantly Foreign-Owned Engineering Industries, 1983*

Sector	*Exports (£m)*	*Potential Foreign Exchange Outflow (£m)*	*Minimum Net Foreign Exchange Earnings (£m)*
Mechanical Engineering	90.1	56.5	33.6
Office & Data Processing Machinery	1,352.2	1,027.0	325.2
Electrical Engineering	341.8	272.0	69.8
Motor Vehicles & Parts	103.2	86.1	17.1
Instrument Engineering	379.9	241.2	138.7
Total	2,267.2	1,682.8	584.4
All Rest of Manufacturing	4,951.0	3,071.4	1,879.6

Source: Derived from IDA survey data.

Technology Transfer

A further secondary effect of foreign-owned industries which might be important is the transfer of more advanced technology into the country, helping indirectly to upgrade the technological capabilities of indigenous industry. It has already been noted that even the high technology foreign-owned industries generally conduct rather little R & D in Ireland compared with the same industries in more advanced economies. But there are other ways, besides formal R & D, in which they could serve to raise the levels of technical knowledge of the labour force and help to improve the capabilities of Irish industry in general. For example, Irish managers, engineers and technicians could gain valuable experience, not only in R & D, but also in applying sophisticated systems and advanced manufacturing technologies (AMT). This in turn could lead to diffusion of technology into the indigenous sector through experienced staff leaving multinational companies to set up their own firms or to work for existing indigenous companies, or by means of a "demonstration effect" which would cause indigenous companies to begin to imitate the practices of the multinationals.

Some research on these issues has been done by others, finding that such a process of diffusion does occur, but that its impact is somewhat limited. The Sectoral Development Committee (1985, p. 8) reached the following conclusion:

> Many of the new overseas companies that have located here over the past ten years have brought with them advanced technology which is among the most sophisticated to be found anywhere in the world. The research and development underlying such technologies has, however, been undertaken overseas . . . Their impact on upgrading the technological infrastructure of this country has, accordingly, been important but less significant than might otherwise have been anticipated. New skills at both operative and management levels have been developed here as well as a wide familiarity with modern industrial production processes . . . The new high-technology overseas industries have also provided a demonstration effect for indigenous Irish industry which is characterised, for the most part, by low technology and a poor record of product and process innovation . . . While good progress has been made by many Irish firms in adapting new technologies, which are the key to competitive success, the process of adaptation needs to be far more widely spread.

Thus, while accepting that the foreign-owned firms were helping to upgrade the process technology of the indigenous sector, the Committee was nevertheless concerned that major "technology gaps" still exist in most indigenous firms, mentioning areas such as computer-aided design and manufacture and the use of CNC machines.

As regards one of the specific mechanisms of technology transfer to the indigenous sector, the Sectoral Development Committee (1985, p. 75) found that the rate of new indigenous electronics firms starting through spin-offs from foreign-owned companies is low, i.e., rather few new firms have been started by Irish people formerly employed in foreign-owned companies. Cogan and Onyenadum (1981) confirm this, finding that by 1980 only 5 out of the 35 indigenous firms in electronics had spun off from the 74 multinational companies and that these 5 employed only 120 people. A significant aspect of their findings is that all 5 of the foreign-owned "incubator" companies were among the minority which undertake R & D in Ireland, and that all of the promoters of the new spin-off companies had gained experience in these product or process development activities. The foreign incubator firms also had in-house marketing functions to a greater extent than most foreign-owned companies in Ireland. The implication appears to be that spin-offs are most likely to occur from foreign firms with such higher-level business functions, so that the fact that most foreign-owned companies in Ireland do not have these functions limits the rate of spin-offs as compared with more advanced industrial economies.

A series of three articles by Onyenadum and Tomlin (1984a, 1984b and 1985) sheds some further light on technology transfer through mobility of staff from foreign-owned companies. They took as case studies two of the largest American subsidiaries in the electronics industry, which together employed 1,600 people, and they interviewed 82 people who had worked in these companies in supervisory, technical or managerial positions and subsequently left them. They found that these people had significant potential as sources of technology transfer by virtue of their qualifications and work experience. While most had moved to other foreign-owned organisations in Ireland 40 per cent were in Irish-owned organisations. In fact, 10 per cent (or 8 people) had started their own small company although only 5 of them were in manufacturing, with 2 of these in electronics. This seems quite a high rate of spin-offs if it were typical, but the 2 American incubator companies concerned conduct significant design and development work, unlike most foreign-owned firms, so it is likely that they would generate more spin-offs than most.

Of the other interviewees working in Irish organisations, only 3 out of 25 were in manufacturing companies while the others were in state agencies such as AnCO or the IIRS, service companies and educational organisations. Thus this pattern of mobility suggests that technology is being transferred into the indigenous sector, but primarily into the supportive infrastructure of services, development agencies and educational institutions rather than directly into Irish industrial companies. In fact, none of the interviewees was engaged in technical work in Irish industrial firms (except perhaps to some extent in their capacity as head of their own company). As Onyenadum and Tomlin (1985) conclude, this pattern is probably explained by the fact that there are few existing Irish electronics companies to which these people could go, or at least very few of such a stature that a move into them would involve a career advancement.

To conclude, there is little doubt that advanced technology is transferred from the foreign-owned to the indigenous sector by means of the demonstration effect, spin-offs and staff mobility. But this effect has been somewhat constrained for a number of reasons. The relatively limited amount of business functions such as R & D and marketing in the foreign-owned sector seems to put a limit on the number of spin-offs. And the scarcity of strong firms in the indigenous sector who would attract experienced staff from the multinational companies means that there is probably not a great deal of technology transfer through direct mobility from foreign to indigenous companies. The indigenous technology infrastructure probably benefits more, however, and this is likely to be important in raising the quality of indigenous technical services, training and education.

The Outlook for Expansion of Foreign Engineering Industries

Since it has been shown that foreign firms have been largely responsible for the improved performance of engineering in Ireland since the 1950s, it is important to consider to what extent can they be relied on to make a similar contribution to growth in the future. The prospects for continuing expansion can be considered in the light of our earlier outline of the nature of foreign firms in Ireland. In particular, it was pointed out that for the most part they are fairly mobile production units, and that the parent companies are often relatively small and inexperienced as multinational companies. This would suggest that, rather than continuing to expand, many foreign companies in Ireland might tend to decline, close down or relocate elsewhere some time after being set up and reaching their initial target size. This is so for several reasons. First, there is the fact that Ireland was one of the earliest important sites for mobile "offshore" or export-oriented foreign investment, which has been followed by the rise of a growing number of other countries with much lower labour costs as acceptable sites. As it became clear that similar types of plants with similar products could be set up successfully in these low-wage NICs, the firms in Ireland could have been tempted to relocate or, if they did not, they could have lost ground increasingly to competition from NICs. This consideration would probably have been important for foreign plants first set up in Ireland before the late 1960s.

Even for those established later, however, with the additional attraction of Ireland's improved market access, and having chosen Ireland despite the existence of lower cost NIC sites, there are other considerations with a similar effect. Most of the newer industries make relatively new high-technology products with rapidly growing sales, at least initially, but the stages of production set up in Ireland were usually not the most highly skilled or technologically demanding operations. The fact that foreign firms investing in Ireland have tended to be relatively small and inexperienced as multinational companies suggests that the products or processes being introduced to Ireland by foreign firms are often at an early stage in the process of dispersal to "offshore" NIC locations. Consequently, for any particular product or process, further dispersal to lower-cost countries may occur, creating new competition for plants in Ireland, as the product life cycle progresses and firms become larger and more experienced. In addition, as time goes on, relatively new industries become more mature and typically undergo a process of concentration as the smaller and weaker firms which prospered in the initial upsurge of new products begin to succumb to stronger competition. This "shake-out" process may tend to be damaging eventually for many of the relatively small firms which locate in Ireland. And finally, the relative scarcity of product development capabilities in Ireland may make the Irish plants vulnerable eventually, particularly in view of the rapid rate of product obsolescence in new high-technology industries.

For these reasons, it may be suggested that foreign plants would commonly experience rapid employment growth in their early years as they build up to initial target size, followed by periods of slower growth, stagnation, and eventually decline or closure. To test this, one can look at new grant-aided foreign plants established in a given period to see how their employment changes in the course of time. Table 6.13 shows the employment change from 1973 to 1980 in foreign New and Small Industry plants established before 1973. (The year 1980 is chosen as the terminal date here because the inclusion of later years might tend to bias the results downwards due to the recession of the early 1980s).

Table 6.13 *Employment in New Grant-Aided Foreign-Owned Industries Established Prior to 1973*

	1973	*1980*	*Percentage Change*
Metals & Engineering	15,017	14,063	-6.4
All Manufacturing	38,178	37,289	-2.3

Source: Derived from IDA Employment Survey.

Employment in the whole group established prior to 1973, and in Metals & Engineering, showed a net decline over the following seven years at a time when Ireland had the fastest growing manufacturing sector in the EEC. This means that Ireland was not only relying mainly on foreign firms for engineering employment growth, but relying more specifically on the continuing inflow of *new* first-time foreign investors. This finding is consistent with the suggestion above that foreign firms in Ireland tend not to grow much after reaching their initial target size but rather tend to decline after some time. To see this trend more clearly, however, these firms can be divided into cohorts according to their date of establishment in Ireland. When this is done (in Table 6.14), it turns out that employment generally declined or grew slowly in the older cohorts. The most recent cohort, for 1969-72, which would have included many firms still in the phase of expansion to initial target size, is the only one with substantially growing employment. Thus if the cut-off date for the exercise in Table 6.13 is moved back four years, so as to include only plants established prior to 1969, their total employment declined by 12 per cent in 1973-80, and by 10 per cent in Metals & Engineering.

Finally, since electronics has been the major growth area in recent years, it is worth looking more closely at trends in that sector. Table 6.15 shows employment change by date of establishment in foreign-owned electronics firms up to 1985. (Since there was little discernible cyclical downturn in the

Table 6.14: *Employment in New Grant-Aided Foreign-Owned Industries, by Date of Establishment in Ireland*

	Metals & Engineering			*All Sectors*		
Date of Establishment	*1973*	*1980*	*Percentage Change*	*1973*	*1980*	*Percentage Change*
Up to 1952	3,650	3,150	−13.7	8,015	6,675	−16.7
1953-60	2,493	2,685	+7.7	6,143	5,935	−7.5
1961-64	2,713	2,821	+4.0	4,662	4,771	+2.3
1965-68	3,213	2,220	−30.9	8,748	7,658	−12.5
1969-72	2,397	2,950	+23.1	7,740	10,473	+35.3

Notes: (1) The precise date of establishment of some firms is not available. These employed 551 in 1973 and 237 in 1980 in Metals & Engineering, a decline of 57 per cent; in All Industry they employed 2,600 in 1973 and 1,777 in 1980, a decline of 31.7 per cent. They are included in Table 6.13 but cannot be included in Table 6.14.
(2) The grant scheme for new industries only began in 1952; thus the firms included here which were established before 1952 are ones which received grants for major expansions.
Source: Derived from IDA Employment Survey.

1980s in electronics, it seems reasonable to include the period up to 1985 here. But even if there is some doubt about the validity of this, it is still valid to compare the experience of different cohorts during the same period of time.) It can be seen that there has been a consistent tendency in foreign-owned electronics for employment to grow rapidly in relatively new firms, to grow more slowly in older firms and to decline in the oldest ones. Given that such a pattern appears to be quite pervasive, it would be prudent to allow for persistence of this pattern in forming future expectations. This means that one could expect future trends to be increasingly influenced by the growing proportion of relatively old declining plants, so that an ever greater inflow of new first-time investors would be needed to attain employment increases of any given amount. A great deal therefore appears to depend on the prospects for new foreign investment.

Prospects for New Inflows of Foreign Investment

It has been suggested above that export-oriented foreign plants established in Ireland show some similarities to those in conventionally recognised NICs, at least in so far as they are fairly mobile production units, capable of operating in some degree of isolation from major industrial centres. The attraction of Ireland for such plants, as compared with lower-wage countries, would lie particularly in ease of access to large European markets, as well as a relatively well-educated English-speaking workforce, political "reliability", the effective promotion efforts of the development agencies and other factors which reduce uncertainty and information costs, and attractive tax concessions and grants. And the attraction of Ireland, as compared with most other European countries, would lie mainly in tax concessions, grant incentives and lower labour costs. Most foreign investment in Ireland in the 1970s and 1980s could be characterised as mobile production units seeking a low cost, tax-free and politically "reliable" site in which to produce for sale in European markets.

Table 6.15: *Employment in Foreign-Owned Electronics Firms, by Date of Establishment in Ireland*

	Employment (Numbers)			*Average Annual Percentage Change*	
Date of Establishment	*1973*	*1980*	*1985*	*1973-80*	*1980-85*
Up to 1964	1,810	1,347	807	−4.1	−9.7
1965-68	1,560	1,064	773	−5.3	−6.2
1969-72	381	1,589	1,744	22.6	1.9
1973-76	0	2,231	3,309	—	8.2
1977-79	0	1,203	3,705	—	25.2

Note: Only companies still in existence in 1985 are included. If companies which closed before then were included, the rates of growth would be somewhat lower, or the rates of decline would be greater.
Source: Derived from the IDA Employment Survey, using the classification of electronics firms adopted for the survey referred to in footnote 26.

Despite these attractions of Ireland for such investors, there has been growing competition from other European countries recently to attract mobile foreign investment[29]. In the UK, in particular, there are now quite intensive efforts to attract foreign firms, and other European countries too have increased their efforts in this regard as they have experienced high levels of unemployment. A further source of increased competition is the recent accession of Greece, Spain and Portugal to the EEC. These developments have probably produced new sources of close competition for the same type of mobile, European-oriented, foreign investment which Ireland attracts. Parts of the UK may well be the strongest of these competitors. A survey in the *Allied Irish Bank Review* (April, 1981) found that 80 per cent of foreign firms in Ireland had seriously considered setting up elsewhere before deciding to locate in Ireland, with Britain being the most favourably considered alternative site some way ahead of Belgium and Spain. This preference was most clearly marked among companies established in Ireland within the previous 5 years.

29. This trend was outlined, for example, by Guy de Jonquieres, "Europe's Quest for Foreign Investment — A War of Diminishing Returns", *Financial Times*, 10th November 1986.

It is not possible, however, to quantify exactly the effect of increased competition on Ireland's "market share" of mobile foreign industry. One indicator of the amount of new foreign investment coming to Ireland each year is IDA data on fixed asset investment planned (but not necessarily all actually undertaken) by new projects from overseas which are approved for grants. Table 6.16 shows recent trends in this planned investment. New overseas investment had been growing in the 1970s and it reached a high level by the years 1979-81, but the table suggests that it has been lower since then, both in Metals & Engineering and in industry as a whole.

Table 6.16: *Planned Fixed Asset Investment in New Overseas Projects, £ million*

	Average 1979-81	*1982*	*1983*	*1984*	*1985*
All Industries	271.7	196.3	86.5	280.8*	102.4
Metals & Engineering	162.0	93.9	38.4	221.1*	n.a.

**Note:* These figures include £180m in one very large project which did not go ahead.
Source: IDA Annual Reports.

Another indicator which is available is the US Department of Commerce data on capital expenditure (i.e., actual expenditure, unlike the IDA data in Table 6.16). Table 6.17 shows the amount of such investment going to Ireland, as well as Ireland's share of such investment in Europe, as an indicator of "market share". Total American manufacturing investment in Ireland stopped growing at the end of the 1970s and it has been fairly stable since then, and Ireland's share of US investment in Europe followed a similar trend. The data on engineering investment are unfortunately more patchy, being unavailable or incomplete in some of the earlier years so that it is not really possible to assess the trend. Table 6.17 presents a rather more favourable impression of

Table 6.17: *Capital Expenditure by US Manufacturing Firms in Ireland*

	1977	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986**
Amount ($m)										
Total Manufacturing	99	102	213	207	229	190	196	224	193	202
Metals & Engineering	15	n.a.	n.a.	n.a.	60	64	50	n.a.	72	70
As Percentage of Europe										
Total Manufacturing	1.7	1.5	2.3	1.9	2.2	2.1	2.4	3.3	2.4	2.3
Metals & Engineering	0.4	n.a.	n.a.	n.a.	0.9	1.8	1.6	n.a.	2.9	2.3

* Forecasts based on a survey in June 1986.
Source: US Department of Commerce, *Survey of Current Business*, various issues up to October 1986.

trends in foreign investment in Ireland than Table 6.16, but which ever one is accepted as more meaningful, there is little sign of growth in the inflow of new investment, which would probably be needed to sustain the momentum of growth experienced in this sector up to the early 1980s.

To conclude this chapter, it has been shown that foreign-owned multinational companies played the major role in developing the engineering industry in Ireland since the 1950s. In doing so, they contributed substantially to the renewed progress of industrialisation in the country, and more specifically, they served, to some extent, to fill the gap left by indigenous firms in developing large-scale and/or high technology industries. But in some important respects they have provided a less than adequate substitute for indigenous development of such industries. For technology-intensity and skill levels are generally significantly lower than in the home countries of the industries concerned and linkages with the Irish economy remain rather low. For these reasons, rates of pay and secondary spin-off benefits are less than one would expect from successful indigenous development of such industries. For there is much more limited development than in advanced industrial centres of the technical knowledge, skills and sub-supplies that would generate continuing self-sustained development and diversification.

In this situation, particularly given the tendency of ageing firms to decline eventually, sustaining the momentum of growth would depend heavily on attracting more and more new foreign investment, unless there is a significant change from past trends. But conditions for doing so appear to have become more difficult. In any case, major efforts are already being made to attract foreign investment and it is widely recognised that this alone is not sufficient to meet employment needs or development aspirations. Consequently, and no doubt correctly, the emphasis in industrial policy is supposed to be shifting more to developing Irish indigenous industries in internationally traded activities, without by any means ruling out new foreign investment. For as the White Paper on *Industrial Policy* (1984) recognised:

> The policies which had clearly served us well in the 1960s and 1970s are now having less success. Competition for a declining volume of mobile investment is constantly intensifying from both industrialised and developing countries.

The next section deals with future development strategy for the engineering industry in the context of this change of emphasis towards indigenous development. Thus it focuses particularly on the issues of how, and in what type of industry, could indigenous development be most readily achieved, and how can foreign firms play a useful complementary role.

SECTION III

DEVELOPING IRELAND'S COMPETITIVE ADVANTAGE

Chapter 7

A STRATEGIC PERSPECTIVE ON FUTURE DEVELOPMENT

A. Objectives

This section is concerned with the general issue of how to develop further Ireland's competitive advantage in Metals & Engineering or, in other words, how to improve Ireland's ability to compete internationally in this sector in activities which bring the greatest possible benefit to the economy. This chapter discusses a general approach to this issue, the next chapter presents a profile of engineering industries in advanced economies and discusses appropriate industries which we might aim to develop further, and the final chapter discusses issues of policy implementation.

It has been shown in Chapters 5 and 6 that the composition of engineering industries in Ireland differs subtantially between Irish-owned indigenous firms and foreign-owned multinational companies. Native Irish firms are mainly concentrated in relatively small-scale, low technology activities with relatively low skill levels, with a particular concentration in Manufacture of Metal Articles because many activities in that sector are of this type. But Irish firms are very weak in, or indeed largely absent from, activities where one or more of these characteristics is necessary to succeed — large scale, advanced technological capabilities, high levels of skills or significant external economies. Another way of saying the same thing is that Irish firms are very largely concentrated in industries with relatively low barriers to entry and have only rarely succeeded in those with more substantial entry barriers.

One might be inclined to conclude from this that we would be best advised to concentrate on promoting small-scale easily entered industries in trying to develop native enterprises, since the record shows that most success has occurred in such industries to date. But unfortunately this approach, which would be the line of least resistance, would be unlikely to yield adequate overall results. For a substantial proportion of the small-scale easily entered industries tend to be local market-oriented or virtually non-traded, and such industries are capable of little expansion independent of growth in domestic demand. And since non-traded industries are virtually guaranteed reasonable growth given strong domestic demand, they do not really require much assistance from industrial development policy. If small-scale easily entered industries are internationally traded, on the other hand, the problem is that they can also be easily entered by other countries, including low-wage LDCs, so that it could become increasingly difficult for Irish firms to compete in such activities.

There is, in fact, no example of an advanced industrial country with a well developed engineering industry depending almost exclusively on small firms, and indeed there scarcely could be. Only a minority of engineering employment or production in the developed world as a whole is in small firms with under a few hundred workers, such as nearly all of Irish indigenous engineering is, and only part of small industry is internationally traded. Thus to develop internationally traded activities much further in small-scale industries alone would mean looking for a greatly disproportionate share of international markets in this type of industry. But from the very fact that the industries in question are small-scale and fragmented, it can be seen that companies or countries do not typically gain very large market shares in them. Rather, they tend to serve limited markets since there is no great advantage in a large size and hence industry concentration is low and firms are small. Thus development of small easily entered industries alone would probably fail to achieve adequate results.

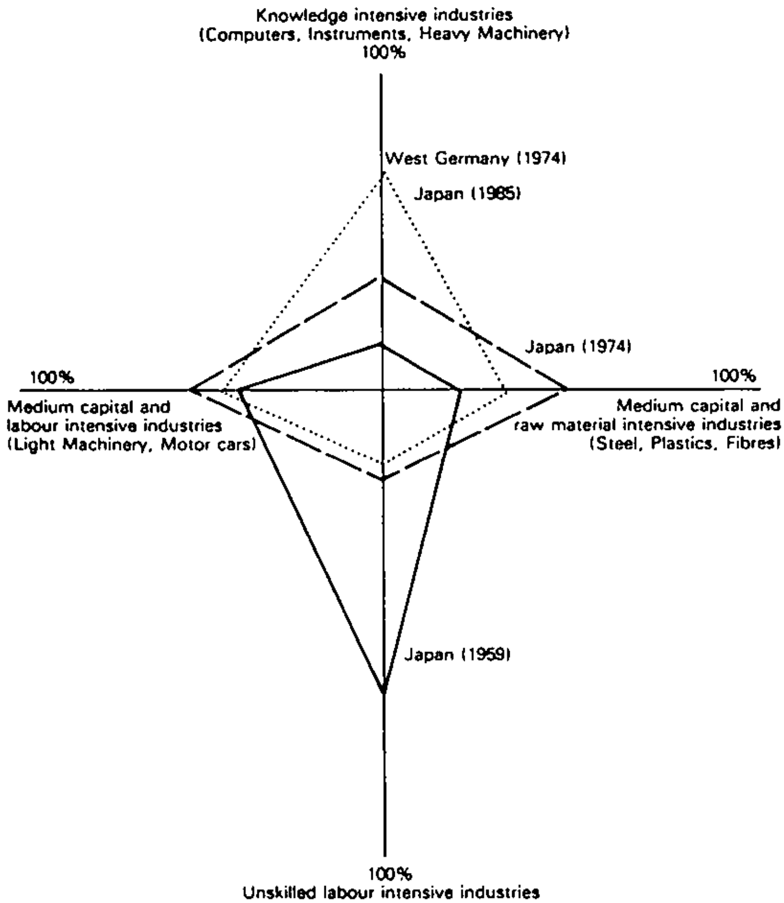
Although Irish firms have succeeded to date mainly in industries with the lowest entry barriers, there is really little option but to aim to do more than this — to develop industries with somewhat more difficult barriers to entry — although we can avoid those at the opposite end of the scale with the greatest entry barriers. This means aiming to develop Irish industries of a somewhat larger scale, a higher level of technology or a higher level of skill-intensity, for example, while accepting realistically that there is little or no hope of success in the very large scale industries or in those based on massive R & D expenditures.

In considering how to go about doing this, it is worth bearing in mind that the entity which produces and competes is the enterprise, not the country as such. Developing "Ireland's competitive advantage", therefore, is essentially a matter of building stronger firms, located in Ireland, which are better able to compete internationally, including some in the more difficult types of industries in which Irish firms are weak or non-existent at present. For the most part, a country's competitive advantage, particularly in engineering as opposed to some resource-based industries, is not naturally determined or God-given, nor is it primarily determined by relative endowments of capital and labour since capital is internationally mobile and labour can be trained for different purposes. Instead, competitive advantage depends primarily on the configuration of skills, technical knowledge and managerial competencies — combined together in specific firms of an adequate scale and with adequate marketing resources for their industry. Thus it can be simply historical accident, combined with the advantages of the early entrant, astute management and sound government policies which give a country strong firms in a particular industry, rather than anything naturally predetermined. This means that a country does not have to accept its current pattern of competitive advantage and disadvantage as something fixed. It is possible to visualise developing new areas of advantage by committing sufficient resources for a sufficient length of time to building specialised labour skills and technical and managerial competence combined together in strong company structures, until the current disadvantages of the new entrant are overcome.

In the older industrial countries, the pattern of development of competitive advantage came about, to a great extent, in an unconscious and unplanned manner, although the role of government has often been important in promoting "strategic" or military-related industries such as aerospace, computers or telecommunications equipment. But some of the late-industrialising countries, faced with the problem of entry barriers in many sectors, have had quite specific plans to change the basis of their competitive advantage by moving progressively into more advanced industries in which they were initially weak or absent. Japan, for example, was a relatively newly industrialising country in the 1950s and 1960s, and a key idea in Japanese thinking on industrial development is shown in Figure 7.1 which illustrates the changing composition of the country's industrial exports in the form of a diamond of changing shape. Each point of the diamond shows the percentage of Japan's industrial exports accounted for by different types of industry at different times — from the actual position in 1959 and 1974 to the position envisaged in 1975 for the year 1985, by which time it was intended that the composition of Japenese exports would be similar to the situation of Germany in 1974.

> The bottom point of the diamond locates the percentage share of Japan's total exports in unskilled labour intensive industries like clothing, light assembly, footwear, toys, etc. These industries require little capital investment or technology relative to the others. The right hand point locates the share of capital intensive processing industries such as steel and fibre. These require heavy capital investment and consume raw materials heavily. The left-hand point represents capital intensive industries which are machine, rather than process, oriented such as motor cars, shipbuilding, light machinery, etc. These require considerable investment in plant and equipment and considerable technology as well. The top of the diamond locates knowledge intensive industries such as computers, fine chemicals, sophisticated machine tools, etc. These industries require high research and development expenditures, appli-

Figure 7.1: *Evolution of Japanese Industrial Structure*



Source: Japan Economic Survey, Economic Planning Agency, 1974-75; reproduced in Magaziner and Hout (1980).

> cations engineering, and marketing; many investments here are often regarded as part of current operating costs.
> Magaziner and Hout (1980)[30].

Japanese industrial policy was geared towards shifting the shape of this diamond from the concentration in unskilled labour-intensive industries seen

30. The "knowledge-intensive" industries referred to here, to judge from Magaziner and Hout's list in their Table II.2, include both highly R & D intensive industries, such as aircraft and telecommunications equipment, and less R & D intensive industries with relatively high levels of white-collar and/or manual skills, such as heating and cooling equipment, machine tools and mechanical handling equipment.

in 1959 through the greater concentration in capital-intensive industries seen in 1974 and on to the higher concentration in knowledge-intensive industries which has emerged in the 1980s. South Korea and Taiwan, have aimed to follow a similar path and they are already arriving at the intermediate stage. For example, the percentage share of ships in Korea's manufactured exports rose from 7.1 per cent in 1978 to 16.3 per cent in 1983, while the share of iron and steel grew from 4.8 per cent to 10.8 per cent and machinery rose from 2.3 per cent to 4.7 per cent[31]. South Korean firms have also begun to export cars on quite a significant scale, with 120,000 exported in 1985, and a target of 460,000 for 1987 and 800,000 by 1991. This would make Korea one of the world's major car exporters, selling almost half as many to the USA by 1991 as Japan was selling in 1984. Initiating the move on to the next stage, with more knowledge intensive exports, Korean firms in electronics are beginning to diversify beyond their existing strength in radios and TVs, which are sectors with low R & D intensity and mature technology, into more sophisticated consumer and industrial electronic products. And Korea has greatly increased its indigenous R & D effort in three main selected types of more R & D intensive industries — microelectronics, machine tools including factory automation, and fine chemicals[32].

The underlying thinking behind this type of strategy is that one is proceeding from the easiest to the most difficult stages, or to put it another way, from those industries in which nearly perfect competition prevails into those characterised by increasingly imperfect competition. This means, in turn, that higher incomes can be sustained as a country leaves behind the industries where entry is easy and competition is consequently intense and is based on low wages, and moves instead into those which are more defensible against low-wage competition. It also means that the country is opening up new areas for industrial development and thereby creating more manufacturing employment opportunities.

Figure 7.1 is based on only one of a number of possible ways of classifying and targeting industries, however, and from the point of view of drawing any lessons for Irish industry it is important to note that this approach takes no account of scale as a constraint. The very large-scale industries such as steel and cars are specifically included as steps on the road to a higher level of development. In fact South Korea apparently quite explicitly has in mind a model of development in which giant firms in large-scale industries play a key role. Thus a director of the technology policy office in Korea's Ministry of Science and Technology says that:

31. *Financial Times* survey on South Korea, 2/7/84.

32. Carla Rapoport, "Motor Vehicle Industry", "Electronics Industry" and "Research and Development" in *Financial Times* survey of South Korea, 9/4/86.

Korea aims to model its development on Sweden or the Netherlands, planning to develop its major companies into equivalents of, say, Philips of the Netherlands or Saab, Electrolux and Ericsson of Sweden (*Financial Times* survey, 9/4/86).

Such a goal is scarcely appropriate for Ireland, however. South Korea has a population some twelve times larger than Ireland, and Japan's is almost three times as large again, and both have been willing and able to use protection of their relatively large domestic markets to build up indigenous firms to an internationally competitive scale, even in the large-scale industries. The development of a number of Korean firms equivalent to Philips or Electrolux is thus conceivable and indeed seems to be coming closer to a reality. But in a much smaller economy, which could not develop competitive large-scale industries even with protection, we are constrained to set our sights on somewhat smaller-scale industries and to rule out the very large ones.

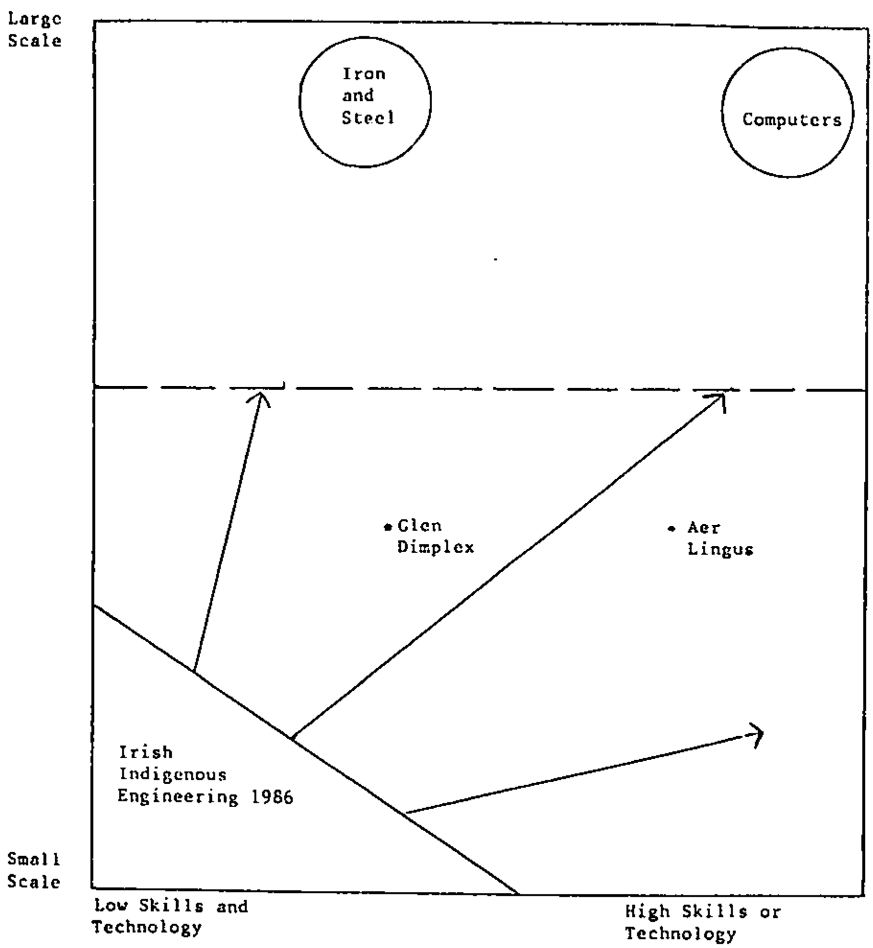
One way of looking at a desirable pattern of evolution for Irish indigenous engineering, therefore, is as shown in Figure 7.2. The box contains the whole range of engineering industries internationally, defined according to scale on the vertical axis, and ranging from low level skills and technology to high level skills or technology on the horizontal axis. Thus, for example, most of Iron and Steel is situated near the top left-hand corner of the box and most of computers is near the top right-hand corner. At present the majority of Irish indigenous firms are engaged in industries clustered towards the bottom left-hand corner, i.e., in relatively small-scale, low-skill and low-technology industries, although there are the exceptions such as Aer Lingus and Glen Dimplex. The goal should be to move progressively into industries beyond the range of very small scale and low skills/technology, as the arrows indicate, but stopping short of those industries in which a very large scale is required.

If this general aim seems too limited as a basis for building an advanced industrial economy, perhaps a simple illustration will serve to indicate the sort of model we could aspire to emulate, and what we probably must seek to avoid. Denmark, like Ireland, is a small economy, but it is a good deal more highly developed and in Metals & Engineering it has quite a number of indigenous firms which are large by Irish standards but it has no really giant firms. There are 8 Danish engineering firms with 1,000-2,000 employees, 5 with 2,000-5,000 and 4 with 5,000-10,000 but none larger than this (Telesis, 1982, p. 349). These 17 companies employ 60,000 people and no doubt they indirectly sustain a good deal more employment as well. The core of Sweden's engineering industry, on the other hand, is a number of much larger companies such as Electrolux with over 100,000 employees (in Sweden and elsewhere), Volvo (with 75,000), SKF (57,000), Saab-Scania (39,000), Alfa Laval

(18,000), Swedyards (18,000) and AGA (12,000)[33]. Whereas Korea might plausibly aim to model its development on Sweden, it would be more suitable for Ireland to take the Danish type of structure as a model to try to emulate rather than the Swedish. Even without companies employing over 5,000, this could be quite sufficient to satisfy any reasonable aspirations for industrial development without taking on the virtually impossible challenge of competing directly with the giants of world industry.

It is one thing, however, to set a general target such as this, but quite

Figure 7.2: *Desired Evolution of Irish Indigenous Engineering*



33. Employment data from companies' annual reports, circa 1983.

another to take effective action to achieve it. The question is, therefore, whether there are new policy approaches which could do more to build indigenous firms in activities beyond the range of small-scale and often local market-oriented industries which characterise a good deal of Irish-owned engineering at present.

B. Policy Approaches

Irish industrial policy over the past 20 years could, for the most part, be described as basically passive and generalist in nature, in the sense that the state makes grants, tax concessions, advisory services, etc., generally available and looks for a response from companies or entrepreneurs. In most respects, policies are not selective and "hands-on" in nature, in the sense that the state does not decide what industries to develop or what companies to build on and then proceed to focus incentives and resources on building up target industries — nor does it invest in them itself on its own initiative to any great extent. There are exceptions to these generalisations, but they are not very significant in relation to the overall approach.

Policies to date, as we have seen, have actually been quite successful in attracting foreign investment and in encouraging a high rate of new start-ups of small indigenous firms[34]. So in these respects the system of incentives and supports for industry seems to have worked quite well. But it has not been very successful in promoting larger internationally traded indigenous firms. One could conclude from this that the general economic environment and the incentives for investment in industry *per se* have not been greatly deficient, but there remain obstacles to development of traded indigenous companies in industries with barriers to entry, which policies have not addressed effectively. Since there is a distinct pattern whereby foreign firms have largely fared better than Irish firms, and Irish firms have fared much better in some industries than others, there is much that cannot be explained by reference to the common economic environment of costs, taxes, etc., or the general system of incentives, but can be explained by the incidence of barriers to entry. Accordingly, promotion of indigenous firms in industries which are less easily entered probably requires a good deal of attention to policies which are more specific or focused than general incentives alone or measures which simply influence the economic environment. This is not to suggest that the general environment of costs and incentives is unimportant, nor is it to suggest abandoning current passive and generalist policies which have worked quite

34. The number of indigenous firms in Metals & Engineering has doubled since 1973, as was mentioned in Chapter 5, which was a faster rate of growth than in indigenous industry as a whole. And O'Farrell and Crouchley (1984) find that the start-up rate of new firms in indigenous industry as a whole has been "similar to those observed in Norway, Canada and the USA, although for different periods, but is perhaps 40 per cent higher than the rate for the UK".

well in some respects. But rather it is suggested that it will be necessary to add on a second tier of policies — more selective and focused — aimed at developing indigenous firms in traded industries with significant entry barriers.

Even within the passive and generalist approach, however, there is, as Roche *et al.* (1984, pp. 116, 117) and Kennedy and Healy (1985, pp. 166, 167) point out, in the existing system of grants and supports for industry an important gap in the area of medium to long-term loan finance for substantial new projects. The problem is that in setting up large new industrial projects, unlike most small projects, there is usually an initial period of some years of loss-making before profits are made. One study of the activities of business units or subsidiaries of large companies in advanced economies has found that when a new business unit is established it typically records losses during its first six to eight years while it is getting off the ground (Carroll, 1985). In advanced industrial economies there are many large companies which can mobilise the resources needed to start up big new projects and support them until they are profitable, but looking at the structure of Irish indigenous engineering it is clear that companies are generally too small to undertake investment in significantly larger-scale industries of this type. Although grants can help with investment costs and bank loans may be available, the need to start repaying loans with interest effectively rules out investment in substantial projects from which no profits may be expected for up to five or six years. To help to overcome this problem there is a need for long-term loan finance, preferably structured so that repayments are low in the early years and perhaps with index-linked interest rates. It is striking that an individual can borrow two or three times his or her annual income to buy a house and pay off the loan over 20 years, but there is no equivalent form of long-term financing for major industrial projects. Some variants of this type of long-term financing for industry could help more large new projects to get started.

However, even if everything is done to make it possible for more medium to large-scale industries to be established, this would still not necessarily happen if there are quicker and/or more secure ways of earning profits on investments, e.g., in gilts, property development, non-traded services or acquisitions of existing companies. For example, in Glen Dimplex one sees a dynamic and successfully expanding company, but the route to expansion has been primarily by means of acquisition of foreign companies — a route which no doubt makes commercial sense because of the lower level of risk and the quicker returns which may be expected than in the case of new start-up ventures of a similar size. For this reason, it is probably necessary for industrial policy to go further with a more active or "hands-on" approach to initiating selected major new projects.

To support this suggestion, it is relevant to point out here that the visible hand of the state, and not just the invisible hand of market forces responding to general incentives, was in evidence in some form in a high proportion of the larger and/or more highly skilled Irish firms existing now. The engineering activities of Aer Lingus and CIE stand out as the major examples within state enterprise and, in addition, the two largest indigenous establishments in Mechanical Engineering in recent years have been branches of Bord na Mona and the Irish Sugar Company, from which exports have arisen. Also, state purchasing of telecommunications equipment assisted the establishment and growth of three of the four Irish firms in Electrical Engineering whose employment has grown to over 100, and again this gave rise to exports. Purchasing by CIE assisted the growth of two internationally traded companies in railway equipment, and purchasing by the Army and Aer Rianta provided the initial market for a producer of armoured cars and fire tenders (Telesis, 1982, pp. 124, 125). Irish Steel is no doubt more in the public eye and its large losses may be more commonly associated with state involvement in industry, but this is really only part of the story. The lesson seems to be that active state involvement can and does achieve development of a type of industry which is rather exceptional among Irish firms, but it is vital to take great care in choosing what industries to develop. (To be strictly accurate, however, the state did not initially choose to develop a steel industry — rather it took over a failing private firm and later elected to continue supporting it as the losses mounted.)

It is also worth noting that in other late-industrialising countries which achieved significant success in developing indigenous industries in sectors with substantial entry barriers, there has been a good deal of active state involvement, in one form or another, in promoting selected target industries. In Taiwan, for example, state enterprises have played an important role and the six biggest industrial state enterprises had sales equal to the 50 largest private industrial firms by 1980 (Wade, 1984). And the *Financial Times* (2/4/79) has described South Korea as:

> . . . one of the free world's most tightly supervised economies, with the Government initiating almost every major investment by the private sector and wielding enough power to ensure that companies which make such investments also make a profit.

Thus the Korean policy operates through selective influencing of the private sector more than direct state investment (see Luedde-Neurath, 1980), and this also appears to have been true of Japan in its earlier phase of development in the 1950s and 1960s, and perhaps later. The strategy of Japan at that time has been summed up by a Japanese policy maker as follows: (a) select industries carefully, (b) prevent ruinous competition at the infancy stage, and (c) nurse them to competitive stature and then expose them to outside competition (see Allen, 1981). More than just protection, this involved selection of target industries, backed up by measures to raise them to competitive standards. For example, there were efforts to match the scale of established foreign competitors by restricting the number of firms in target industries in order to allow a few to grow strong. There was also selective control of material, machinery and technology imports so as to press firms to concentrate on target industries, and indirect tax systems were geared to favour domestic purchases of the products of target industries.

This is not the place to go into a detailed discussion of Japanese industrial policy, but it must be acknowledged that the importance of government policy in transforming Japanese industry has been questioned in recent years, particularly by some American economists (e.g., Schultze, 1983; Norton, 1986 refers to a number of others). For the interested reader, Boltho (1985) provides a good survey of this controversy, coming down in favour of attributing to Japan's policies a very important role in shaping the country's post-war industrial development. The judgement of Adams and Ichimura (1983) seems reasonably balanced:

> On the one hand, it is certainly not correct to attribute all of the spectacular development of Japanese industry in domestic and foreign markets to IPs [industrial policies]. Indeed, private enterprises, many operating with little or no governmental aid, are responsible for some of the greatest successes of Japanese industry. On the other hand, there is evidence in many directions that the policies achieved many of their objectives. For example, an analysis of changes in Japanese industrial structure shows clearly that the shift toward heavy industries and the chemical industries, which had been planned in the earliest visions of MITI, occurred by 1970 . . .
>
> With regard to allocation of funds, the evidence supports the notion that funds went more heavily into the industries selected for development.

At any rate, it seems to be more than coincidence that Japan, South Korea and Taiwan all adopted a "hands-on" approach to developing selected target industries and that these countries have had about the greatest success, among late-industrialisers since the Second World War, in developing competitive indigenous firms in sectors with substantial entry barriers. At the same time, the variety of methods used, ranging from state enterprise investment to different ways of influencing private sector firms, indicates that there is more than one way of developing selected industries. But the practice of selecting target industries for development, and focusing resources and incentives on them to a considerable extent, has been common to all three countries. Thus there is some support here for the suggestion that Ireland must adopt a more active and selective approach if it is to make significant progress in developing internationally traded indigenous industries further. The next chapter discusses which industries might be considered promising targets for Irish development and Chapter 9 deals with policy implementation.

Chapter 8

PROMISING INDUSTRIES FOR DEVELOPMENT

A. Selection Criteria

In considering which industries would make promising targets for development by Irish companies, there are a number of different factors which should be taken into account. The approach adopted here is based on similar principles to the method used in a discussion document from the National Board for Science and Technology (1983) in the case of the electronics industry, although our analysis treats a broader range of sectors in less depth. We can begin by examining the structure and nature of the different industries internationally in order to see what are the important characteristics required for success and what types of barriers to entry exist. A fairly obvious criterion for selection is that we would need to rule out the very large-scale activities which are dominated by giant firms since it would be very costly to enter them on a competitive scale and it could take a long time to gain an adequate market share. It would also be unacceptably risky for a small country to concentrate its resources in a very small number of major investments.

A second criterion is that highly capital-intensive industries should generally be regarded as unattractive, even if they are not very large in scale, since it would be desirable to maximise employment per pound invested. Most of the capital equipment required for such industries would have to be imported, whereas even if high levels of expenditure per employee are needed for training, R & D or marketing in more labour-intensive activities, much of this expenditure would remain within the country and would also be of more lasting benefit. Lest there be any misunderstanding, it must be stressed that this is not an argument against investment in advanced capital equipment in any particular industry, since this may be imperative for survival and competitive success. Rather, the point is that industries vary in the degree of capital-intensity which is necessary to succeed, and in general, we should not favour those which have to be most capital-intensive.

A third issue in selecting target industries is the prospect of strong competition from low-wage countries. Ireland has a labour cost advantage over most of the developed countries but clearly cannot compete with LDCs or NICs on the basis of labour costs. Their labour cost advantage most obviously applies in unskilled labour-intensive industries with low entry barriers, but it can also give them an edge in large-scale or capital-intensive industries if scale and capital requirements are the only significant sources of barriers to entry. For even quite poor countries can borrow capital for investment and the bigger ones can build up competitive large-scale industries with the initial aid of protection of their domestic markets. If it is possible for NICs to purchase the same plant and technology as anyone else in an industry, and hence to produce the same product, wage costs may be left as the main difference between competitors, giving low-wage countries an important advantage even in a capital-intensive industry. This means that we should aim to develop industries in which our competitive strength could be based on factors such as specialised skills, learning economies, technological innovation, product differentiation or strong marketing, distribution and after-sales service networks focused in particular areas[35].

A fourth criterion for selection is the rate of growth of an industry. Other things being equal it would, of course, be preferable to have industries which are enjoying rapid growth in demand rather than slow-growing or declining ones. This is partly because with any given market share, or change in market share, Irish companies in fast-growing industries would fare better than those in slow-growing ones, but also because new entrants in a slow-growing or declining industry can expect stiff resistance from established competitors. For with fast growth all can share in expansion, but with slow growth existing firms can only lose from a newcomer's success so their resistance to new competition would probably be correspondingly greater.

A fifth important point to consider in deciding which industries would be most suitable for development by Irish firms is the existing composition and strength of Irish industry. It should be easier to proceed by building on the capabilities of existing industries than by starting out fresh in wholly new types of activity. This point is particularly significant and we will return to it in Chapter 9.

Finally, since there can be significant advantages of external economies in concentrated clusters or groups of engineering industries which are related by skills, technologies or purchasing linkages, it would often be important to think in terms of developing integrated industrial structures in particular locations and not just widely dispersed individual projects or enterprises. This would help to create a basis for self-sustaining growth by generating a "critical mass" of similar or related technical and labour skills from which more new products or enterprises could evolve. Although the discussion of this chapter is concerned with the development of indigenous industries, it would also be valuable, in seeking to attract foreign-owned multinational companies, to concentrate most on bringing in those which complement the effort to build clusters of related industries.

35. Telesis (1982, Ch. 1) contains a good discussion of such bases of competitive advantage, as does Porter (1980).

To apply these criteria in practice in assessing the whole range of Metals & Engineering industries would be a complex undertaking if it were done in sufficient detail to make actual selections of target industries. The remainder of this chapter simply aims to take a first step, by using a number of statistical indicators of relevance to some of the criteria above. These indicators help to point in certain directions rather than others. Thus the procedure followed here does not produce ultimate answers as to which would be the most suitable target industries for Ireland, but it should help to indicate which sectors would be most worth considering in greater and more qualitative detail.

There are, however, definite limitations to the approach used here which should be fully acknowledged at the outset. One basic problem is that the categories or classifications used in industrial statistics do not necessarily represent meaningful industries within which firms make similar products in competition with each other. "Motor Vehicles", for example, is a statistical category (NACE code 351), but it is not really an industry in this sense since different firms in it produce different types of vehicles — such as cars, lorries, buses or special-purpose vehicles ranging from armoured cars to ambulances. Thus the data may tell us that Motor Vehicles is very highly concentrated in very large firms, suggesting that there are overwhelming entry barriers due to economies of scale, with 99 per cent of US production, for example, being accounted for by eight giant companies. But this reflects the make-up of the car industry, or vans, more than some other types of vehicles. One could not conclude, therefore, that there is no room for small to medium-size enterprises producing motor vehicles, although one could conclude that there is very little in relation to the overall size of the sector.

But even leaving aside the problem of inappropriate groupings of industries in the statistics, there are further elements of diversity which can be concealed by the bare data. A brief sketch of the European car industry will serve as an example to show how much may be revealed or concealed by statistics alone. In Western Europe at the start of the 1980s, about 99 per cent of car production was concentrated in the top eleven firms, of which the major ones employed well over 100,000 people each (Jones, 1981). But within this group of eleven, there was a big difference between the top six or seven and the others, as the smaller ones are in some cases not much more than one-tenth as large in terms of numbers of cars produced, yet they survive. For there can be quite different ways of competing in an industry which allow companies of widely varying sizes to succeed. Thus the major European car makers generally subdivide the market into seven segments or classes, ranging from the smallest and cheapest cars to large luxury vehicles (Innocenti, 1983). Each of the top six firms, which together accounted for about 85 per cent of Western European production (Jones, 1981), aims to produce at least one model, usually with variants of engine size, quality of trim, etc., in each segment. Since there are very large investments in R & D, capital equipment and marketing behind each model, they must be sold in large numbers to cover fixed costs and consequently the maker of a full range of models has to be a very large company indeed, producing over a million cars a year. The companies or groups in this class in Western Europe at the start of the 1980s were Peugeot-Citroen-Talbot, Renault/Volvo (Renault being part-owner and a joint venture partner of Volvo), Fiat-Lancia, Volkswagen-Audi and the European branches of Ford and General Motors (which owns Opel and Vauxhall). In addition, British Leyland was in the rather uncomfortable position of being a full-range producer but with sales well below the others and just 5 per cent of Western European production.

At the next level were four considerably smaller producers, although they were still very large companies by Irish standards; these were Mercedes, BMW, Alfa Romeo and Saab, with just 9 per cent of Western European production between them in the early 1980s. They survive by focusing on a limited range of model segments and by achieving a competitive scale of production within those segments. They do not ignore the competitive dictates of economies of scale, but by concentrating on just a few segments — generally the relatively small ones at the top of the model range — they achieve a competitive scale in their chosen activities without being nearly as large as the full-range producers. Mercedes and BMW, for example, were actually much the largest producers of "executive" cars[36]. They could still be at a disadvantage in some aspects of economies of scale which cut across the range of model segments, e.g., part of R & D costs and the practice of using the same engine in different variants of a number of models. But they overcome such disadvantages in various ways — by forging links with other firms, for example, in jointly developing or producing a new engine, gearbox or other major components for use by more than one company, by sub-contracting design or component production, or by acquiring an image of exclusivity and prestige which allows them to charge higher prices.

Although the top eleven firms accounted for all but 1 or 2 per cent of Western European production, there was still room for a substantial number of other firms, many of them quite small by any standards. The larger and better-known of these include Rolls-Royce, Lotus, Aston Martin and Maserati, but there were many others too, generally narrowly focused producers of specialty vehicles such as high-powered sports cars like the TMC Costin which is made in Wexford. Such small producers have to concentrate on making specialty cars for which demand is so limited that nobody can achieve significant economies of scale and in this way they survive despite their small

36. *Financial Times* Survey on Executive Cars, 19/6/86.

size. Generally, too, they limit themselves to certain stages of production, buying in the major components, for example, and concentrating only on design and assembly, or (as in the case of Maserati)[37] making the engine, if this is a specialty feature, but contracting out most of the other work.

The survival of these small firms in what is, for the most part, a very large-scale business can thus be explained in terms of the concept of "strategic groups" (see Porter, 1980, ch. 7). A strategic group is a group of firms in an industry following a similar business strategy with respect to the key competitive dimensions such as product quality, brand identification, product range, vertical integration, cost position, price policy, or channels of distribution. Companies such as Rolls-Royce or Maserati place themselves in different strategic groups to the large car makers by their choice of product quality and range and by establishing strong brand identification. Thus they do not have to compete directly with the major companies on costs and in this way they do not have to achieve comparable economies of scale.

Most industries, in fact, contain a number of different strategic groups and because of this one usually cannot make absolutely comprehensive generalisations about the nature of competition or the significance of entry barriers in a whole industry, and for the same reason bare statistics on an industry do not tell the whole story. For example, in the case of the car industy, the data show that about 99 per cent of production in Western Europe is concentrated in eleven firms which are all very large by Irish standards, but this does not mean that there is no room for small to medium-size firms or that economies of scale create absolutely prohibitive entry barriers. What it does mean — and one would be justified in concluding so from the figures — is that there is very little scope for small to medium-size firms in relation to the size of the industry. If there is room for such companies, it has to be in highly specialised niches, and these may present other problems for new entrants if they require particularly advanced technologicl capabilities, specialised skills or strong brand recognition.

These caveats should be borne in mind in the next section which uses a number of statistical indicators to assess the nature of competition and significance of barriers to entry in different industries. The main point to remember is that no industry can be completely ruled out by this method as a possible area for development by Irish firms. Rather the data serve to suggest where the best opportunities are most (or least) likely to be concentrated and in this way they indicate which industries are likely to be most worth considering in further detail. But such further detailed investigation is not undertaken in this paper. Further investigation would need to include consideration of likely future trends in demand and competitive conditions, and consideration of the

37. James Burton, "Maserati Back in the Fast Lane", *Financial Times*, 23/12/83.

marketing and commercial practices of leading engineering companies.

B. International Industrial Structures and Target Industries for Ireland

This section uses a number of statistical indicators to show the general outlines of the structure and nature of competition in different engineering industries in advanced economies. The type of data used are quite similar to those in Chapter 3, but the industries are disaggregated a good deal further to show the picture in greater detail. Since this involves a large amount of statistical information, most of the data are shown in Appendix 3 and they are presented in summary form in the text with some discussion. The least satisfactory data, in terms of the level of detail, are those on R & D, as an indicator of the importance of advanced technological capabilities, since the American data already shown in Table 3.5 distinguishing between 14 categories of engineering seem to be the most disaggregated available for a representative large advanced economy.

As an indicator of the prevalence of economies of scale, there are data on the proportion of each industry's employment in the major EEC countries which is concentrated in large enterprises, at the NACE 3 digit level which distinguishes between about 40 different categories of Metals & Engineering. There are also much more disaggregated US data on concentration ratios and the size of top firms, i.e., the proportion of each industry which is concentrated in the largest firms and the size of those firms. These data distinguish between 174 different Metals & Engineering industries at the US 4 digit level of classification, and several times this number at the next (5 digit) level. It seems to be generally agreed that the US 4 digit classification often corresponds well with real product markets (Jacquemin and de Jong, 1977, p. 45, and Porter, 1980, p. 370), although the 5 digit classification is sometimes better, whereas few real product markets are distinguishable at the NACE 3 digit level. However, even the US classification system cannot draw the boundaries between strategic groups within industries.

A point which should be noted about these disaggregated US data is that the enterprises which are classified in an individual industry may, in fact, be subsidiaries of larger multi-product firms. In such a case the data on the size of top companies in an industry refer to the subsidiaries within the industry, not the larger firms as a whole. This may be all for the best for the purpose of trying to gain an impression of how large do companies need to be in an individual industry. But it could be in some cases that companies need to be larger than the data suggest if the data refer only to subsidiaries which actually benefit from economies of scale in R & D or marketing, for example, carried out within a larger multi-product company. This is an issue which could only be resolved by more detailed investigation.

Both the EEC's NACE data and the US data (at the 4 digit level) are given in Appendix 3, with the EEC industries ranked according to the proportion of employment in large firms. It must be acknowledged that the data are somewhat out of date and thus in principle they could misrepresent the present situation. In practice, however, this is not a serious problem, apart from exceptional cases, since it usually takes quite a long time for the structure of a given industry to change substantially with respect to concentration in large firms. To illustrate this point, Table 8.1 shows the eight-firm concentration ratios of the twelve largest Metals & Engineering industries in the USA in 1972 and 1977 (these ratios are the percentage of sales accounted for by the eight largest firms in the industry). It can be seen that the changes over the five year period are generally small or practically insignificant and the rank order also changes little from 1972 to 1977. The main exception, Electronic Computing Equipment, being a relatively young industry based on rapidly evolving technology, is most subject to change, so we may be dubious about the current accuracy of out of date data for this type of industry.

Table 8.1: *Eight-Firm Concentration Ratios in the Largest US Engineering Industries, 1972 and 1977*

US Industry Code	*Industry*	*1972*	*1977*	*Change*
3711	Motor Vehicles & Car Bodies	99	99	0
3721	Aircraft	86	81	−5
3861	Photographic Equipment & Supplies	85	86	+1
3465	Automotive Stampings	72	70	−2
3714	Motor Vehicle Parts & Accessories	69	70	+1
3312	Blast Furnaces & Steel Mills	65	65	0
3573	Electronic Computing Equipment	63	55	−8
3523	Farm Machinery & Equipment	61	61	0
3531	Construction Machinery	54	59	+5
3585	Refrigeration & Heating Equipment	53	51	−2
3321	Gray Iron Foundries	45	44	−1
3662	Radio & TV Equipment	33	33	0

Source: Statistical Abstract of the United States 1985.

Also shown in Appendix 3 are figures on the percentage of employment in each industry accounted for by white-collar workers (Managerial, Administrative, Technical and Clerical) and skilled manual workers (Craftsmen) in the UK. These are seen as indicators of the relative importance of experience or learning economies in different industries in advanced economies, which could create entry barriers for newcomers as discussed in Chapter 2. The two remaining indicators shown in Appendix 3 are data on developing countries' share of all market economies' exports for each industry, and data on recent rates of growth of all market economies' exports in each category. The former is chosen as an indicator of comparative advantage of developing countries, a factor which could cause competitive difficulties for Irish firms, and the latter is chosen as an indicator of relative rates of growth of international demand for the products of each industry. The data for both of these indicators are grouped according to the NACE 3 digit categories as far as practicable, as explained in Appendix 3, in order to present them in a form which corresponds with the scale and skills data. Similarly the US R & D intensity data are matched up with the NACE categories as far as possible, as is also explained in the Appendix.

In order to present these indicators in a summary form which is not too difficult to absorb, the industries (NACE 3 digit categories) can first be ranked in order on each indicator. Thus on the scale indicator, the ranking begins with the industry with the highest percentage of its employment in large firms, on the skill indicators it begins with those with the highest proportion of skilled employment and on R & D intensity it begins with the one with the highest R & D as a percentage of sales. On penetration by developing countries it begins with the industry in which they have the highest export market share, and on growth the industries are ranked starting with those with the fastest growth down to those with the slowest growth.

Having ranked the industries in this way on the various indicators, for greater simplicity of presentation they are then divided up into deciles to construct Table 8.2. For example, if there were 40 categories of industry for one indicator, the top four would be in the first decile and assigned the number 1 in Table 8.2, the next four would be in the second decile and would be assigned the number 2 in the table, and so on. And if there were 20 categories of industry for another indicator, the top two would be in the first decile, the next two in the second decile, and so on. Table 8.2 thus presents the various indicators in summary form according to this common format for all of them, assigning to each industry a score from 1 to 10 for each indicator[38]. Although the more disaggregated US concentration data are not included in Table 8.2, they are referred to in the discussion below, and in Appendix 4, of potential target industries for Ireland.

For example, the first line of the table tells us that, relative to other Metals & Engineering industries, Iron and Steel is very highly concentrated in large firms (with a score of 1 on "scale"), has a rather low level of white-collar employment (score 7), about an average level of skilled manual employment (score 5) and very low R & D intensity (score 10); it is also an industry in which

38. Note that the industry descriptions in the table are necessarily in abbreviated form but, by using the NACE code reference, a full description of the coverage of each industry can be found in Appendix 1.

developing countries are particularly strong (score 2) and it has been experiencing slow growth (score 8). To interpret this information, what it suggests is that there are substantial barriers to entry arising from economies of scale in Iron and Steel, but not much from learning economies in skilled work or from the importance of advanced technological capabilities. This, in turn, suggests that large developing countries should be able to develop this industry to competitive standards with the initial aid of protection, since the need to achieve a substantial scale presents the only major problem for newcomers, and accordingly developing countries have grown relatively strong in Iron and Steel. Given this fact, and the fact that growth is slow, one would expect competitive conditions to be intense. Particularly for a small free-trading economy such as Ireland, which cannot develop large-scale industries with the aid of protection, all of this suggests that most of Iron and Steel is not an attractive prospect for future development here.

Table 8.2: *Industries Ranked by Decile on International Indicators of Structure, Competition and Growth*

NACE Code	*Industry*	*Scale*	*White Collar Skills*	*Manual Skills*	*R & D Intensity*	*Developing Countries*	*Growth*
22	*Metals*						
221	Iron and Steel	1	7	5	10	2	8
222	Steel Tubes	3	8	6	10	5	9
223	Extruded, Rolled Steel	8	9	8	10	4	9
224	Non-Ferrous Metals	4	8	7	8/9	1	4
31	*Metal Articles*						
311	Foundries	7	n.a.	n.a.	10	8	10
312	Forgings, Stampings	10	10	5	8/9	n.a.	n.a.
313	Secondary Metal Processing	10	8	8	8/9	3	7
314	Structural Metal	9	5	6	8/9	4	7
315	Boilers, Tanks, etc.	7	n.a.	n.a.	8/9	10	3
316	Tools, Hardware, etc.	9	9	4	8/9	2	5
319	Other Metal Articles	n.a.	n.a.	n.a.	8/9	n.a.	n.a.
32	*Mechanical Engineering*						
321	Agricultural Machinery	5	5	6	5/6	9	9
322	Machine Tools	8	5	1	5/6	9	8
323	Textile Machinery	5	6	1	5/6	7	6
324	Process Machinery	8	2	2	5/6	10	10
325	Mining, Construction Machinery	6	4	2	5/6	8	8
326	Transmission Equipment	5	6	3	5/6	6	7
327	Wood, Paper etc. Machinery	7	3	2	5/6	10	5
328	Other Machinery	6	4	3	5/6	6	3
33	*Office & Data Processing Machinery*	2	1	10	1	6	1

(continued)

Table 8.2:
(continued)

NACE Code	Industry	Scale	White Collar Skills	Manual Skills	R & D Intensity	Developing Countries	Growth
34	*Electrical Engineering*						
341	Insulated Wires, Cables	3	5	9	3	5	3
342	Electric Motors, Generators	4	4	4	3	3	3
343	Electric Industrial Equipment	5	3	8	3	4	2
344	Telecommunications Equipment	3	1	9	1	2	2
345	Radio, TV etc.	3	3	10	8/9	1	1
346	Electrical Appliances	2	8	10	3	2	5
347	Lamps, Lighting	7	7	9	3	4	5
35	*Motor Vehicles*						
351	Vehicles, Engines	1	10	4	4	10	4
352	Vehicle Bodies, Trailers	9	10	5	4	9	4
353	Vehicle Parts	4	7	5	4	9	4
36	*Other Transport*						
361	Shipbuilding	2	n.a.	n.a.	7	3	10
362	Railway Equipment	2	10	1	7	7	9
363	Cycles, Motorcycles	4	9	10	7	7	6
364	Aerospace	1	2	3	1	8	1
365	Prams, Carts etc.	n.a.	n.a.	n.a.	7	n.a.	n.a.
37	*Instrument Engineering*						
371	Measuring, Precision Insts.	9	1	7	2	8	2
372	Medical Instruments	10	3	3	2	6	1
373	Optical, Photographic	6	2	7	2	5	7
374	Clocks, Watches	8	6	8	n.a.	1	6

Source: As explained in Appendix 3.

It can be seen in Table 8.2 that the industries in the Metal Articles group, which are relatively well developed by Irish indigenous firms (see Chapter 5), are characterised by indications of relatively low entry barriers in nearly all respects, i.e., in terms of scale, white-collar and manual skills and R & D intensity. So this gives some confirmation that the information in the table is of some practical use in explaining or predicting where late developing indigenous industries can succeed most readily. The multinational engineering companies in Ireland, on the other hand, are most heavily concentrated in the Office & Data Processing Machinery, Electrical Engineering and Instrument Engineering groups. These are industries with considerably greater entry barriers — in terms of scale, white-collar skills and R & D in Office & Data Processing Machinery and much of Electrical Engineering, and in terms of white-collar skills and R & D but not in terms of scale in most of Instrument

Engineering. A common feature of nearly all of these industries is a particularly low level of manual labour skills, which makes it relatively easy for companies to decompose parts of the production process and to set up production units in less-developed areas, as was mentioned in Chapter 6. The generally high rate of growth in these industries also means that companies tend to be expanding and therefore frequently establishing new plants. Thus recent multinational investment is disproportionately concentrated in these industries in developing countries as well as in Ireland.

Since it requires a rather lengthy discussion to consider the suitability of each individual industry as a potential target sector for development by Irish firms, this discussion is contained in Appendix 4. The main points in that Appendix are briefly summarised below, under the broad sector headings of the NACE 2 digit level.

Production and Preliminary Processing of Metals (NACE 22)

Because of entry barriers arising from economies of scale or a high level of capital-intensity or because of competition from NICs or slow growth, or some combination of these factors, the Metals industries are generally not attractive targets for Irish indigenous development, apart from a few activities which are possible minor exceptions.

Manufacture of Metal Articles (NACE 31)

Many of these industries, e.g., structural metal products, boilers, tanks and low-grade castings are naturally protected, virtually non-traded industries. They should, therefore, not be important targets for industrial development policy although there may still be a little scope for some further import-substitution here. Many of the low-skilled and small-scale internationally traded industries in this sector, e.g., cutlery, nails, springs and chains, are vulnerable to competition from LDCs and NICs, and these too are not appropriate target industries.

A few defensible areas might be found among the small-scale traded industries, however, if attention is paid to product differentiation, quality and focused marketing strategies, perhaps particularly in some consumer products such as household or garden equipment. But the main point about this broad sector is that it would be both relatively feasible and strategically important to develop some of the sub-supply or sub-contract industries further, especially in the more highly skilled activities such as precision castings. The main obstacles to their development lie in the problem of acquiring the skills needed to turn out high quality products in the minimum time, but the skill factor in turn would offer a defence against low-wage competition. Decisions about which sub-supply industries to focus on would need to be taken in conjunction with selection of the relevant purchasing industries.

Mechanical Engineering (NACE 32)

Because of large scale and/or high concentration ratios, a number of the major mechanical engineering industries seem too difficult to develop. These include tractors, combine harvesters, machine tools, sewing machines, most construction machinery, mining machinery, bearings, home woodworking machinery and internal combustion engines.

On the other hand, this broad sector is perhaps the main area in which it would be relatively feasible to build a strong cluster or clusters of related indigenous industries. In many of the activities here, scale presents only moderate entry barriers, while a defensible position against low-wage competition could be based on specialised skills, technological strength not requiring very large R & D expenditures, or geographically focused marketing and after-sales service networks. Industries worth considering here include agricultural machinery (except tractors and combines), precision toolmaking, machine-tool accessories, textile machinery, process plant and machinery, mechanical handling equipment such as conveying equipment, hoists and cranes, and custom-made gears.

Office and Data Processing Machinery (NACE 33)

Owing to a variety of entry barriers, most of the major products here, such as computers, typewriters, copiers and calculators, are generally not promising for Irish indigenous development. But there should be opportunities for Irish development in some narrow niches involving specialised *applications* of the major advanced technologies developed elsewhere or the combination of high technology products in new *systems* with specialised applications. Examples include specialised small business computing systems and specialised terminals.

Electrical Engineering (NACE 34)

Again, a variety of entry barriers, combined with NIC competition in some cases, mean that many of the major products here are not promising, e.g., electric motors, batteries, consumer electronics, the major domestic electrical appliances, the main items of telecommunications equipment, and electric light bulbs and tubes. However, there should be some niche opportunities worth consideration, for example, in electro-medical equipment, limited areas of telecommunications equipment, small domestic appliances and lighting fixtures.

Motor Vehicles, Parts and Accessories (NACE 35)

The major products in this sector look most unpromising, primarily because of the very large scale of production. However, it might well be feasible to develop a cluster of small to medium-size firms in special-purpose vehicles and vehicle bodies of various types, building on the existing base in this area. Although this constitutes a very minor proportion of the whole sector internationally, it could make a useful contribution to indigenous development in a small country such as Ireland. In addition, there are likely to be suitable niche opportunities in vehicle parts and accessories.

Other Means of Transport (NACE 36)

The main products in this sector, too, do not look at all promising. This applies to virtually all of shipbuilding, aerospace and motor-cycles, and to much of railway equipment. However, it should still be worth considering what scope there is for further expansion by building on the relatively large concentrations of engineering skills in Aer Lingus and CIE. In addition, there should be some suitable specialist niches which can be exploited through Ireland's membership of the European Space Agency and industrial participation in Arianespace. Also, boats and bicycles appear to offer relatively attractive opportunities for further development.

Instrument Engineering (NACE 37)

Some of the products in this sector are virtually ruled out for various reasons, e.g., clocks and watches because of strong NIC competition, and fluid meters, motor vehicle instruments and photographic equipment because of high concentration ratios and/or large scale. Nevertheless, along with Mechanical Engineering, this looks like an important area in which it would be relatively feasible to build a strong cluster or clusters of related industries. In most industries in this sector, scale presents only low to moderate entry barriers, while they are defensible against low-wage competition because of skill or technology intensity. The sort of industries that would be worth consideration here include medical and surgical instruments and equipment, and most measuring and checking instruments.

To conclude, there are quite a number of higher skilled, internationally traded industries in which it is not too difficult to visualise Irish firms succeeding, if they could overcome initial barriers to entry. As we have seen, however, there has been rather little progress of this nature to date under the prevailing passive and generalised policies. It has already been argued in Chapter 7 that additional active and selective policies are needed to develop target industries, and the next chapter elaborates further on suggestions for policy implementation.

Chapter 9

POLICY IMPLEMENTATION

There are a number of different forms which more active state involvement in developing new industries could take. Telesis (1982, pp. 233-234) proposed, for example, that a development agency (or agencies) should identify suitable target areas of industry and initiate their development by means such as assembling and backing a consortium of interests in a holding company with the necessary managerial and financial resources to undertake a major investment in the industry concerned. The final selection of products, technologies, markets, etc., would have to be worked out largely by the enterprise concerned, in consultation with the development agency which could scarcely be expected to operate at this level of detail by itself. Or it might be more suitable to fund a single large existing private sector company or state enterprise to undertake such a project, to do so through a vehicle such as the National Development Corporation, or to fund foreign entrepreneurs in joint ventures with Irish partners. The choice depends a good deal on where one can find the necessary managerial competence and experience in the industry concerned or a related industry, or where one can find companies with relevant skills, marketing systems, etc.

Another relevant proposal is that of the NBST and IDA (1982) who suggested, in the context of aiming to promote the agricultural machinery industry, that a Development and Marketing Corporation might be established. This company would concentrate on developing and marketing products, which would be manufactured by existing small companies which at present lack the capacity for significant product development or export marketing. It was also suggested that this company could either be based on Armer Salmon, a state enterprise (part of the Irish Sugar company) described as the most advanced indigenous company in the sector, or else private investment might be attracted to take a major share in forming the new company.

In implementing these proposals, the choice between private and state enterprises would partly depend on whether private firms can be persuaded to get involved in a type of project which they have not already decided to undertake on their own initiative. This, in turn, depends on state commitment — in the form of soft loans, grants, equity investment or purchasing orders — being perceived as adequate to compensate for the risks and the delays to be expected before earning profits in an industry characterised by significant barriers to entry. One way or another, if the level of risk and returns for the private investors concerned are to be acceptable to them, in projects which do not seem immediately attractive, the state may have to bear a disproportionate share of the risk, to guarantee a minimum level of profits, and/or postpone seeking returns on loans or equity investment until some specified minimum level of profitability is achieved. This might make it more costly for the state to aim for private sector involvement than to operate through state enterprises, but the costs and risks would really have to be assessed case by case, taking account of what strengths of relevance to a particular industry the different forms of enterprise have to offer.

The approaches mentioned above which were proposed by Telesis were suggested with a view to establishing new relatively large-scale projects, but it should also be possible to build on some of the small existing firms. Kennedy and Healy (1985, Ch. 10) proposed, for example, that there should be a second tier to the approach to small industry. The first tier would operate in much the same way as existing policy for small industry, with some reforms, while the second tier would involve identifying and developing a selected number of small firms with solid growth prospects, proven strong management and a willingness on the part of proprietors to co-operate in the steps needed to realise growth potential quickly, e.g., dilution of equity. These companies would then be supported in undertaking an agreed development programme.

Also in the area of small industry, the National Linkage Programme is an interesting example of a selective approach to developing sub-supply industries which should be worth watching and learning from. This Programme involves selecting sub-supply firms according to certain criteria of size and performance and helping them to gain contracts with multinational companies in Ireland by means of working out schedules for phased improvement in quality and delivery standards. If and when they meet the final standards demanded, they would become formally accredited suppliers to the multinationals concerned, giving rise to significant opportunities for exporting to other branches of the same companies, and other multinationals too. This type of programme is suitable for areas such as electronics sub-supplies, precision castings, forgings, toolmaking, etc. Although they are generally small in scale, such industries are quite important because they are part of the industrial infrastructure, and strength in these areas would facilitate more significant growth of larger engineering industries.

This brings us again to the question of developing external economies in large integrated industrial structures. It is important to think in terms of building integrated structures, with matching suppliers and purchasers and with groups of similar and related industries which would generate a "critical mass" of technical and labour skills from which more new products and enterprises would evolve. To the extent that there has been much thinking along these lines to date, it has mostly concerned the electronics industry. Multinational firms have been attracted to Ireland fairly readily in electronics and the idea was conceived that they would be a catalyst for indigenous development too, by developing purchasing linkages as well as the crucial skills and technical knowledge which would generate new Irish-owned "spin-off" firms. However, without much concerted or planned action to bring this about (at least until recently), it has happened slowly and only to a limited extent. Indigenous electronics remains quite small with employment at less than 2,000 and "spin-offs" have been few, as was noted in Chapter 6.

The scarcity of spin-offs, is largely because the multinational plants concerned are mostly production units which do not conduct very substantial R & D or marketing and hence do not embody to a great extent the key business functions and skills which actually generate the self-sustaining evolutionary process in this industry. One approach to overcoming this problem would be to offer sufficient financial inducements to foreign firms to get them to locate R & D and marketing in this country. O'Brien (1985) discusses this and concludes that the costs could often outweigh the benefits because multinationals tend to have a strong preference for keeping such functions at home, and if they are prepared to establish them abroad Ireland is not a particularly attractive location for them compared with large advanced European countries. He does point out, however, that one could aim to identify and target those multinationals which are most likely to locate significant R & D and skilled processes in subsidiaries in Ireland. The evidence to date suggests that these would be subsidiaries which are the sole producers within the corporation of a particular product line; thus multinationals which are organised into relatively small and autonomous product divisions would be most likely to establish autonomous R & D and marketing in a subsidiary in Ireland. Such firms are generally in the more fragmented industries or product groups and have a range of specialised products manufactured in relatively low volumes. It would appear to be worthwhile to pay particular attention to approaching this type of company in seeking new foreign investment in Ireland, and to be prepared to offer greater inducements to get them.

One could raise the question, too, whether over-optimistic expectations of rapid development of an integrated electronics industry led to some neglect of other sectors which could offer opportunities to attract skilled operations of foreign firms. It has proved relatively easy to attract foreign investment in electronic/electrical engineering, but not so easy to attract the higher-skilled functions of these industries. Thus despite the fact that foreign investment and employment is disproportionately concentrated in these industries, it is not clear that they offer particularly good opportunities for bringing in the sort of higher-skilled activities which would impart a self-sustaining momentum to Irish development.

To take the case of Mechanical Engineering as a contrast, there is proportionately much less foreign investment anywhere in the world in this sector, partly because companies are smaller but more because production processes tend to require a good deal of specialised skilled labour. Consequently it is less easy to isolate relatively low-skilled production processes and establish them in "mobile" production units in relatively undeveloped areas. Thus as much as 30 per cent of the 175 largest American Mechanical Engineering firms had no investments abroad in the early 1980s, compared with only 8 per cent of the top firms in Electrical Engineering, and those which have invested abroad are generally in the most advanced economies. Only 6 per cent of these companies had a subsidiary in Ireland compared with 33 per cent of the top firms in Electrical Engineering (Telesis, 1982, p. 144). While this does clearly suggest that it is not so easy to generate substantial employment in foreign-owned Mechanical Engineering industries, it might be no more difficult than in electronic/electrical engineering to attract a similar or greater amount of the sort of activities which would help to give a self-sustaining momentum to industrial development. In Mechanical Engineering, this is more a matter of attracting skilled labour-intensive activities, manual skills being particularly important in this industry, rather than business functions such as R & D which companies are generally reluctant to relocate abroad.

Thus if Ireland could offer attractive training grants or programmes for medium to long-term development of skills to foreign companies establishing such highly skilled activities, and if such grants or programmes were offered for a period of some years in recognition of the time dimension involved in perfecting specialised skills on the job, it might be possible to attract more investment in Mechanical Engineering and thereby help to build up a pool of skills. This would facilitate the growth of Irish firms in the same or related industries, but as in electronics, we should probably not expect foreign investment to provide the ultimate answer and we should not expect an automatic development of substantial Irish firms arising out of the foreign investment stimulus. We would probably still need an active approach, along the lines mentioned above, to promoting substantial Irish firms. And in aiming to develop particular Irish industries and in targeting foreign companies to be approached, it would be important to achieve some complementarity between these two arms of policy, so as to build a critical mass of technical knowledge and skills in related and geographically concentrated groups of industries.

Assessing the Options

Before going ahead with the sort of measures suggested above, it would, of course, be necessary to undertake a considerably more thorough and detailed assessment of possible target industries than that contained in Chapter 8. In particular, although it was mentioned there that opportunities for building on existing resources such as skills, managerial experience or relatively strong company structures should be included as a criterion for selecting target industries, a proper assessment of such resources has not been carried out in this paper. It would be important to do this in selecting target industries. For selection should not be just a matter of looking for relatively promising opportunities existing in the international economy, but it should also involve matching and applying our greatest existing strengths to exploiting relatively promising openings in the international scene. Rather than having to carry out such a detailed assessment of every individual industry, however, the discussion in Chapter 8 perhaps gives some ideas on where such inquiries are likely to prove most fruitful.

To undertake a more detailed assessment of the options, there is a need for some sort of expert group or task force combining people with a variety of experience — not primarily in economics, but more importantly in areas such as business management and corporate strategy, technology development and acquisition, and marketing. Such a task force, including people from private and public enterprises and the development agencies, would require a certain amount of autonomy but it might be organised by, and report to, the Department of Industry and Commerce, the National Development Corporation, or the Management Committee on Industrial Policy composed of chief executives of the principal development agencies. But perhaps the IDA, as the major development agency, would be best suited to taking the initiating role. There are a number of options here which those responsible for industrial policy are better placed to judge. The formation of the team working on the National Linkage Programme, led by a private sector company chief executive and including people from a range of development agencies, is a kind of precedent for such a task force. And indeed a task force similar to that suggested here has already been recommended by the Sectoral Development Committee (1985, p. 35).

An important step for this task force would be to organise or carry out an inventory of relevant skills, strong companies or other resources existing in the country at present. This could be done under a number of headings. For a start it would be necessary to identify the largest indigenous companies, smaller ones engaged in exporting successfully, particularly in relatively high-skilled or high technology areas, and relatively high-skilled sub-supply companies with a good performance record. Then these companies should be asked if they see possibilities for major expansions or diversifications which are beyond their capabilities with their present resources but could become viable propositions given sufficient focused support to help them through the initial period of overcoming entry barriers. Workers as well as management might have such suggestions.

At the same time, it would be useful to collate information on the products, R & D activities, machinery and equipment and methods and areas of marketing of these key companies with a view to assessing into what sort of new products or markets they are best equipped to expand. Similarly, it would be useful to collate information on the types of skills existing in these companies, or indeed elsewhere in the country, for the same purpose. Much of this information is already known to, or could be readily gathered by, agencies such as the IDA, IIRS and AnCO in their own fields. Given this information, along with some preliminary ideas about where the best opportunities are likely to arise as a result of international industry structures, it should then be possible to narrow the focus somewhat to a smaller range of possible target industries or products for further consideration.

At this stage some further issues could be investigated. One such issue is the availability of technology. Irish firms would often find it difficult or impossible to develop a wholly new product in a major new area of business within a reasonable period of time if significant R & D is required over an extended period before any return can be earned. But in many cases foreign technology can be acquired under licence, which was a key tactic in Japan in the 1950s and 1960s and in South Korea up to the present. Although they did establish significant R & D capabilities, they were often able to import licensed technology, so that their own R & D efforts could be concentrated on adaptations and improvements to product design or production processes. In this way, they could emerge eventually with superior or cheaper products. Technological licenses, however, are often not so readily available in the very high technology industries where technological capabilities are the key to competitive success so that firms will not sell their technology. But licensing is generally more feasible in the more mature, medium technology industries such as most of Mechanical Engineering or parts of Electrical and Instrument Engineering. It would be useful to investigate the availability of such licenses in potential target industries under consideration, e.g., from medium-size American or Japanese companies which lack the resources or ambition to market their products in Europe. The IIRS, NBST, or both, could play a part in this.

In addition to this, bearing in mind the historic role of "leading sectors" in generating the initial demand for engineering industries in a particular locality, and the role of state purchasing in this regard in many modern high technology industries, it can be seen that some form of favoured purchasing giving a degree of early protection is often important for success. Likewise, as was mentioned in Chapter 7, state purchasing or in-house development in state enterprises has played an important role in developing some of the more outstanding indigenous engineering enterprises, in both the public and private sectors. These tactics could probably be used in a more concerted way in developing selected industries. Admittedly, Irish State purchasing is rather small but it is large enough to foster some industries at least, particularly if one sees it as a tactic which could be used in the early stages of a phased entry/development strategy when output might be relatively small. (The notion of a phased entry/development strategy is discussed further below.) Thus it would be useful to consider whether the use of state purchasing could be brought to bear on potential target industries.

In the light of all this, it should then be possible to narrow the focus further and to carry out a thorough examination of international industry structures and the nature of competition in a small number of promising product groups. International consultants, or expatriate Irish people with relevant experience, could usefully be engaged to assist at this stage, when the task force would be in a position to give them clear terms of reference for an investigation of the prospects for successful entry or development in a limited number of product groups. One issue which should be considered in such an investigation is whether it would be feasible to employ a phased entry/development strategy in each case.

To explain what is meant by a phased entry/development strategy, we can refer again to the fact that many engineering industries are composed of different "strategic groups" in which companies with the same general type of product, e.g., cars or bicycles, can actually differ considerably in the size of their product range, their extent of vertical integration, or the range of business functions such as R & D, manufacturing or distribution which they carry out for themselves. A phased entry or development strategy could involve starting with a limited range of products or business functions or a low degree of vertical integration and progressively increasing the extent of involvement, taking one relatively easy step at a time. Where it is feasible, this would be less demanding on capital and managerial resources and less risky than full scale entry in one move, so it would therefore be a desirable way to proceed. And in the early stages of such a strategy, e.g., with a limited product range or a low degree of vertical integration, so that the firm concerned could be relatively small with a small output, Irish State purchasing could provide sufficient demand in quite a number of industries, enabling companies to build up their skills, managerial experience and specialised knowledge of the industry concerned.

A variant of this type of development was the example of Aer Lingus, which was referred to in Chapter 5. This state enterprise first built up the capacity to overhaul and maintain its own aircraft, purchasing the service itself, then expanded into doing the same work on a larger scale for others and moved into aircraft engine overhaul and maintenance on a large scale in the same way. Another variant was the example of Telectron, which was once the largest indigenous engineering firm in the private sector. It was initially formed in 1960 as a distribution company importing private telephone exchanges, then gradually began to manufacture and sell transmission equipment to the Irish post office and then began to export this equipment. It also began to diversify its product range, again with the help of orders from the post office, and new exports developed subsequently. Throughout the process, licensed foreign technology was employed to a considerable degree so that the company was not fully integrated into R & D and thus largely bypassed this heavy cost which could have been too great for a relatively minor company in this large-scale industry.

It can be seen that there could be many variants of a phased entry/development strategy, involving different combinations of progression in developing product ranges, vertical integration or the various business functions such as R & D, manufacturing, marketing, distribution and after-sales service, and progressing from one target market area, such as Ireland, to wider markets. Capabilities in any of these areas could serve as a starting point. So although there may be few significant Irish manufacturers of machinery, for example, there are quite a number of companies and people with experience somewhere in the chain of making machine parts, marketing and distributing machinery and servicing, repairing or refurbishing machinery. These are useful capabilities which could offer a way into greater involvement. And some of these capabilities, e.g., machine repair, maintenance and distribution, are located in quite large companies with fairly substantial resources outside the engineering sector *per se.* Such companies could be considered as possible bases to build on, or as participants in a consortium to undertake a project, along with firms which are primarily engaged in the manufacture of engineering products.

Having made a final selection of a number of target product groups, the next step for the task force would be to enlist an enterprise or consortium of enterprises to undertake each of the projects concerned. Each enterprise or consortium would work out the final details concerning products, processes, marketing and project development. It would also be necessary to arrange with the development agencies or the government a suitable financial package to back each project, with the emphasis on support in the early years and aids being withdrawn and loan repayments or dividends on state-held equity beginning some time after start-up. If relevant experience is scarce in Ireland, it might also be necessary to recruit some of the required managerial or technical staff abroad, at least on a contract basis during the early development phase, and relatively high salaries might have to be paid for this purpose requiring further financial provision.

Financing Investment in Target Industries

Finally, there is the question of how can the government finance such a selective development strategy; where is the money to come from, given the already over-stretched condition of the public finances? Despite legitimate grave concern about the size of the national debt, it would still make sense to borrow for productive investment so long as it can be expected to yield an adequate return to the Exchequer, in the form of increased tax revenue, savings on unemployment benefits, loan repayments or profits on state-held equity. This is in line with the current practice whereby the IDA, for example, gives grants to projects which, among other criteria, are expected to generate more revenue for the Exchequer than the cost of state aids. Thus IDA grants are generally intended to be, and should be, ultimately self-financing. The only difference with the approach suggested here is that we are talking of projects which may be larger than those normally undertaken by Irish firms and which would typically take longer to reach profitability, either for themselves or the Exchequer. But the general principle still applies that borrowing for investment in viable productive projects which generate sufficient returns for the government makes financial sense.

The National Planning Board in its *Proposals for Plan 1984-87,* made the point that the limit to borrowing for productive public investment:

> . . . will not be set in the immediate future by difficulties in borrowing abroad but rather by the supply of productive investments within the public sector or financed in part by it. The basic problem is to increase the supply of productive projects.

In other words, the problem in promoting industrial investment is not inability to finance new projects, by borrowing if necessary, but rather that there are not enough credible investment projects seeking to take advantage of existing grant incentives. The approach suggested above could be regarded as essentially a way of increasing the "supply of productive projects", by a concerted effort to overcome, in selected areas, the barriers to entry which inhibit investment by new or small Irish firms in a great many industries. In addition, apart from borrowing as a source of finance, an expanded EEC

Regional Development Fund could provide an additional source of investment funds.

What exactly the overall scale of this effort should be is a matter of judgment since there are no very obvious objective criteria for deciding this. As an illustrative hypothetical example, however, suppose it is assumed that total indigenous manufacturing employment would do no better than maintain its present level under current policies, whereas one might aim to have it doubling over, say, a 20-year period. Such a rate of employment growth, at 3.5 per cent a year, would not be entirely unprecedented, but it would mean sustained growth for 20 years at about the highest rate ever seen in Ireland for shorter periods. It would also mean increasing indigenous manufacturing employment by about 130,000 over 20 years. Suppose it is assumed further that all of this increase had to come in selected target projects of a substantial size — say employing a few hundred to a few thousand people each, with average employment of 1,000 to 1,500 — and that these projects take 5 years to reach maturity so that they would have to be started over the next 15 years if they are all to reach their target size by the 20th year.

This would mean aiming to start an average of about 6 to 9 such projects each year, with each year's selected projects combined having the potential to employ about 8,000 or 9,000 people at maturity. How many of these projects should be in the Metals & Engineering sector is difficult to say without first assessing the options thoroughly in engineering and other industries, but about 2 to 5 each year would be appropriate if one sees engineering as at least retaining its current proportionate importance in Irish industry and at most growing to the proportions typical of more advanced European countries.

One could not, of course, cost such a programme without detailed information on what precisely it would contain. For a very rough indication of the order of magnitude of costs, going by past experience, the IDA spent £15,800 (in 1985 prices) for each job created in new projects in the period 1978-84 and sustained until the end of that period. In the "New Industry" programme, which covers the larger projects, the costs were greater at £19,900 per job (IDA *Annual Report*, 1984). In discussing financing of selected target industries above, reference was made to various forms of financing, but perhaps we can take the IDA figures as some indication of the "grant" or aid element required from the state. For the type of large target industries discussed above, however, in activities with significant entry barriers, the costs to the state might well be greater. In particular, there would probably be a need for support for significant investments in areas such as R & D, marketing or training, whereas most of the IDA expenditure referred to was support for fixed capital investment. If we take £20,000 per job created and sustained as a minimum figure for the "grant" element in a financial package and, say,

£30,000 as a maximum, the cost to the state of creating 130,000 jobs in this way over 20 years would come to between £130 million and £195 million per year.

For comparison, the IDA spent £151 million on grants, land and factories in 1984, so the new programme could involve adding to the annual capital budget an amount roughly comparable to IDA expenditure in that year. This would not be such a drastic or unprecedented step as it might seem, however, since IDA expenditure in 1984 had actually fallen sharply from an earlier peak, due to the lack of projects coming forward. The IDA expenditure in 1981 was £261 million (in constant 1984 prices), or 73 per cent higher than in 1984. Thus, while the calculations above are very approximate indications of the amounts involved, it could be that the "grant" costs of the type of programme suggested would be somewhat larger, but not a great deal larger, than returning to the level of funding of new projects which occurred in 1981. Presumably this could be generally regarded as acceptable and desirable if there were, in fact, an effective means of increasing the supply of viable projects offering an adequate return on Exchequer funding.

The type of programme outlined above would involve taking risks with public money, of course, but the risks could be kept to a minimum by gradual and careful implementation. The initial step of establishing a task force to assess the options for a trial period of a year or two would not be very expensive, particularly if some of its members were seconded from existing public sector employment. Depending on its findings, it could then be decided whether to proceed with commitment of expenditure on investment, perhaps beginning with a few relatively small and highly promising projects for which there is particular enthusiasm among relevant commercial enterprises. By phasing entry or expansion in such projects, the risks could be minimised. If the projects undertaken at first are found to be working out reasonably well, providing a greater basis for confidence in this type of policy, there would be justification for further investment in a gradually increasing number of larger projects. The amount of state expenditure at risk at any one time in unproved projects and policies could thus be kept to a fairly low level.

The possible risks of such a programme also have to be set against the risks of continuing with policies simply as they are. Going by past experience, there is surely a considerable risk, even a likelihood, that current policies will not generate substantial growth in internationally traded indigenous industries, which is now officially the first objective of industrial policy. There has not been a great deal of progress in this respect to date. Since we cannot depend with confidence on new foreign investment for a high rate of industrial growth, and since unemployment clearly threatens to be a major problem for the foreseeable future, it is vital to take some action to reverse the marked decline in indigenous industry which has occurred since the beginning of the 1980s. While it is understandable that there should be caution about undertaking any major new policy initiative, it nevertheless seems inevitable that major new departures have to be contemplated if one seeks outcomes which are quite radically different from past experience.

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Appendix 1.

METALS & ENGINEERING CLASSIFIED ACCORDING TO THE NACE SYSTEM

The Metals & Engineering sector, as classified in the EEC's NACE system, consists of eight broad classes of industry, numbered 22 and 31 to 37. These are Production and Preliminary Processing of Metals (22); Manufacture of Metal Articles (31); Mechanical Engineering (32); Office and Data Processing Machinery (33); Electrical Engineering (34); Motor Vehicles, including parts and accessories (35); Other Means of Transport (36); and Instrument Engineering (37). The composition of these industries is shown in some detail in the listing below.

(The source of this list is Eurostat, 1985, *NACE: General Industrial Classification of Economic Activities within the European Communities.)*

Classes	Groups	Subgroups and items	Description
22			PRODUCTION AND PRELIMINARY PROCESSING OF METALS
	221		**Iron and steel industry (as defined in the E.C.S.C. Treaty), excluding integrated coke ovens**
		221.1	Manufacture of pig iron (including high carbon ferro-manganese) and crude steel; hot rolling (including continuous casting but excluding the production of tubes and tyres); cold rolling of plates and sheets
		221.2	Coating of sheets and plates
	222		**Manufacture of steel tubes**
	223		**Drawing, cold rolling and cold folding of steel**
		223.1	Cold drawing of steel
		223.2	Cold rolling of hoop and strip
		223.3	Cold forming or folding of angles, shapes and sections from flat rolled steel products
		223.4	Steel-wire drawing and manufacture of steel-wire products
		.41	*Steel-wire drawing*
		.42	*Manufacture of steel-wire products*
	224		**Production and preliminary processing of non-ferrous metals**
		224.1	Refining of non-ferrous metals
		224.2	Remelting of non-ferrous metals
		224.3	Preliminary processing of non-ferrous metals: rolling, drawing, extrusion
		224.4	Specialized production of ferro-alloys outside the iron and steel industry

3. METAL MANUFACTURE; MECHANICAL, ELECTRICAL AND INSTRUMENT ENGINEERING

Classes	Groups	Subgroups and items	Description
31			**MANUFACTURE OF METAL ARTICLES (EXCEPT FOR MECHANICAL, ELECTRICAL AND INSTRUMENT ENGINEERING AND VEHICLES)**
	311		**Foundries**
		311.1	Ferrous metal foundries
		311.2	Non-ferrous metal foundries
	312		**Forging; drop forging, closed die-forging, pressing and stamping**
		312.1	Forging; drop forging, closed die-forging
		.11	*Forging*
		.12	*Drop forging, closed die-forging*
		312.2	Stamping, pressing (dropstamping)
	313		**Secondary transformation, treatment and coating of metals**
		313.1	Manufacture of articles on metal turning or forming machines (screws, bolts and nuts)
		.11	*Manufacture of articles on turning machines or lathe, including the manufacture of turned screws*
		.12	*Manufacture of bolts, rivets and related products on metal-forming machines*
		313.2	Manufacture of springs (except furniture and watch springs)
		313.3	Sintering of metals
		313.4	Manufacture of chains (except articulated link chains)
		313.5	Treatment and coating of metals
		313.6	General mechanical engineering on a subcontract basis
	314		**Manufacture of structural metal products (incl. integrated assembly and installation)**
		314.1	Manufacture of metal structures and parts of structures (bridges, bridge-sections, frames, frameworks, superstructures)
		314.2	Manufacture of metal doors, windows, etc. from rolled angles, shapes and sections
		314.3	Manufacture of pit-propping equipment
		314.4	Manufacture of standard-gauge railway track, fixtures and fittings
	315		**Boilermaking, manufacture of reservoirs, tanks and other sheet-metal containers**
		315.1	Manufacture of large boilers, including complete furnaces
		315.2	Manufacture of other boiler house products, reservoirs, tanks and other containers
	316		**Manufacture of tools and finished metal goods, except electrical equipment**
		316.1	Manufacture of hand tools and agricultural tools
		.11	*Manufacture of hand tools*
		.12	*Manufacture of agricultural tools*
		316.2	Manufacture of cutlery and of forks, spoons and similar kitchen or tableware
		316.3	Manufacture of general hardware (locks, fittings)
		316.4	Manufacture of metal boxes and other metal packing products
		.41	*Manufacture of heavy metal packaging*
		.42	*Manufacture of light metal packaging*
		316.5	Manufacture of domestic heating appliances and kitchen heating appliances of all kinds

Classes	Groups	Subgroups and items	Description
		316.6	Manufacture of metal furniture (including safes)
		316.7	Manufacture of domestic and similar articles of base metal
		316.8	Manufacture of small arms and ammunition thereof
		316.9	Manufacture of finished metal products not elsewhere specified
		.91	*Founding of printing type*
		.92	*Manufacture of small metal articles*
	319		**Other metal workshops not elsewhere specified**
		319.1	Soldering, welding, smithery, blacksmithery
		319.2	Rural workshops for the repair of agricultural equipment
32			**MECHANICAL ENGINEERING**
	321		**Manufacture of agricultural machinery and tractors**
		321.1	Manufacture of agricultural machinery
		321.2	Manufacture of agricultural tractors
	322		**Manufacture of machine-tools for working metal, and of other tools and equipment for use with machines**
		322.1	Manufacture of metal-working machine-tools
		.11	*Manufacture of metal-cutting machine-tools*
		.12	*Manufacture of metal-forming machine-tools*
		322.2	Manufacture of tools and equipment for use with machines
	323		**Manufacture of textile machinery and accessories; manufacture of sewing machines**
		323.1	Manufacture of textile machinery and accessories
		.11	*Manufacture of textile machinery*
		.12	*Manufacture of accessories for textile machinery*
		323.2	Manufacture of sewing machines
	324		**Manufacture of machinery for the food, chemical and related industries**
		324.1	Manufacture of food and drink processing machinery and of machinery for the chemical industry
		.11	*Manufacture of food, drink and tobacco processing machinery*
		.12	*Manufacture of machinery for the chemical industry*
		324.2	Manufacture of bottling, packaging, wrapping and related machinery
		324.3	Manufacture of rubber and artificial plastics-working machinery
	325		**Manufacture of plant for mines, the iron and steel industry and foundries, civil engineering and the building trade; manufacture of mechanical handling equipment**
		325.1	Manufacture of mining machinery
		325.2	Manufacture of plant for the iron and steel and metallurgical industries and for foundries
		325.3	Manufacture of brick making and other machinery for the preparation of building materials

Classes	Groups	Subgroups and items	Description
		325.4	Manufacture of construction and civil engineering equipment
		325.5	Manufacture of mechanical lifting and handling equipment
	326		**Manufacture of transmission equipment for motive power**
		326.1	Manufacture of gears and gearing (including variable speed gears), transmission chains (including bicycle chains) and other transmission equipment
		326.2	Manufacture of ball, roller and similar bearings
	327		**Manufacture of other machinery and equipment for use in specific branches of industry**
		327.1	Manufacture of machinery for working wood and similar materials
		327.2	Manufacture of paper, paper goods making, printing and bookbinding machinery
		327.3	Manufacture of laundry and dry cleaning machinery
		327.4	Manufacture of plant for the leather industry, including boot and shoe machinery
	328		**Manufacture of other machinery and equipment**
		328.1	Manufacture of internal combustion engines except those for road vehicles and aircraft
		328.2	Manufacture of water-wheels and water and heat-turbines and other mechanical energy producing machinery
		328.3	Manufacture of compressors, pumps and equipment for operating machinery by hydraulic or pneumatic means
		328.4	Manufacture of space-heating, ventilating and air-conditioning equipment
		328.5	Manufacture of refrigerating machinery (except domestic type refrigerators and domestic deep freeze units)
		328.6	Manufacture of non-electric industrial furnaces and ovens
		328.7	Manufacture of non-electric welding-equipment
		328.8	Manufacture of taps, cocks, valves and similar appliances
		328.9	Manufacture of machinery and appliances not elsewhere specified
33	330		MANUFACTURE OF OFFICE MACHINERY AND DATA PROCESSING MACHINERY
34			ELECTRICAL ENGINEERING
	341		**Manufacture of insulated wires and cables**
	342		**Manufacture of electrical machinery (comprising electric motors, electricity generators, transformers, switches, switchgear and other basic electrical plant)**
	343		**Manufacture of electrical apparatus and appliances for industrial use; manufacture of batteries and accumulators**
		343.1	Manufacture of electrical equipment for industrial use
		343.2	Manufacture of batteries and accumulators
	344		**Manufacture of telecommunications equipment, electrical and electronic measuring and recording equipment, and electro-medical equipment**

Classes	Groups	Subgroups and items	Description
	345		**Manufacture of radio and television receiving sets, sound reproducing and recording equipment and of electronic equipment and apparatus (except electronic computers); manufacture of gramophone records and prerecorded magnetic tapes**
		345.1	Manufacture of radio and television receivers, sound reproducing and recording equipment and of electronic equipment and apparatus (except electronic computers)
		345.2	Manufacture of gramophone records and prerecorded tape
	346		**Manufacture of domestic type electric appliances**
	347		**Manufacture of electric lamps and other electric lighting equipment**
		347.1	Manufacture of electric lamps
		347.2	Manufacture of other electric lighting equipment
	348		**Assembly and installation of electrical equipment and apparatus (except for work relating to the wiring of buildings)**
35			**MANUFACTURE OF MOTOR VEHICLES AND OF MOTOR VEHICLE PARTS AND ACCESSORIES**
	351		**Manufacture and assembly of motor vehicles (including road tractors) and manufacture of motor vehicle engines**
	352		**Manufacture of bodies for motor vehicles and of motor-drawn trailers and caravans**
	353		**Manufacture of parts and accessories for motor vehicles**
36			**MANUFACTURE OF OTHER MEANS OF TRANSPORT**
	361		**Shipbuilding**
		361.1	Building and repair of sea-going vessels
		361.2	Building and repair of vessels for inland navigation
		361.3	Building and repair of boats and yachts
		361.4	Painting of ships
		361.5	Shipbreaking
	362		**Manufacture of standard and narrow-gauge railway and tramway rolling-stock**
		362.1	Manufacture of locomotives
		362.2	Manufacture of other railway and tramway rolling-stock, including mechanically propelled coaches, vans and trucks
		362.3	Repair of railway and tramway rolling-stock
	363		**Manufacture of cycles, motor-cycles and parts and accessories thereof**
		363.1	Manufacture of cycles, motor-cycles and mopeds
		363.2	Manufacture of parts and accessories for cycles, motor-cycles and mopeds

Classes	Groups	Subgroups and items	Description
	364		**Aerospace equipment manufacturing and repairing**
		364.1	Manufacture of aeroplanes and helicopters (including the engines)
		364.2	Repair of aeroplanes and helicopters
		364.3	Manufacture and repair of other aerospace equipment, including air cushion vehicles (hovercraft), guided weapons and spacecraft
	365		**Manufacture of transport equipment not elsewhere specified**
		365.1	Manufacture of baby carriages
		365.2	Manufacture of other vehicles
37			**INSTRUMENT ENGINEERING**
	371		**Manufacture of measuring, checking and precision instruments and apparatus**
		371.1	Manufacture of gas meters, water meters and other liquid supply meters (including petrol pump meters)
		371.2	Manufacture of measuring, checking or automatically controlling instruments and apparatus
		371.3	Manufacture of navigational, hydrological, geophysical and meteorological instruments
		371.4	Manufacture of drawing and mathematical calculating instruments
		371.5	Manufacture of precision measuring instruments
		371.6	Manufacture of precision balances, laboratory apparatus and teaching equipment
		371.7	Manufacture of other precision instruments and apparatus
	372		**Manufacture of medical and surgical equipment and orthopaedic appliances (except orthopaedic footwear)**
		372.1	Manufacture of medical apparatus for diagnostic work
		372.2	Manufacture of medical, surgical and veterinary equipment (except diagnostic apparatus)
		372.3	Manufacture of dental instruments and apparatus
		372.4	Manufacture of orthopaedic appliances and of artificial limbs, eyes, teeth and other artificial parts of the body
	373		**Manufacture of optical instruments and photographic equipment**
		373.1	Manufacture of spectacles, including lenses, frames and mountings, and of equipment for use by opticians
		373.2	Manufacture of optical precision instruments
		373.3	Manufacture of photographic and cinematographic equipment
	374		**Manufacture of clocks and watches and parts thereof**

Appendix 2

A NOTE ON DATA SOURCES

In Chapters 5 and 6 of this paper, an attempt is made to analyse industry structures and trends in Ireland distinguishing between Irish-owned indigenous firms (in Chapter 5) and foreign-owned multinational companies (in Chapter 6). A problem in doing this is that, at the time of writing, the industrial data series published by the Central Statistics Office are not broken down by nationality of ownership, although the CSO is to begin making such a distinction this year. This means that one has to rely on a few occasional surveys, such as McAleese (1977) and IDA (1985), for data on the output, exports, Irish economy expenditures, etc., of industry distinguishing nationality of ownership. For employment, however, there is a source of regular data, distinguishing between Irish and foreign-owned firms, in the IDA's annual employment survey. The results of this survey, which began in 1973, are not published in detail, although the IDA gives the principal results in its *Annual Report* and occasional press releases. I am grateful to the IDA for making available quite detailed results of their employment survey, and also unpublished details of the IDA (1985) survey, without which much of this paper would not have been possible.

Since Chapters 5 and 6 refer to the IDA employment survey quite extensively, it would be as well to explain how it compares with the official CSO data from the Census of Industrial Production (CIP). First, the IDA survey is not a sample but is rather a full census of all manufacturing employment. As such, it should give very similar overall results to the CIP, although small differences could legitimately arise because the data for the two are collected at different times of the year and because the CIP leaves out very small establishments employing only one or two people. In the 1970s, however, the IDA survey sometimes gave totals as much as about 10 per cent greater than the CIP, which seems to have been partly, if not mainly, due to the CIP not having comprehensive coverage, particularly of very new firms. But, since 1979, the coverage of the CIP has been improved and more recent CIP results compare quite well with the IDA survey. The results for total Metals & Engineering employment (indigenous and foreign) in 1979-1982 are shown below.

	1979	*1980*	*1981*	*1982*
IDA	61,400	68,700	68,500	69,400
CIP	63,100	65,900	66,100	65,900

The rather small differences of up to a few thousand (or 5 per cent at most) do not seem to be much cause for concern, especially in view of the reasons mentioned above to expect small differences. Within Metals & Engineering, however, there are some quite significant differences in the classifications by sector. First, the IDA employs two categories, "Precision Toolmaking" and "Healthcare Products", which are not part of the NACE system. For the purpose of this paper, unless stated otherwise, these are included respectively under Mechanical Engineering and Instrument Engineering, which is where most (but perhaps not all) of the products concerned belong in the NACE system. When this is done, Mechanical and Instrument Engineering have quite similar total employment in the CIP and IDA surveys.

A more serious discrepancy concerns Office & Data Processing Machinery and Electrical Engineering. In 1982, for example, the sum of employment in these two sectors was 22,200 in the IDA survey and almost identical at 21,900 in the CIP. But the IDA recorded 9,600 in Office & Data Processing Machinery compared with only 5,300 in the CIP, while the IDA recorded only 12,600 in Electrical Engineering compared with 16,600 in the CIP. Our firm impression is that the IDA data include rather too many companies in Office & Data Processing Machinery at the expense of Electrical Engineering, to judge from information on individual companies in IIRS (1982). In the one place in this paper where this discrepancy could be most seriously misleading, i.e., in Table 5.4, the IDA data on indigenous employment in Office & Data Processing Machinery were adjusted downwards to make allowance for this. Two new estimates were calculated (a) by removing three relatively large Irish companies which do not appear to belong to this sector, and (b) by taking the CIP figure as the correct total for the sector, multiplied by the proportion of indigenous employment in the whole sector according to the IDA data, to give an estimate of indigenous employment. This accounts for the estimated "range" shown in Table 5.4 in indigenous Office & Data Processing Machinery.

Appendix 3

INTERNATIONAL INDICATORS OF STRUCTURE, COMPETITION AND GROWTH IN ENGINEERING INDUSTRIES

This appendix presents the detailed data referred to in Chapter 8 and given in summary form in Table 8.2. First, as an indicator of the relative importance of economies of scale in the different industries, there are data on the percentage of each industry's employment (at the NACE 3 digit level) which is in large enterprises with over 500 workers in the major EEC countries. In calculating these percentages, enterprises with less than 20 employees are excluded from each industry's total employment, which means that the percentages are a little too high, but the relative position of each industry should be scarcely affected. The percentages are calculated for Germany, France, the UK and Italy combined wherever the data are available for all four countries (in practice, in just over half of the industries). But unavailability of data on some industries in some countries means that in a minority of industries the figures represent the situation in three of the four major EEC countries, and in a few cases in just two of these countries. The data are shown in rank order in Table A.3.1, together with the decile ranking used in Table 8.2.

Table A.3.1: *Percentage of Each Industry's Employment in Enterprises with over 500 Workers in the Four Major EEC Countries, 1981*

NACE Code	*Industry*	*Percentage Over 500*	*Decile*
351	Motor Vehicles and Engines	99.2	1
364	Aerospace Equipment	92	1
221	Iron and Steel	91.6	1
330	Office and Data Processing Machinery	87.9	2
362	Railway and Tramway Rolling-Stock	82.7	2
361	Shipbuilding	80.2	2
346	Domestic Electrical Appliances	79.3	2
344	Telecommunications Equipment	78.9	3
341	Insulated Wires and Cables	74.5	3
345	Radio, TV, Electronic Recording Equipment	73.7	3
222	Steel Tubes	73.2	3
342	Electric Motors, Generators, Transformers	73	4
353	Motor Vehicle Parts and Accessories	71	4
224	Non-Ferrous Metals	70	4
363	Cycles and Motorcycles	68.9	4
326	Gears, Transmission Equipment	67.7	5
343	Electrical Industrial Equipment	58.2	5

(continued)

Table A.3.1:
(continued)

NACE Code	*Industry*	*Percentage Over 500*	*Decile*
323	Textile Machinery, Sewing Machines	58	5
321	Agricultural Machinery	56.7	5
325	Mining, Construction, Handling Equipment	55.4	6
328	Other Machinery and Equipment	54.5	6
373	Optical Instruments, Photographic Equipment	51.5	6
347	Lamps and Lighting Equipment	46.7	7
315	Boilers, Tanks, Sheet Metal Containers	46.6	7
311	Foundries	45.6	7
327	Wood, Paper, etc., Machinery	44.5	7
324	Food, Chemical, Process Machinery	39.7	8
223	Extruded, Rolled Steel	37.7	8
374	Clocks and Watches	37	8
322	Metal-Working Machine-Tools	36.1	8
352	Vehicle Bodies and Trailers	34.7	9
371	Measuring, Precision Instruments	33.9	9
316	Tools, Finished Metal Goods	33	9
314	Structural Metal Products	27.6	9
372	Medical Instruments and Equipment	23.2	10
312	Forging, Pressing and Stamping	22.4	10
313	Secondary Transformation, Treatment of Metal	19.4	10

Source: Derived from Eurostat, 1981, *Structure and Activity of Industry, Data by Size of Enterprises,* Theme 4, Series C.

The other data on scale or firm size referred to in Chapter 8 are US figures on 8 firm concentration ratios (the percentage of an industry's shipments, i.e., sales, accounted for by the top 8 firms) and average employment in the top 8 firms. These figures are given in Table A.3.2, listing industries at the 4 digit level of the American industrial classification system, which is different to NACE. In the text in Chapter 8 and in Appendix 4, reference is also occasionally made to concentration ratios in industries at the more disaggregated 5 digit level, but in view of the very large number of industries at this level, these data are not presented here; they are available from the same source as Table A.3.2.

Table A.3.2: *Eight-Firm Concentration Ratios and Average Employment in the Top 8 Firms in Engineering Industries in the USA*

Industry Code	*Industry*	*Concentration Ratio*	*Average Employment in Top 8 Firms*
	PRIMARY METAL INDUSTRIES		
3312	Blast Furnaces and Steel Mills	69	36,450
3313	Electrometallurgical Products	84	930
3315	Steel Wire and Related Products	32	1,190
3316	Cold Finishing of Steel Shapes	54	1,110
3317	Steel Pipe and Tubes	39	1,210
3321	Gray Iron Foundries	44	6,040
3322	Malleable Iron Foundries	72	1,460
3324	Steel Investment Foundries	66	860
3325	Steel Foundries n.e.c.	38	2,560
3331	Primary Copper	100	1,640
3332	Primary Lead	100	620
3333	Primary Zinc	100	570
3334	Primary Aluminium	93	3,220
3339	Primary Nonferrous Metals n.e.c.	76	790
3341	Secondary Nonferrous Metals	36	800
3351	Copper Rolling and Drawing	63	2,200
3353	Aluminium Sheet, Plate and Foil	88	3,330
3354	Aluminium Extruded Products	54	1,600
3355	Aluminium Rolling and Drawing n.e.c.	95	530
3356	Nonferrous Rolling and Drawing n.e.c.	57	880
3357	Nonferrous Wiredrawing, Insulating	54	3,470
3361	Aluminium Foundries	29	1,280
3362	Brass, Bronze, Copper Foundries	23	290
3369	Nonferrous Foundries n.e.c.	29	550
3398	Metal Heat Treating	32	310
3399	Primary Metal Products n.e.c.	36	270
	FABRICATED METAL PRODUCTS		
3411	Metal Cans	74	5,020
3412	Metal Barrels, Drums, Pails	47	630
3421	Cutlery	65	1,050
3423	Hand and Edge Tools n.e.c.	38	1,770
3425	Handsaws and Saw Blades	69	610
3429	Hardware n.e.c.	45	4,560
3431	Metal Sanitary Ware	68	650
3432	Plumbing Fittings and Brass Goods	49	1,000
3433	Heating Equipment (non-electric)	26	650
3441	Fabricated Structural Metal	15	1,810
3442	Metal Doors, Sash and Trim	15	1,130
3443	Fabricated Platework, Boiler Shops	32	3,630
3444	Sheet Metalwork	17	650

(continued)

Table A.3.2:
(continued)

Industry Code	*Industry*	*Concentration Ratio*	*Average Employment in Top 8 Firms*
3446	Architectural Metalwork	26	510
3448	Prefabricated Metal Buildings	34	700
3449	Miscellaneous Metalwork	45	750
3451	Screw Machine Products	11	400
3452	Bolts, Nuts, Rivets and Washers	23	1,810
3462	Iron and Steel Forgings	34	1,480
3463	Nonferrous Forgings	85	510
3465	Automotive Stampings	70	10,330
3466	Crowns and Closures	73	640
3469	Metal Stampings n.e.c.	16	1,530
3471	Plating and Polishing	12	470
3479	Metal Coating and Allied Services	32	400
3482	Small Arms Ammunition	97	1,260
3483	Ammunition, excluding Small Arms	71	1,701
3484	Small Arms	78	1,620
3489	Ordnance and Accessories n.e.c.	72	2,360
3493	Steel Springs, except Wire	59	560
3494	Valves and Pipe Fittings	21	2,740
3495	Wire Springs	41	920
3496	Miscellaneous Fabricated Wire Products	16	530
3497	Metal Foil and Leaf	66	680
3498	Fabricated Pipe and Fittings	29	720
3499	Fabricated Metal Products n.e.c.	18	840
	MACHINERY		
3511	Turbines, Generator Sets	97	4,870
3519	Internal Combustion Engines n.e.c.	70	6,880
3523	Farm Machinery and Equipment	61	7,520
3524	Lawn and Garden Equipment	51	1,040
3531	Construction Machinery	59	9,400
3532	Mining Machinery	50	1,959
3533	Oilfield Machinery	45	3,160
3534	Elevators and Moving Stairways	68	800
3535	Conveyors and Conveying Equipment	30	980
3536	Hoists, Cranes and Monorails	30	580
3537	Industrial Trucks and Tractors	61	1,830
3541	Machine-Tools, Metal-Cutting	35	2,450
3542	Machine-Tools, Metal-Forming	32	930
3544	Special Dies, Tools and Jigs	10	860
3545	Machine-Tool Accessories	31	1,740
3546	Power Driven Handtools	70	2,220
3547	Rolling Mill Machinery	77	690

(continued)

Table A.3.2:
(continued)

Industry Code	*Industry*	*Concentration Ratio*	*Average Employment in Top 8 Firms*
3549	Metalworking Machinery n.e.c.	24	500
3551	Food Products Machinery	24	1,060
3552	Textile Machinery	35	1,140
3553	Woodworking Machinery	46	460
3554	Paper Industries Machinery	52	1,010
3555	Printing Trades Machinery	50	1,500
3559	Special Industry Machinery n.e.c.	20	1,630
3561	Pumps and Pumping Equipment	29	2,040
3562	Ball and Roller Bearings	71	4,410
3563	Air and Gas Compressors	64	2,410
3564	Blowers and Fans	28	750
3565	Industrial Patterns	14	110
3566	Speed Changers, Drives and Gears	42	1,410
3567	Industrial Furnaces and Ovens	39	640
3568	Power Transmission Equipment n.e.c.	44	1,620
3569	General Industrial Machinery n.e.c.	16	950
3573	Electronic Computing Equipment	56	10,600
3574	Calculating, Accounting Machines	83	1,690
3576	Scales and Balances, excl. Laboratory	66	520
3579	Office Machines, Typewriters, etc.	76	3,570
3581	Automatic Merchandising Machines	67	650
3582	Commercial Laundry Equipment	63	340
3585	Refrigeration, Heating Equipment	48	7,050
3586	Measuring and Dispensing Pumps	73	650
3589	Service Industry Machinery n.e.c.	21	700
3592	Carburettors, Pistons, Rings, etc.	71	2,900
3599	Machinery, except Electrical n.e.c.	3	520
	ELECTRIC EQUIPMENT		
3612	Transformers	70	3,590
3613	Switchgear, Switchboard Apparatus	65	5,060
3621	Motors and Generators	55	5,900
3622	Industrial Controls	54	3,350
3623	Welding Apparatus, Electric	65	1,210
3624	Carbon and Graphite Products	88	1,200
3629	Electric Industrial Apparatus n.e.c.	43	810
3631	Household Cooking Equipment	71	2,130
3632	Household Refrigerators, Freezers	98	4,330
3633	Household Laundry Equipment	100	2,020
3634	Electric Housewares and Fans	59	3,100
3635	Household Vacuum Cleaners	95	1,230
3636	Sewing Machines	91	930

(continued)

Table A.3.2:
(continued)

Industry Code	*Industry*	*Concentration Ratio*	*Average Employment in Top 8 Firms*
3639	Household Appliances n.e.c.	83	1,660
3641	Electric Lamps	95	3,310
3643	Current-Carrying Wiring Devices	38	2,110
3644	Noncurrent-Carrying Wiring Devices	39	1,200
3645	Residential Lighting Fixtures	33	890
3546	Commercial Lighting Fixtures	46	730
3647	Vehicular Lighting Equipment	86	1,440
3648	Lighting Equipment n.e.c.	39	550
3651	Radio and TV Receivers	65	4,700
3652	Records, Pre-recorded Tape	62	1,460
3661	Telephone and Telegraph Apparatus	90	13,900
3662	Radio and TV Communication Equipment	33	13,160
3671	Electronic Tubes, Receiving Type	78	3,540
3674	Semiconductors, Related Devices	62	8,100
3675	Electronic Capacitors	62	2,110
3676	Electronic Resistors	63	1,580
3677	Electronic Coils and Transformers	30	600
3678	Electronic Connectors	65	1,900
3679	Electronic Components n.e.c.	36	3,160
3691	Storage Batteries	84	2,530
3692	Primary Batteries, Dry and Wet	94	1,250
3693	X-Ray Apparatus and Tubes	51	1,650
3694	Engine Electrical Equipment	75	5,070
3699	Electrical Equipment n.e.c.	33	760
	TRANSPORTATION EQUIPMENT		
3711	Motor Vehicles and Car Bodies	99	41,360
3713	Truck and Bus Bodies	40	1,270
3714	Motor Vehicle Parts, Accessories	70	32,230
3715	Truck Trailers	56	1,710
3716	Motor Homes	58	1,270
3721	Aircraft	81	20,350
3724	Aircraft Engines and Engine Parts	86	10,740
3728	Aircraft Equipment n.e.c.	56	6,430
3731	Ship Building and Repairing	58	13,410
3732	Boat Building and Repairing	19	900
3743	Railroad Equipment	65	4,240
3751	Motorcycles, Bicycles and Parts	81	1,400
3761	Guided Missiles, Space Vehicles	94	10,850
3764	Space Propulsion Units and Parts	93	2,170
3769	Space Vehicle Equipment n.e.c.	86	730
3792	Travel Trailers and Campers	44	1,200

(continued)

Table A.3.2:
(continued)

Industry Code	Industry	Concentration Ratio	Average Employment in Top 8 Firms
3795	Tanks and Tank Components	97	1,500
3799	Transportation Equipment n.e.c.	46	420
	INSTRUMENTS AND RELATED PRODUCTS		
3822	Environmental Controls	81	3,710
3823	Process Control Instruments	46	2,800
3824	Fluid Meters and Counting Devices	67	1,290
3825	Instruments to Measure Electricity	43	3,470
3829	Measuring, Controlling Devices, n.e.c.	35	1,760
3832	Optical Instruments and Lenses	43	1,540
3841	Surgical and Medical Instruments	48	2,330
3842	Surgical Appliances and Supplies	49	2,360
3843	Dental Equipment and Supplies	46	800
3851	Ophthalmic Goods	56	1,970
3861	Photographic Equipment and Supplies	86	10,650
3873	Watches, Clocks and Watchcases	66	2,150

Note: In calculating these data, a "company" is defined as the total of the individual establishments under one ownership within one industry. Consequently, parts of the same large company can appear in several industries if it has diversified activities.
Source: Derived from US *Census of Manufactures, 1977, Concentration Ratios in Manufacturing.*

The data on skills referred to in Chapter 8 are from the UK and they are classified according to the NACE system. They show the percentage of each industry's employment in the UK accounted for by white-collar occupations (Managerial, Administrative, Technical and Clerical), and by craftworkers. These data are shown in Table A.3.3, together with the decile ranking order used in Table 8.2.

Table A.3.3: *Percentage of Each Industry's Employment Accounted for by Skilled Workers, UK 1983*

NACE Code	Industry	White Collar Employment Percentage	White Collar Employment Decile	Craftworkers Percentage	Craftworkers Decile
22	*METALS*				
221	Iron and Steel	27	7	14.3	5
222	Steel Tubes	25.2	8	12.8	6
223	Extruded, Rolled Steel	23.5	9	9.7	8
224	Non-Ferrous Metals	24.9	8	12.7	7

(continued)

Table A.3.3:
(continued)

NACE Code	Industry	White Collar Employment Percentage	White Collar Employment Decile	Craftworkers Percentage	Craftworkers Decile
31	*METAL ARTICLES*				
311	Foundries	n.a.	—	n.a.	—
312	Forgings, Stampings	20.9	10	14.9	5
313	Secondary Metal Processing	25.7	8	11.9	8
314	Structural Metal	33.8	5	12.8	6
315	Boilers, Tanks, etc.	n.a.	—	n.a.	—
316	Tools, Hardware, etc.	24.6	9	16.7	4
319	Other Metal Articles	n.a.	—	n.a.	—
32	*MECHANICAL ENGINEERING*				
321	Agricultural Machinery	33.1	5	13.9	6
322	Machine Tools	30.6	5	34.7	1
323	Textile Machinery	30.5	6	34.2	1
324	Process Machinery	43.7	2	30.7	2
325	Mining, Construction Machinery	37.8	4	29.7	2
326	Transmission Equipment	28.3	6	20.1	3
327	Wood, Paper, etc., Machinery	43.4	3	30.3	2
328	Other Machinery	35.1	4	24.4	3
330	*OFFICE & DATA PROCESSING MACHINERY*	69.7	1	4.0	10
34	*ELECTRICAL ENGINEERING*				
341	Insulated Wires, Cables	32.3	5	8.7	9
342	Electric Motors, Generators	37.7	4	19.2	4
343	Electric Industrial Equipment	43.1	3	10.7	8
344	Telecommunications Equipment	49.7	1	8.2	9
345	Radio, TV, etc.	42.3	3	6.3	10
346	Electrical Appliances	25.3	8	6.7	10
347	Lamps, Lighting	27.4	7	7.9	9
35	*MOTOR VEHICLES*				
351	Vehicles, Engines	21.9	10	16.5	4
352	Vehicle Bodies, Trailers	17.8	10	15.6	5
353	Vehicle Parts	26.1	7	14.4	5
36	*OTHER TRANSPORT*				
361	Shipbuilding	n.a.	—	n.a.	—
362	Railway Equipment	20	10	47.7	1
363	Cycles, Motorcycles	24.9	9	6.4	10
364	Aerospace	48.3	2	28.6	3
365	Prams, Carts, etc.	n.a.	—	n.a.	—

(continued)

Table A.3.3:
(continued)

NACE Code	Industry	White Collar Employment Percentage	Decile	Craftworkers Percentage	Decile
37	*INSTRUMENT ENGINEERING*				
371	Measuring, Precision Instruments	53.9	1	12.4	7
372	Medical Instruments	38.7	3	20.1	3
373	Optical, Photographic	48.9	2	12.1	7
374	Clocks, Watches	28.9	6	10.5	8

Source: Engineering Industry Training Board. Published in UK *Annual Abstract of Statistics 1986*, HMSO.

The data on R & D intensity referred to in Chapter 8 have already been shown in Table 3.5 in the text. However, these data are not classified according to the NACE system and so they had to be matched up with the NACE categories as far as possible. This matching is shown in Table A.3.4. The decile ranking order as used in Chapter 8 is also shown and, as can be seen, this has to be a rather imprecise exercise since the grouping together of the NACE industries does not allow them to be divided up into 10 groups of equal size. The objective in assigning the decile ranking orders was to have, as far as possible, about three or four NACE industries in each decile.

Table A.3.4: *US R & D Intensity and Corresponding NACE Industries*

US Industry	*US R & D as percent of Sales*	*Corresponding NACE Codes*	*Decile*
Aircraft and Missiles	12.3	364	1
Office, Computing Machinery	11.7	330	1
Communication Equipment	7.7	344	1
Electronic Components	6.6		
Optical, Medical and Photographic Instruments	6.2	372, 373	2
Scientific Instruments	5.8	371	2
Other Electrical Equipment	5.3	341-348 less 344, 345	3
Motor Vehicles	3.3	351-353	4
Other Machinery	2.1	321-328	5/6
Other Transport Equipment	1.4	361, 362, 363, 365	7
Radio and TV	1.1	345	
Fabricated Metal Products	1.1	312-319	8/9
Non-Ferrous Metals	0.9	224	
Ferrous Metals	0.5	221-223, 311	10

Source: US R & D data from Freeman (1982), Table 1.3a.

A somewhat similar difficulty in matching up different classification systems arises with the data on developing countries' shares of export markets and international growth rates of exports referred to in Chapter 8. For both of these data sets are trade statistics, classified according to the SITC system. The objective here was to match SITC categories with NACE categories, as far as possible, so that the trends in the SITC categories concerned would be reasonably representative of the situation for the corresponding NACE category industries discussed in Chapter 8. This matching was done as follows:

NACE Code	*SITC Code*	*NACE Code*	*SITC Code*
221	671,672,674	342	716, 771, 772
222	678	343	7781
223	673, 675, 677	344	764, 774
224	68	345	761, 762, 763, 776
311	679	346	775
312	n.a.	347	7782, 8124
313	693, 694	348	n.a.
314	676, 691	351	781, 782, 783
315	711, 6921	352	7783, 784, 786
316	6924, 695, 696, 697, 8121, 82191	353	7783, 784, 786
319	n.a.	361	793
321	721, 722	362	791
322	736, 737, 7281	363	785
323	7243, 7244, 7245, 72469	364	792
324	727, 72842, 74522	365	n.a.
325	723, 7283, 744	371	873, 874
326	7491, 7493	372	872
327	725, 726	373	871, 881, 884
328	712, 713, 714, 74132, 7414, 7415, 742, 743, 7492	374	885
330	751, 752, 759		
341	7731		

Based on these corresponding SITC categories, the data on developing countries' share of all market economies' exports and growth rates of market economies' exports are as shown in Table A.3.5.

Table A.3.5: *Developing Countries' Export Shares, 1983, and Growth Rates of World Exports, 1976-83*

NACE Code	Industry	Developing Countries' Share of Exports Percentage	Decile	Growth of World Exports Percentage	Decile
22	*METALS*				
221	Iron and Steel	14.1	2	43.4	8
222	Steel Tubes	7.9	5	35.1	9
223	Extruded, Rolled Steel	10.1	4	28.3	9
224	Non-Ferrous Metals	28.6	1	82.1	4
31	*METAL ARTICLES*				
311	Foundries	3.3	8	−29.4	10
312	Forgings, Stampings	n.a.	—	n.a.	—
313	Secondary Metal Processing	10.9	3	45.4	7
314	Structural Metal	8.3	4	59.8	7
315	Boilers, Tanks, etc.	2.4	10	91.7	3
316	Tools, Hardware, etc.	11.9	2	76.4	5
319	Other Metal Articles	n.a.	—	n.a.	—
32	*MECHANICAL ENGINEERING*				
321	Agricultural Machinery	2.7	9	21.2	9
322	Machine Tools	2.9	9	43.5	8
323	Textile Machinery	3.7	7	69.5	6
324	Process Machinery	2.1	10	−16.4	10
325	Mining, Construction Machinery	3.6	8	40	8
326	Transmission Equipment	5.4	6	53.5	7
327	Wood, Paper, etc., Machinery	1.9	10	76.1	5
328	Other Machinery	5.4	6	96.2	3
330	*OFFICE AND DATA PROCESSING MACHINERY*	6.8	6	264.3	1
34	*ELECTRICAL ENGINEERING*				
341	Insulated Wires, Cables	7.3	5	97.2	3
342	Electric Motors, Generators	10.9	3	100.5	3
343	Electric Industrial Equipment	10.8	4	119.8	2
344	Telecommunications Equipment	12.2	2	101.2	2
345	Radio, TV, etc.	25.2	1	138.1	1
346	Electrical Appliances	13	2	78.7	5
347	Lamps, Lighting	10	4	78.5	5
35	*MOTOR VEHICLES*				
351	Vehicles, Engines	1.8	10	88.3	4
352 353	Vehicle Bodies, Trailers Vehicle Parts	2.4	9	80.8	4

(continued)

Table A.3.5:
(continued)

NACE Code	Industry	Developing Countries' Share of Exports Percentage	Decile	Growth of World Exports Percentage	Decile
36	*OTHER TRANSPORT*				
361	Shipbuilding	11.4	3	1.7	10
362	Railway Equipment	3.8	7	32.1	9
363	Cycles, Motorcycles	3.8	7	75.5	6
364	Aerospace	3.4	8	151.5	1
365	Prams, Carts, etc.	n.a.	—	n.a.	—
37	*INSTRUMENT ENGINEERING*				
371	Measuring, Precision Instruments	3.3	8	129.7	2
372	Medical Instruments	4.1	6	140.5	1
373	Optical, Photographic	7.8	5	58.3	7
374	Clocks, Watches	31.5	1	75.6	6

Notes: Column 1 shows the percentage of exports from all market economies accounted for by developing market economies in 1983. Column 3 shows the percentage increase in exports of all market economies in the period 1976-83, measured in current dollar prices. The decile ranking order for these growth rates starts with the fastest growing at number 1 and proceeds to the slowest growing at number 10.

Source: Derived from United Nations, *International Trade Statistics Yearbook 1983.*

Appendix 4

SUITABLE INDUSTRIES FOR IRISH INDIGENOUS DEVELOPMENT

This appendix briefly considers the suitability of the individual industries as potential target sectors for Irish indigenous development. In doing so it follows the NACE (3 digit level) classification system and draws on the information in Appendix 3.

Production and Preliminary Processing of Metals (NACE 22)

Production of Iron and Steel (NACE 221)

This is mostly a very large-scale industry, as seen in the case of the EEC in Table A.3.1 while the main corresponding US industry, Blast Furnaces and Steel Mills, is 69 per cent concentrated in 8 firms with average employment of over 30,000 each. Japanese blast furnaces and mills and some in the NICs are even bigger (Magaziner and Hout, 1980, pp. 14-16). Thus there are major entry barriers arising from economies of scale and capital costs. Since some large NICs have nevertheless overcome these barriers with the aid of protection, and demand growth has been slow, there has been chronic excess capacity and widespread low or negative profitability. For the most part, this is not an attractive or feasible industry for Irish indigenous development.

There are exceptions to the general picture which are smaller in scale, including mini-mills such as Irish Steel which reprocess scrap, but these still face poor market conditions. And makers of more specialised products, such as stainless steel or hardened steels for high-speed tools or bearings, are also smaller (and generally more profitable) than the mainstream companies, but these industrial segments are quite highly concentrated or oligopolistic as well as being capital-intensive.[39] So they would probably be costly to enter, both in terms of capital costs and likely initial losses while building up an adequate market share.

Steel Tubes (NACE 222)

The story here appears to be broadly similar. But it is worth noting that steel pipes and tubes are produced both in large vertically integrated steelworks and in smaller more specialised establishments which purchase their inputs of steel from elsewhere. This more specialised industry is not nearly so heavily concentrated in large firms, with only 39 per cent of the industry in the USA being concentrated in the top 8 firms which employ an average of 1,210 each. This type of activity should be easier to enter, but then the same applies to

39. Ian Rodger, "Stainless Steel Recovers its Shine", *Financial Times*, 22/6/84.
David Brown, "Success Brings Problems for Swedish Steel", *FT*, 21/8/84.

developing countries and demand growth has been slow so that competitive conditions are probably quite intense. One defensible specialised niche, however, is in supplying relatively small batches of pipe or tube made or cut to order for a fragmented customer base. One of the larger Irish companies does this in what is essentially a local market-oriented activity with a degree of natural protection against distant competitors (Telesis, 1982, p. 109).

Extruded, Drawn, Cold-Rolled Steel (NACE 223)

Entry barriers in this industry are generally not very great, but again this means that some developing countries are becoming significant competitors, and growth is slow. Thus, in general, it is not a particularly attractive industry for development by Irish firms, although there may be some possibilities which would be worth investigation.

Non-ferrous Metals (NACE 224)

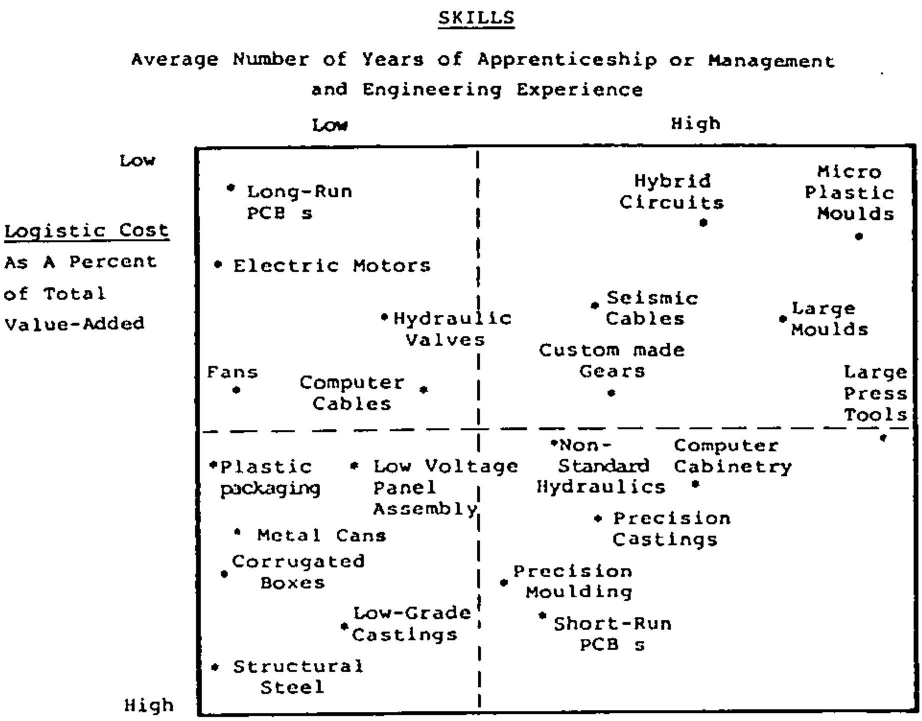
The non-ferrous metal industries are generally much smaller in scale than iron and steel but they are nevertheless mostly highly concentrated or oligopolistic in structure. In the USA the top 8 firms account for over 90 per cent of sales in primary copper, lead, zinc and aluminium, although the average employment size of the top 8 companies ranges from only 570 in zinc to 3,200 in aluminium. These industries are also capital-intensive, so they would probably be costly to enter, both in terms of capital costs and likely initial losses while building up an adequate market share. In addition, developing countries which possess the relevant natural resources are particularly strong in these industries, and in some metals there is little production outside the countries with the resources. For these reasons, the primary production stages, at least, look unattractive despite the fact that growth is relatively strong. But concentration ratios are substantially lower in some secondary activities such as reprocessing or alloying of metals, aluminium extruded products, and electronic wires and cables. There might be some minor opportunities here.

Manufacture of Metal Articles (NACE 31)

Foundries (NACE 311)

Foundries, which produce metal castings, are an important part of the industrial infrastructure for engineering, as sub-suppliers or sub-contractors (Sectoral Consultative Committee — Engineering, 1983, pp. 68-73). Thus it would be a matter of some strategic importance to develop this industry further in order to improve the environment for other industries too. For the most part foundries are not particularly large-scale or high-technology industries, but entry barriers arise from skills and learning economies and/or logistical costs, depending on the grade or precision of castings involved. Figure A.4.1 shows various sub-supply industries arrayed according to skill levels and logistics costs. In low-grade castings (e.g., manhole or drain covers), the high logistics costs in relation to value-added give a degree of natural protection in the local market against distant competitors, and the relatively low skill levels also make this industry fairly easy to develop but because it is virtually non-traded little development is feasible beyond meeting local demand. In precision castings (e.g., engine or machine parts), on the other hand, the need to build a considerable concentration of skills which take time to acquire poses an entry barrier. And since logistics costs are lower, companies which have acquired the skills (generally supplying local customers initially) often become substantial exporters. The skill factor also provides a defensible position against low-wage developing countries (Telesis, 1982, p.

Figure A.4.1: Competitive Economics of Sub-Supply Industries



Note: Quantification of each axis is derived from confidential company data which cannot be published.
Source: Telesis, (1982), Exhibit 3.48.

54, 116). This type of industry would be desirable for Irish firms to develop further, and it could be feasible provided that sufficient support is made available to help firms through the early years while skills and markets are developed. It is worth noting, too, that concentration ratios and firm size are lower in non-ferrous foundries than in iron and steel foundries, so non-ferrous foundries of a competitive size should be easier to develop.

Forging, Pressing and Stamping (NACE 312)

This industry appears to be fairly similar to Foundries in most respects discussed above, although there may be a lower proportion of skilled precision activities. Also, economies of scale would probably create major entry barriers in automotive stampings since in the USA that industry is highly concentrated in large firms, and non-ferrous forgings is also a highly concentrated industry although the top firm's are not large.

Secondary Transformation, Treatment and Coating of Metals (NACE 313)

In this group of industries, entry barriers due to scale, skills or technology are generally low. Many of these activities are sub-supply or sub-contract industries which may depend on close contact with customers and consequently supply only quite limited local markets. These sub-supply industries probably cannot be developed a great deal further by Irish firms except in meeting local demand but they may nevertheless be important to develop as part of the infrastructure for other industries. Other industries in this sector which are more highly traded internationally, such as screws, bolts, nails, springs and chains, are vulnerable to low-wage competition from developing countries, as Irish firms have found (Telesis, 1982, p. 95) and so they do not seem particularly attractive.

Structural Metal Products (NACE 314)

In this industry, too, entry barriers arising from scale, skills or technology are generally low to moderate. There is quite a substantial degree of natural protection in local markets against distant competitors, arising from logistical costs (see the position of structural steel in Figure A.4.1) and often from a need for on-the-spot contact with customers, e.g., in erecting the metal structures concerned. Thus this industry is already well developed by Irish firms and, apart from some limited scope for further import-substitution or exports to the UK, probably not much more can be expected here than growth in line with domestic demand.

Boilermaking, Reservoirs, Tanks, Sheet-Metal Containers (NACE 315)

This industry, again, presents only relatively minor entry barriers due to scale, skills or technology and it tends to be sheltered by transport costs (Telesis, 1982, p. 109). So it is quite well developed by Irish firms supplying the local market and there is probably only limited scope for further import-substitution or exports to the UK.

Tools and Finished Metal Goods (NACE 316)

There are relatively low entry barriers here too for the most part, exceptions being small arms and ammunition which are highly concentrated industries in the USA although the top firms are of fairly moderate size. Some of the products in this sector, such as metal boxes or radiators are also quite sheltered or "non-traded" due to transport costs, so there may still be some scope for relatively easy import-substitution by Irish firms. Most of the products here, however, are internationally traded and, combined with low entry barriers, this can make them vulnerable to competition from low-wage developing countries, as some Irish firms have found in industries such as cutlery, simple agricultural implements and fasteners. However, there might be scope here for further development by Irish firms if attention is paid to product differentiation, quality and marketing strategies, perhaps particularly in consumer products where these things count, e.g., household or garden equipment.

Mechanical Engineering (NACE 32)

Agricultural Machinery and Tractors (NACE 321)

In this sector, taken as a whole, barriers to entry arising from scale, skills and technology appear to be about average among engineering industries, but there is a major divide between the larger more complex items, particularly tractors and combine harvesters, and the rest. Both the detailed (5 digit level) US data and Heath *et al.* (1975) indicate that production of tractors and combines is highly concentrated in large firms and, therefore, probably out of reach for Irish indigenous industry. Much of the rest of the sector, including the related lawnmowers and garden equipment industry, appears to be more accessible to Irish firms on grounds of scale, with skills and technology presenting moderate entry barriers but also making for a defensible position against developing countries if the barriers are overcome. Some of the larger-scale developments to date in Irish indigenous Mechanical Engineering have been in this industry, including companies making (and sometimes exporting) beet and vegetable harvesters, dairy equipment and peat harvesting machinery. But, as Telesis (1982) concluded, most companies still have an insufficient scale and resources to develop new products, adapt them to suit a range of export markets (beyond the UK) and sell them in a range of markets.

Considerable further development here may well be possible with a focused and sustained effort to develop some firms above this threshold and, indeed, if it cannot be done in this industry, it is difficult to say where else significant development of internationally traded indigenous engineering is more feasible.

Metal-Working Machine Tools; Tools and Equipment for Use with Machines (NACE 322)

Although even the top companies in the machine tools industry are often not very large, there are considerable entry barriers arising from skills and learning economies and also increasingly from application of advanced technology (despite the rather moderate R & D indicator given in Table 8.2 which really reflects *all* of Mechanical Engineering). A further difficulty with trying to develop a machine tool industry is that it tends to be regarded by large countries as a key strategic sector since it influences the competitiveness of many other industries through the efficiency and price of its products which are important inputs for the others. Thus they are keen to foster and support this industry and it has been a focus of particular attention in Japan (Magaziner and Hout, 1980) and more recently Korea (*Financial Times* survey, 9/4/86). Furthermore although both the EEC and US data in Appendix 3 suggest that this industry is not very highly concentrated in large firms, the concentration ratios for more finely defined segments (at the US 5 digit level) within the industry are generally a good deal higher, indicating that there are oligopolistic industry structures which could cause greater difficulties for new entrants than the size of firms suggests. Thus US 8-firm concentration ratios of about 60 to 90 per cent are found in nearly all branches of the machine tool industry defined at this level, with much less concentrated exceptions occurring in parts for machine tools, rebuilding of machines, machine tool accessories, and special dies, tools and jigs.

This suggests that if there is a way for Irish firms to get into this industry significantly, it could be by starting with parts such as precision toolmaking and/or refurbishing of machines, perhaps with the ultimate aim of somewhat greater vertical integration. In any case, the components industries, such as precision toolmaking, are worth developing in their own right and there has been some progress in this among Irish firms which could be built on further. In this type of skilled labour-intensive industry, as in precision castings or forgings, skill levels and the ability to produce high quality products in the minimum time are the key to success, so learning economies present initial barriers for new entrants but this could be overcome by supporting firms initially while skills are being perfected.

Textile Machinery, Sewing Machines (NACE 323)

In textile machinery, again, skill levels and learning economies are an important source of entry barriers (but also defensibility against developing countries), and companies are not only of moderate size but concentration also seems lower than in machine tools. There may be openings here for Irish firms, given focused initial support in the early years, and a way in might be found by starting with components and/or refurbishing of machines, and then progressing to greater vertical integration.

Sewing machines is a highly concentrated industry with relatively mature products in which scale and length of production runs are important factors which would tend to suit large established producers or large NICs more than Ireland.

Machinery for the Food, Chemical and Related Industries (NACE 324)

In this group of industries, which mainly produce process plant and machinery, scale is generally low to moderate, while high levels of skills, both manual and white-collar (presumably because of a good deal of design work), indicate significant entry barriers arising from learning economies. It is worth noting too that there are high 8-firm concentration ratios of over 60 per cent in the USA in a few segments (at the 5 digit level), including dairy products machinery, chemical machinery and rubber-working machinery.

For the most part, these would be desirable industries for Irish firms to develop, with scale at least presenting relatively minor difficulties. The main barriers are in the development of specialised skills, which takes time and can mean initial losses, and in attaining a significant share of often quite specialised or customised markets to keep per-unit design and production costs competitive. Again, a phased type of entry/development strategy may be possible here starting, for example, with design of a specialised process plant and moving on to production of an increasing proportion of the modules of the plant, and then widening the range of types of plants, or some variation on these steps.

Machinery for Mining, Iron and Steel Industry, Foundries, Construction; Mechanical Handling Equipment (NACE 325)

In this group of industries, as in most of Mechanical Engineering, a relatively high level of skills, especially manual skills, is required so that there are entry barriers due to learning economies, while barriers to entry due to a large scale are, in some cases at least, less significant. Within the group, however, there are some industries which are dominated by a small number of large firms while some others are also highly concentrated although in smaller firms. These industries, for the most part, would be less suitable for Irish indigenous development whereas the others might be more readily undertaken. Thus in the USA, construction machinery is almost 60 per cent concentrated in 8 firms employing over 9,000 people each. Mining machinery is less concentrated and the top 8 firms employ only about 2,000 people each, but individual segments within the industry (at the 5 digit level) are oligopolistic with 8-firm concentration ratios in the range 62 to 81 per cent. And rolling-mill machinery is even more highly concentrated although the top firms are smaller. By comparison, foundry machinery and equipment and — even more so — mechanical handling equipment, particularly conveying equipment, hoists, cranes and monorails, are more fragmented and small-scale and could be quite suitable for Irish firms.

Transmission Equipment for Motive Power (NACE 326)

In this sector a large scale or long runs of production are generally important in ball and roller bearings, as seen in the US data in Appendix 3 and in data on other countries in Magaziner and Hout (1980, p. 12), and this industry is also capital-intensive. Telesis (1982, p. 121) also point out that the scale and market share necessary for competitive production of bearings presents very high entry barriers for Irish firms. But gears and other transmission equipment are smaller scale and more fragmented industries which could be suitable for Irish firms, again subject to the problem of overcoming barriers arising from skill levels and learning economies. Custom made gears is rather similar in skill levels to precision castings, for example (see Figure A.4.1) and it could be comparably suitable as a potential growth industry for Irish firms which would be defensible against low-wage competition.

Other Machinery for Use in Specific Industries (NACE 327)

In this group of industries, as in most of Mechanical Engineering, skill levels and learning economies would again present significant entry barriers, which might possibly be overcome with sustained support. Even the top firms are generally not very large, however, although in some cases there is a high degree of concentration, which probably presents an aspiring entrant with the attendant problem of having to gain a substantial market share to be competitive. Very high 8-firm concentration ratios (in excess of 80 per cent) are found in the USA in home woodworking machinery (but not other woodworking machines) and in several types of printing machinery. Telesis (1982, pp. 61, 62, 143) also make the point that for industrial machinery sold in relatively small quantities, where each customer purchases infrequently, the performance and operation costs of each new product generation generally sells the product, rather than a low selling price. This puts a premium on strong innovation and technological capabilities in such industries, which would create further entry barriers for newcomers unless, perhaps, licensed technology can be acquired from a firm not aiming to compete in the same markets. Industries referred to by Telesis as typical of this sort include paper machinery, which is in this sector (as well as steel rolling mills and jet aircraft which are in other sectors). Nevertheless it might be worth examining some industries in this sector as potential areas for Irish development.

Other Machinery and Equipment (NACE 328)

This is quite a diverse group of industries which, taken as a whole, seem fairly typical of Mechanical Engineering, with relatively high skill levels but relatively moderate scale and limited penetration by low-wage countries. One industry among the group which seems least attractive for Irish firms on grounds of high concentration in large firms is internal combustion engines, while to a lesser extent the same is true of compressors, and part of air-conditioning and refrigeration equipment. Among the other industries in the group, however, there appear to be some that would be worth examining as potentially suitable for Irish firms.

Office and Data Processing Machinery (NACE 330)

Office & Data Processing Machinery, based on rapidly developing technology, has been the fastest growing engineering industry for some time and continuing fairly rapid growth is generally expected. If for no other reason, this makes it a very attractive industry to develop, but from the point of view of Irish firms there are unfortunately major obstacles to significant involvement. Concentration in large firms, very high levels of specialised white-collar skills, very high R & D intensity, and often special government support in large countries combine to create exceptional entry barriers for new or small firms in a small peripheral country such as Ireland, at least as regards the principal types of products.

Leaving aside computing equipment for the moment, the more technologically mature products such as typewriters, copiers and other office machines are very highly concentrated in large firms. The same is true of calculators, although the top firms are not quite so large, and a further competitive difficulty here is successful penetration by NICs as the technology has matured. In computers, the level of concentration in large firms, large R & D costs and high levels of specialised white-collar skills present an intimidating combination of entry barriers. As a National Board for Science and Technology (1983) discussion document concludes, the best chance for Irish indigenous development is likely to be in more specialised niches, involving specialised *applications* of the major advanced technologies developed elsewhere at great expense, or the combination of high-technology products in new *systems* with specialised applications (see also O'Brien, 1985). Specifically the NBST pointed to specialised small business computing systems and specialised terminals as areas offering suitable opportunities.

Electrical Engineering (NACE 34)

Insulated Wires and Cables (NACE 341)

This industry is one of the more highly concentrated in large-scale firms, suggesting that there are significant entry barriers due to scale, with only moderate levels of white-collar skills, mature technology and relatively low manual skills. It appears to be one in which large NICs could make greater progress. There would be little here to recommend it as being of particular interest for Irish firms but for the fact that there is an existing large company in the industry which was originally foreign-owned but has recently been taken over by Irish owners. This company, which makes some other products as well, exports cables successfully to Britain, partly aided by a degree of protection against non-UK competition because of differences in specifications and standards (Telesis, 1982, p. 100). Given the scarcity of Irish involvement in large firms, it would be worth considering whether a company of such a size (employing over 1,000), and with a relatively successful record could be built on further, and what sort of incentives or assistance would be needed to do so.

Electric Motors, Generators, Transformers, Switches, etc. (NACE 342)

The industries in this group are again rather highly concentrated in large-scale firms, with moderate skill levels. This is a combination which, for the most part, suggests significant entry barriers arising from economies of scale and potential development by large NICs, and indeed the developing countries are relatively strong in this sector. There may, of course, be some scope here for development by Irish firms in smaller-scale specialised products, but for the most part it does not look particularly promising.

Industrial Electrical Equipment; Batteries and Accumulators (NACE 343)

The production of batteries is a very highly concentrated industry, in firms of a fairly large size, or very large by present Irish standards. This makes it unattractive as an area for development by Irish firms. Among the other industries here, however, there may be a few fairly suitable products where the demands of scale are not too great; a relatively high level of white collar skills and perhaps R & D intensity seem to be fairly significant sources of entry barriers, however, which would need to be considered.

Telecommunications Equipment, Electrical and Electronic Measuring Equipment, Electro-Medical Equipment (NACE 344)

These are advanced technology industries, greatly affected by rapid developments in electronic technology, so that there are generally high levels of R & D intensity and specialised white-collar skills. The major products in telecommunications equipment are also highly concentrated in large firms, and there is often "hidden" protection in the form of public procurement policies favouring domestic manufacturers. A few fairly sizeable Irish firms have already emerged in this industry, in fact, initially on the basis of contracts from P & T/Telecom Eireann, and this is a process which might be repeated. The NBST (1983) suggests that there may be some suitable niches for Irish firms here, e.g., in subscriber add-on equipment, or in specialised security systems and equipment, subject to building up the necessary expertise which might require concentrated programmes with initial state support. Electro-Medical Equipment is generally somewhat more fragmented in smaller-scale firms and may also offer some specialised niche opportunities if a concentration of relevant expertise can be developed.

Radio and TV Receivers, Sound Reproducing and Recording Equipment, Electronic Equipment (except computers), Records and Tapes (NACE 345)

The consumer electronics industries here are mostly more technologically mature and a good deal less R & D intensive than much of the rest of electronics, so technological entry barriers are not great. But they are highly concentrated in firms of quite a substantial size. Furthermore, since a low level of labour skills is required, and licensed technology has been available for some time, developing countries have moved strongly into these industries. For these reasons, consumer electronics seems largely unattractive for Irish firms. The NBST (1983) reached a similar conclusion on consumer electronics.

Domestic-Type Electrical Appliances (NACE 346)

A high degree of concentration in firms of a substantial size in most types of household electrical appliances indicates that economies of scale create significant entry barriers here. Product differentiation and brand identification also play a part in protecting the strength of established firms in these consumer industries, thereby creating further difficulties for potential new entrants. Nevertheless, since skill levels are relatively low and there is no great need for advanced technological capabilities, large NICs have been able to penetrate these industries with the initial aid of protection, sometimes producing appliances for known brand names.

Whereas nearly all the product groups in this sector in the USA are very highly concentrated, with 8-firm concentration ratios of 80 per cent or more, small electric housewares and fans is something of an exception with a lower ratio of 59 per cent. This industry includes nearly all of the products made by Glen Dimplex, the largest Irish-owned firm in the private sector in Metals & Engineering. So, while it would not have been particularly easy to succeed in this industry, the chances here were certainly better than in the major appliances. In view of the relatively small number of successful large Irish firms, it would be worth considering whether, and how, the established position and success of such a company can be built on further with a greater benefit for Irish employment, i.e., by expanding production more in Ireland as opposed to the more commercially attractive route of takeovers abroad.

Electric Lamps and Other Electric Lighting Equipment (NACE 347)

The production of electric light bulbs and tubes is a highly concentrated large-scale industry which would pose significant entry barriers arising from scale. But both residential and commercial lighting fixtures are fairly fragmented among small to medium-size firms. Since skills and technological capabilities are not at particularly high levels either, entry into these industries may not be excessively difficult. This means, however, that competition from developing countries has become a fairly significant feature, but it should still be possible to build a defensible position here by attention to design, quality and focused marketing and distribution. Waterford Glass has done so, for example, in its own rather distinctive way, and there should be other ways of going about it.

Motor Vehicles, Parts and Accessories (NACE 35)

Manufacture and Assembly of Motor Vehicles and Motor Vehicle Engines (NACE 351)

This industry, as was noted already, is very highly concentrated in very large firms, which creates major entry barriers. This is true virtually of all cars and vans, except for very small highly specialised niches, and also (although to a lesser extent) of lorries, buses, etc., where the manufacturers make their own chassis. But there are also special-purpose vehicles such as ambulances, fire tenders, etc. (which, depending on the degree of vertical integration, may be classified under the next industry heading), in which quite small firms can succeed. A few Irish firms have appeared here and it may be possible to build further on this by diversification. It is worth noting, too, that state purchasing played a role in providing the initial market for Irish production of armoured cars and fire tenders, which suggests a lesson for future strategy.

Vehicle Bodies, Trailers and Caravans (NACE 352)

This is a much smaller-scale, more fragmented (and, in some cases, virtually "non-traded") industry, involving building of vehicle bodies for direct sale or for sale as a complete vehicle on a purchased chassis. Some Irish firms are already engaged in this and it may be possible to develop it further by diversification, since there is quite a range of specialised possibilities, and perhaps to proceed to somewhat greater vertical integration.

Parts and Accessories for Motor Vehicles (NACE 353)

Much of this sector is highly concentrated in quite large firms and would not be easy to break into, particularly in the case of the major components. But there are likely to be significant opportunities in some parts and accessories (and indeed several expert observers offering comments on earlier drafts of this paper specifically mentioned opportunities in this sector). Refurbishing of engines and parts for motor vehicles is also a niche possibility which is quite small-scale and fragmented, and it could be worth looking into.

Other Means of Transport (NACE 36)

Shipbuilding (NACE 361)

Shipbuilding, again, is mostly concentrated in large firms so there are entry barriers due to economies of scale. In addition, there has been chronic excess capacity for some time as growth has been slow or negative, and some of the large NICs (and Japan before them) have moved strongly into this sector. Consequently competitive conditions are intense and profitability has been low or negative for the majority of companies. For the most part, therefore, shipbuilding looks unattractive for Irish firms. Possible exceptions are in shipbreaking or repair, which can be smaller in scale, but these would need to be looked at carefully since competition also appears to be quite intense. A considerably more attractive exception which is also in this sector, is boat building, which is much more fragmented and smaller in scale.

Railway and Tramway Rolling-Stock (NACE 362)

This industry, too, is mostly highly concentrated in large firms, and a high level of manual labour skills suggests that learning economies are probably another source of entry barriers. Hence this would normally not be an easy industry for Irish firms to succeed in, but one should take account of the fact that there is an existing basis which might be built on further. CIE has quite a substantial pool of skilled workers already in place, and there is also past experience of purchasing by CIE assisting the growth of small private companies making railway bolts and shunting locomotives (Telesis, 1982, p.

124). There may well be further scope to develop competitive production of relatively specialised products, whether in CIE itself or in other companies assisted by CIE orders initially.

Cycles and Motor-Cycles, Including Parts and Accessories (NACE 363)

The world motor-cycle industry is highly concentrated in large firms, particularly in Japan which accounts for over 60 per cent of the exports of market economies. Since the technology is quite mature and the main entry barriers arise from economies of scale, this is also an industry in which large NICs may become more prominent (India and South Korea are already exporters of some significance). So motor-cycles does not look very attractive for Irish firms.

The bicycle industry is also highly concentrated, but firms are a good deal smaller. Furthermore, although quite a small number of the largest firms are dominant with large market shares, it is possible for much smaller firms to survive with small market shares. For example, in the UK in the early 1970s, Raleigh accounted for 80 per cent of production while 11 other firms, employing a total of a few thousand people, shared the rest of the market (Pratten, 1971, Ch. 16).This structure is accounted for by a combination of diversity of products (in size, style, etc.) and differing economies of scale for different components and processes. The largest firms design and assemble a wide range of models and make virtually all the components for them, while smaller firms stick to a narrower range of models and buy in any components in which large-scale production is needed; in other words, there are different strategic groups within the industry based on the key dimensions of breadth of product range and extent of vertical integration. There should be ways in here for Irish firms, e.g., by starting with a narrow product range and low vertical integration and proceeding to wider ranges and greater vertical integration.

Aerospace Equipment, Including Repairing (NACE 364)

With a very high degree of concentration in very large firms, very high R & D intensity and high levels of skill, Aerospace, including virtually all the industries within the sector, presents exceptionally difficult barriers to entry. Preferential state purchasing of military aircraft, missiles and space vehicles from domestic manufacturers in large countries gives further advantages to large established producers, e.g., in attaining greater economies of scale in R & D, engine production or production of parts of aircraft. For all these reasons, there seem to be major obstacles in the way of significant development of an Irish aerospace industry, at least in the major activities. Yet Aer Lingus is established in overhaul and maintenance of aircraft and engines, which is a relatively small niche within the sector but is nevertheless sufficiently large to make Aer Lingus the largest employer of engineering workers in Ireland and the source of over 20 per cent of indigenous engineering export earnings (Telesis, 1982, p. 131). Further developments here, building on the established concentration of skills, may be possible in making some aircraft or engine parts and accessories, refurbishing of aircraft for the substantial second-hand market, or contract work in building parts of aircraft or engines. In addition, there should be some suitable specialised niches which can be exploited further through Ireland's membership of the European Space Agency and industrial participation in Arianspace.

Instrument Engineering (NACE 37)

Measuring, Checking and Precision Instruments and Apparatus (NACE 371)

Most of the industries in this group are relatively fragmented in firms of moderate size, except for automatic temperature controls, fluid meters and counting devices, motor vehicle instruments and some electricity measuring instruments, which are quite highly concentrated, in the USA at least. The main entry barriers arise from the need for strong technological capabilities and specialised white collar skills. These high-growth, high skill industries would be desirable to develop in Ireland, and not particularly costly in terms of capital investment. But the main difficulties arise in establishing a concentration or "critical mass" of skills and expertise and in sustaining firms through the period required to benefit from learning economies, which might be done with the help of concentrated programmes and initial state support. It may well be possible, too, to use purchasing by public sector bodies such as Telecom Eireann, the ESB or RTE to assist the development of such industries, as has happened with some other sectors mentioned above.

Medical and Surgical Equipment and Orthopaedic Appliances (NACE 372)

The industries in this group share much the same characteristics as those in the previous sector (NACE 371), except that a higher level of manual skills seems to be necessary, so much the same conclusions apply. One very highly concentrated exception here is electronic hearing aids. Since most health services are part of, or largely financed by, the public sector, it would again be possible to use public sector purchasing in assisting the development of some of these industries.

Optical Instruments and Photographic Equipment (NACE 373)

Photographic equipment is very highly concentrated in large firms and would mostly be difficult to break into. The potential for development in optical instruments looks rather better than this, but less attractive than in most other Instrument Engineering industries for two reasons. There is a somewhat higher level of concentration in a small number of firms and there are signs of somewhat greater penetration by NICs. Nevertheless some of the product groups could be worth investigating.

Clocks and Watches (NACE 374)

This industry seems to have relatively low entry barriers with respect to scale, skills and technology, but the corollary of this is that there is very strong competition from developing countries which account for about one-third of the exports of market economies — more than in any other engineering sector. Companies in high-wage developed countries still survive, of course, largely by concentrating on quality and style at the higher end of the market and perhaps also due to established strengths in marketing and distribution. While there may be some possibility of development here by Irish firms, the competitive conditions appear to be quite intense, making this industry a generally unattractive proposition.

Small-Scale Industries and Geographical Concentration

Finally, there are a few general points worth making about small-scale fragmented industries. These industries are of some interest because they appear to present the least significant entry barriers in the form of economies of scale, even though they might present other types of entry barriers. Thus they might, at first sight at least, be among the easiest ones for Irish firms to develop further. On closer examination, many of these industries appear to be largely sheltered or virtually non-traded, so that they are fragmented among geographically dispersed small-scale firms supplying limited local markets. Others are specialised sub-supply or sub-contract industries which mostly operate in close contact with larger purchasing industries and they tend to be a good deal more geographically concentrated in large engineering centres. And there are others which fall into neither of these groups. If we take, for example, the 51 American engineering industries with 8-firm concentration ratios below 40 and average employment in the top 8 firms below 2,500, there are adequate data to analyse the pattern of location by State in the USA in the case of 35 of them.

We can calculate an index of geographical concentration for each of these 35 industries, derived by first calculating the percentage of value-added in each industry in the USA accounted for by the 4 States with the largest value-added in the industry concerned. Then, in order to minimise the distortion caused by large variations in the size of total manufacturing in different States, the percentage share of the top 4 States in the industry concerned is divided by the share of those 4 States in total US manufacturing value-added. Thus an index of 1 calculated in this way would mean that the industry is widely dispersed, being no more concentrated in the top 4 States than the share of those States in manufacturing as a whole; an index of 2 would mean that the top 4 States have twice as large a share of the industry concerned as they do in all manufacturing. These indices, for 35 of the small-scale fragmented industries in the USA, are as follows:

Index	*Industry*	*Type*
2.63	Iron and Steel Forgings	Sub-supply
2.48	Industrial Patterns	Sub-supply
2.45	Screw Machine Products	Sub-supply
2.35	Industrial Furnaces and Ovens	
2.33	Metal-Forming Machine Tools	
2.25	Special Dies, Tools, Jigs, etc.	Sub-supply
2.1	Non-Ferrous Foundries nec	Sub-supply
2.08	Residential Lighting Fixtures	
2.04	Fabricated Pipe and Fittings	
.1.95	Steel Pipe and Tubes	
1.85	Primary Metal Products nec	
1.83	Bolts, Nuts, Rivets and Washers	
1.82	Aluminium Foundries	Sub-supply
1.76	Metal Heat Treating	Sub-supply
1.76	Food Products Machinery	
1.72	Measuring, Controlling Devices nec	
1.71	Conveyors and Conveying Equipment	
1.68	Special Industrial Machinery nec	
1.66	Plating and Polishing	Sub-supply
1.61	Engineering, Scientific Instruments	
1.6	Metal Coating and Allied Services	Sub-supply
1.6	Hoists, Cranes and Monorails	
1.59	Noncurrent-carrying Wiring Devices	
1.52	Brass, Bronze, Copper Foundries	
1.44	Heating Equipment, except Electric	Metal Fabrication
1.42	Prefabricated Metal Buildings	Metal Fabrication
1.41	Steel Wire and Related Products	
1.4	Architectural Metalwork	Metal Fabrication
1.4	Lighting Equipment nec	
1.39	Fabricated Metal Products nec	Metal Fabrication
1.29	Miscellaneous Fabricated Wire Products	Metal Fabrication

Index	*Industry*	*Type*
1.26	Blowers and fans	
1.21	Sheet Metalwork	Metal Fabrication
1.2	Metal Doors, Sash and Trim	Metal Fabrication
1.06	Fabricated Structural Metal	Metal Fabrication

There is quite a wide range of geographical concentration here and some definite patterns are apparent in the make-up of the list. First, there are a number of metal fabrication industries grouped towards the end of the list, 4 of them being structural metal. The fact that these industries are widely dispersed in location is a reflection of the fact that they produce items which may have to be customised for particular customers, or which involve an element of on the spot service such as construction, as well as being heavy relatively low-value products, so that logistical and transport considerations make them virtually "non-traded". This tends to cause them to be geographically dispersed, in line with the pattern of location of customers. Since the technology is relatively simple and they do not need a pool of very specialised skilled labour, there are no strong forces of external economies constraining this dispersal. Relatively small-scale, non-traded industries such as these should be easiest for late-industrialising countries to develop and indeed this type of industry (which is part of Manufacture of Metal Articles) has already proved exceptionally successful in Irish indigenous industry. To the extent that we are still importing some of these products, the indications are that there may be scope here for some relatively easy import-substitution, with the help of a degree of natural protection against imports. However, this scope is probably fairly limited by now and substantial export development of these types of products is not really in prospect.

Possibly of more interest, for examination as prospects for development in industries which are not yet very strong in Ireland, are the remaining industries included towards the bottom end or the middle of the list — industries such as blowers and fans, lighting equipment and fixtures, hoists, cranes and monorails, engineering and scientific instruments, and food products machinery. It is quite likely that learning economies or marketing could pose entry barriers to new entrepreneurial investment in some of these, but that could be overcome with a sustained and concentrated commitment backed by the state. Furthermore, *some* relatively moderate entry barriers due, for example, to skill development, technological expertise or marketing, is not really a bad characteristic for an industry we would aim to develop, since we need industries which are defensible against very low-wage unskilled competition.

The top end of the list above shows the small-scale industries which are highly concentrated geographically within the United States. One type found here is certain sub-supply or sub-contract industries which appear to be concentrated around the industries which are their main customers. This would occur because they arose out of close contact with the customers, and there may still be advantages in this in order to respond flexibly to diverse demands and/or because their products may be relatively low in value and costly to transport. Some of these sub-supply industries, e.g., special dies, tools and jigs, would also depend on specialised skills which are in good supply in concentrated centres of engineering, but not elsewhere. The same consideration no doubt affects some other industries near the top of the list, such as metal-forming machine tools.

Admittedly, the analysis of geographical concentration used here is a rather crude and indirect indication of the existence of external economies of the type just mentioned. But it can at least serve as a warning that the geographically concentrated small-scale industries may be unlikely to develop substantially in a region without major integrated engineering centres, such as Ireland is by comparison with the more advanced industrial countries. It might well require a planned and selective effort to develop the specialised skills involved, or to link up skilled sub-supply industries with major customers at home or abroad.

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