THE INTERINDUSTRY STRUCTURE OF IRELAND, 1956-1982:
IMPLICATIONS FOR ECONOMIC DEVELOPMENT AND INDUSTRIAL POLICY

by

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ABSTRACT

This thesis addresses issues of industrial structure and industrial policy in Ireland, and develops applications of interindustry (input-output) analysis for assessing structural change and interindustry relationships. The development of Ireland's industrial structure is explored historically, and it is argued that the focus of industrial policy in Ireland has shifted from developing large, global markets for standardized goods (produced largely by foreign multinationals in Ireland) to developing niches in the European market for high-quality specialized Irish goods.

It is further argued that the demonstrated emphasis in Irish industrial policy on value added and local supplier networks suggests future changes in Ireland's industrial structure. Interindustry analysis is proposed as an initial approach to understanding Ireland's industrial structure. Previous applications of interindustry analysis in industrial development are reviewed, and interindustry analysis itself is explained and critiqued. Economic indicators are derived from two matrices of technical coefficients and their inverses, and are the basis for an intertemporal interindustry analysis using Irish input-output tables for the years 1956, 1964, 1968, 1969, 1974, 1976, 1978 and 1982. The comparative analysis shows changes in forward and backward linkages, value added, imports, exports and intermediate and final markets for six industrial sectors. Finally, three manufacturing industries--food, textiles and metal/engineering are analyzed in terms of their direct and total requirements and intermediate and final markets.

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THE INTERINDUSTRY STRUCTURE OF IRELAND, 1956-1982:
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INTRODUCTION

In addition to beautiful countryside and hospitable people, the visitor to Ireland is struck by many development dichotomies. Subsistence-level agricultural production, a limited endogenous technological capacity, a weak industrial infrastructure and imported basic commodities coexist with plant closings, high unemployment and other signs of disinvestment.

Its small size and peripheral relationship to Europe has made Ireland vulnerable to shocks and shifts in the European market. In response to these conditions, efforts to industrialize over the past several decades have been successfully directed toward foreign multinationals. The government has continuously tried to attract foreign firms in growing, global industries to check both employment and balance-of-payments instability in Ireland. New computer-assembly plants and closed textile factories reflect both the successes and failures of this policy. And the isolated nature of these factories often reflects the low degree of integration into the Irish economy, and a continuously changing structure of foreign industrial production superimposed on an unchanging structure of local production.

Ireland is also a country of traditional and firmly rooted national institutions. These institutions often appear rigid,
as well as uncooperative with one another. One frequently hears managers in Ireland express frustration with the lack of entrepreneurship in Ireland and the view that Irish institutions are stifling Irish enterprise.

The institutional rigidity and lack of cooperation, however, and the role of multinationals in the Irish economy appear to be changing. A new Irish industrial policy is coordinating educational, industrial, governmental and financial institutions to promote technological advancement and inter-firm and inter-industry linkages in Ireland. Efforts to better integrate industrial development and technological advancement with Ireland's traditional agriculture and food sectors are also evident. One interesting example of this is Ireland's recent proposal to the ESPRIT program of the EEC to develop robotics for agricultural use.

All of this has led me to study industrialization in Ireland, and to look at industrialization through changes in interindustry structure. In so doing, I have become interested in the political and institutional process of industrial development in Ireland. This thesis is thus the result of my efforts to understand production in Ireland and to explore future institutional roles in the process of industrial development.

I have organized the thesis around five chapters. In chapter One, I develop the argument that recent institutional developments in Ireland are signs that a major shift is taking place in industrial policy. A policy designed to develop an industrial structure capable of producing high-quality,
technologically advanced Irish products for a diversity of niches in the large European market has replaced a long-standing policy that focused on integrated markets for the standardized products of foreign multinationals. I then describe the history of industrial development and industrial policy in Ireland. In Chapter Two, I introduce the application of input-output tools to industrial policy and development planning. In Chapter Three, I explore input-output tables and input-output analysis more technically, and develop a set of economic indicators for intertemporal comparison of industrial structure.

The results of this analysis are presented in Chapter Four. Finally, in Chapter Five, I discuss implications and derive conclusions from the analysis.
Recent Policy and Institutional Developments

In the summer of 1984, the government of Ireland issued its White Paper on Industrial Policy. In so doing, it set the stage for a pronounced shift from the industrial development policies of the past thirty years. These policies had been directed generally at developing industries for export, and more specifically at promoting Ireland as a manufacturing location for American and Japanese firms seeking to penetrate the European market, and European firms, looking for low-cost sites for assembly operations.

Such outward-looking, export-promotion policies, initiated in the mid-1950s, were themselves regarded as a significant departure, both in theory and practice, from industrial policies of the previous several decades (since the establishment of the Irish Free State). These were generally import-substitution policies which involved protectionist measures such as tariffs and quotas. The "opening up" of the Irish economy in the mid-1950s did indeed appear to be a fundamental departure from the former policies.

The outward-looking export-promotion policies and the inward-looking import-substitution policies are, however, really two sides of the same coin. Fundamental to each policy is the leading role of a market in the process of industrialization. In other words, the primary goal of both of these strategies was to establish a market that industrial
policy makers and planners believed to be most suitable for encouraging industrial development and growth in Ireland. Whether that market was purely domestic, regional, or global was the central issue underlying the industrial development strategies from the establishment of the state through to the late 1970s. Industrial policy makers based strategies on characteristics of markets—location, size, rate of growth, strength, and stability.

Inward policies, for example, were designed to develop a strong domestic market. This would develop along with the increasing scale of production in protected, "infant" local industries. Outward policies, on the other hand, were designed to integrate Irish industries into a wider, more competitive market. This would force local industries to become more efficient and thus more competitive. Under either orientation, the characteristics of the market would determine what is produced and how it is produced. Market characteristics, such as the frequency and scale of transactions, would determine the organization of production itself, and the overall industrialization process and the path of economic growth.

More importantly, industrial, political, and commercial institutions were developed to cater to a particular market structure. Indeed, they were assumed to be logical outcomes of a particular market structure and market orientation. Elsewhere, I have more fully developed the argument that inward and outward policies operated on the same principle, by looking closely at the theoretical debates between inward and outward proponents (Delmar, 1986).
Recently developed industrial policy in Ireland is designed to develop new relationships between firms and industries. It is geared toward developing a competitive industrial structure within Ireland, rather than new markets for goods produced in Ireland. Over the last several years, the government and financial and business communities have become concerned that, despite the increasing integration of Ireland into growing markets for manufactured products, Irish industry was suffering relative declines. Productivity, product quality, skill development and technological advancement were all abysmally low. These concerns have motivated the development of new policies, new institutions, and changes within existing institutions.

The new industrial policy aims to change the fundamental organization of industrial production in Ireland. Five specific goals reflect this: 1) to increase value added in production and promote skill development; 2) to foster inter-firm and inter-industry linkages; 3) to develop small firms in indigenous industries; 4) to develop research and development (R&D) capacity in Irish industry and in transnationals producing in Ireland; and 5) to promote technology transfer through joint ventures between Irish and foreign firms.

Institutional developments include the following:

- The National Software Center, established and designed to "increase the technical capability of Irish software companies and to improve the international image of Ireland as a location for software development" (Industrial Development Authority, 1985). The Center provides marketing services, R&D,
training and product development services to Irish software firms. It also seeks to negotiate joint venture agreements with foreign software firms.

- Centers of Excellence, designed to provide technical support to industries in robotics, biotechnology and electronics. Currently, support for the development and application of microelectronics has been established at the National Microelectronics Research Center in Cork and the Microelectronics Applications Center in Limerick.

- The National Linkage Program, designed to "develop a successful core of companies supplying components and materials to manufacturing industries so that the spin-off benefits arising from purchases by major companies may be retained" (IDA, 1985).

- An Irish standard specification for product quality assurance, established by the National Standard Authority.

Several new programs have begun within the Industrial Development Authority (IDA), Ireland's state-sponsored development institution:

- The Company Development Program, an approach to industrial development through the overall development needs of individual companies, rather than across-the-board industrial projects. The program is designed to assist established Irish companies in drawing up development plans covering all aspects of their operations and to provide appropriate resources -- grant assistance, expertise, international contacts -- to successfully implement these plans.

- Small Business Development Centers, designed to encourage
students and academics to establish businesses and to encourage the development of technology-based small businesses.

- Incubator units. The IDA provides facilities for small companies in the start-up stage.
- Enterprise Centers, which provide central management, secretarial and other support services for small companies involved in all types of business.
- New assessment criteria and procedures for IDA grants. The main criterion now for IDA investment is the value added generated from an industrial project, rather than on the number of jobs created. Success within the IDA product divisions is now measured by Irish expenditure generated rather than by the number of projects approved by the IDA Board of Directors.

These new institutional arrangements differ markedly from arrangements under previous industrial policies. For example, capital grants, designed to help Irish companies reap scale economies through greater production volumes, export subsidies and substantial tax breaks to transnationals were geared toward the establishment of a large, growing and relatively stable global market for Irish products. The IDA itself was created in 1950 and reorganized in 1969 (under the guidance of Arthur D. Little management consultants) in response to changing market conditions.

Charged with the mission of industrial development through market development, the IDA has emphasized Ireland's ability to service the production requirements of
transnationals and to offer free access to a large European market. The IDA promotes the young, well-educated labor force in Ireland and the country's access to the European Community (EC) to foreign industrialists through a well-planned marketing campaign, advertising abroad with these campaigns: "The Republic of Ireland: We're the Young Europeans"; "Twentieth Century Knowledge in an 11th Century University"; "People are to Ireland as Champagne is to France" and People are to Ireland as Oil is to Texas" (a columnist for the Irish Times recently pointed out the aptness of these latter metaphorical promotions--oil and champagne are the largest exports of Texas and France!). At the same time, the IDA has attempted to open up global and regional markets for Irish-owned firms.

The new institutional arrangements, however, are designed not to develop markets explicitly but to develop both a cooperative and competitive industrial structure within Ireland. These are clear signs that structure-building has replaced market-development as the industrial strategy in Ireland. The implications for the development of industries themselves, for institutional developments, and thus the process of industrialization in Ireland are potentially significant.

I would suggest that the White Paper of 1984 and the policies and institutional arrangements developed thereafter have introduced a shift in industrial policy in Ireland, from a market-based strategy to one based on structure. Further, I believe that a structure-based strategy is not only
appropriate but extremely neccessary for a small, late-industrializing country like Ireland. Trying to industrialize in a world of increasingly globalized and increasingly unstable markets for producer and consumer goods is no easy venture. Ireland is in a particularly challenging position. Its underdeveloped characteristics—the constant need for foreign exchange, the agricultural base, the lack of endogenous technological capacity—put it in competition with the world's undeveloped economies to attract foreign investment and the transfer of technology. Yet its industrialized characteristics—its well-developed educational, financial, legal and political institutions, for example—offer the potential for industrial innovation and a globally competitive industrial capacity.

The overall goal of Ireland's industrial policy is to develop this potential. The success of this policy will depend to a large extent on the ability of Irish institutions to a) coordinate functions to b) encourage and support a flexible, changeable industrial structure.

The foregoing must not be interpreted in a vacuum. A discussion of Irish industrial policy needs to be grounded in the industrial history of Ireland. I will thus provide a brief review of industrial development and industrial policy in Ireland.

Review of Industrial Development and Industrial Policy

Ireland gained its independence from Great Britain in 1922. For the first ten years after the establishment of the
Irish Free State, however, Ireland remained an economic and industrial colony to Britain. At this time, Ireland was an underdeveloped country with a small and narrow industrial base. Industrial production was concentrated in the distilling, brewing and food processing industries. Population was falling due to extremely high emigration, reinforced by the failure of industrial development.

There are many arguments as to why Irish industry failed to develop. Most arguments focus generally on British colonial policies towards Ireland. The colonial government's antagonistic measures taken against Irish industry in the 17th and 18th centuries and its later failure to develop industry in Ireland despite the scale advantages of British industry are held by many to be early deterrents to industrialization in Ireland (McAleese, 1985). Other views emphasize the regional imbalance of industry between the south of Ireland, Ulster and the midlands of Britain in the industrialization of the United Kingdom as a whole. Economic historian E.R. Green emphasizes the industrial strength of early nineteenth-century Ireland in textiles and tannery that was checked by the removal of protection in Ireland with the Act of Union in the nineteenth century, after which "Irish industry proved to be too feeble to long withstand English rivals." In his view, "it would seem incautious to go any further in suggesting that industrial decay was not to a large extent inevitable (Green, 1976). Still others believe industrialization in the south of Ireland never took off industrially because the dominant Catholic Church absorbed substantial amounts of capital,
whereas in Northern Ireland, capital was invested by Protestants in industrial enterprise (Cooney, 1985).

Formal studies and analyses of development in Ireland have focussed on questions pertaining to the availability and productivity of capital (McAleese, 1985a). Some studies have taken a historical materialist approach, where Ireland's development is viewed in the context of an evolving spatial division of labor of capitalist production (Perrons, 1981; Regan, 1980; Walsh, 1980). These studies attempt to show that Ireland has undergone a process of peripheral development, in which the direction and level of development has been controlled by "external factors originating in centers of capitalist power" (Walsh, 1980).

In any case, underdeveloped economic conditions, combined with a strong nationalist political movement at the time of independence, contributed to a tradition of interventionism in Irish industrial development. Comprehensive import-substitution policies were enacted in the 1930s, replacing an initial period of more selective protection. The government provided tariffs and quotas to a wide range of import-substitution industries (such as footwear and clothing, textiles, light metal manufacturing, glassware) and legislated the Control of Manufacturers Acts. These were intended to ensure that import-substitution industries were Irish owned and controlled. In the words of Dermot McAleese, economist at Trinity college, Dublin, "it was seen as essential that a cadre of Irish entrepreneurs should be encouraged into existence by the lure of a guaranteed home market" (McAleese,
The protection system incurred a strong anti-export bias, however, and prevented any dynamism from developing in the Irish economy, according to McAleese. Other countries obtained necessary dynamism by specializing production within industries and by exploiting export-market opportunities (McAleese, 1985).

Following the introduction of strong protectionist policies in the 1930s, manufacturing employment grew rapidly for two decades, from 62,000 in 1931 to 140,000 in 1951. The average growth rate during this period was 4.2% a year, while labor productivity grew by only 1.4% during the period (O'Malley, 1985). Sales in the protected industries were concentrated on the small and protected domestic market and few industries were able to compete on the export market. Ireland in 1950 still had a relatively backward industrial sector, illustrated by the composition of manufacturing output: 64% of total manufacturing output was food, drink and tobacco, textiles, clothing and footwear, and wood and furniture. Metals and engineering contributed 13% and chemicals 4% (Farley, 1973). Farley's study shows that Metals and engineering production was concentrated in tools and implements and motor-vehicle assembly. The bulk of industrial output came from within limited-processing manufacturing sectors, or industries which take on importance at the early stages of industrialization.

Export and import composition also reflect Ireland's relatively backward industrial development in 1950. Of total
exports, primary exports constituted 57.9%, and limited-processing manufactures 22.9% (37.4% and 25.3% were attributed to live animals and food manufactures, respectively). Advanced manufacturing accounted for only 6.8% of exports. On the import side, limited-processing manufactures accounted for 4.1%, primary products 41.6%, and advanced manufactures 51.3% of total imports (Farley, 1973).

The shift in industrial policy to an export orientation began in the mid-1950s. This was initiated with the creation of the IDA, but the reorientation of policy became more pronounced with the publication of a government document entitled "Economic Development" followed by the government's introduction of the Program for Economic Expansion. The document, and the program based on it, emphasized the need for export expansion, increasing output and productivity, and larger inflows of foreign capital (Farley, 1973). While general incentives to promote export industries and to attract foreign investment were introduced in the 1950s, the removal of protection began in the mid-1960s.

Export promotion began with government grant programs, which steadily expanded along with tax incentives. The first grants were provided with the creation of An Foras Tionscal, an institution empowered by the Irish government to give grants up to 100% of the cost of land, buildings and the training of workers, and up to 50% of the cost of machinery and equipment. Grant aid expanded progressively from a selected regional base to nationwide coverage, and from assistance for specific types of assets to a wide variety of
grant types.

Tax incentives given by the government to encourage industrial investment began in 1956 with the granting of a 50% tax remission on profits earned on increases in export sales over the previous year. Incentives were continually expanded over the following 25 years--time periods of tax remission were extended, assets and locations for depreciation widened, plant and machinery allowances were increased.

Most of these export-promotion policies were implemented through specially created institutions. Two institutions that have had the greatest effect on export promotion in Ireland are the Shannon Free Airport Development Company (SFADCO) which oversees the Shannon Free Airport Enterprise Zone, and the Industrial Development Authority (IDA). SFADCO was created and empowered to make grants up to 50% of the cost of machinery and equipment to companies investing in the Shannon enterprise zone. It also provided training grants and factories for lease. The free-trade zone is the embodiment of export-promotion policies. With the creation of the Shannon zone and SFADCO in 1959, the first of numerous free-trade zones internationally was established in Ireland.

The IDA, established in 1950, gradually took control of the administration of grants for industrial projects and the promotion of new products in Ireland. Through the IDA, additional incentives were developed and implemented. These incentives included training grants, advance-manufacturing facilities, R&D assistance, export promotion grants, and small industry assistance. By 1969, the IDA had become the premier
institution for the development of industry in Ireland. At this time, An Foras Tionscal merged into the IDA, and the new IDA was given quasi-state status. It then reorganized into its own corporate structure, characterized by separately functioning product divisions (such as Electronics, Pharmaceuticals, Textiles). Its internal organization and its external operations responded to a growing, global market. The IDA was the institutional mechanism for implementing outward policies. It marketed Ireland to a global marketplace, promoting exports and attracting foreign investment to Ireland.

The removal of protection began in the 1960s. A unilateral tariff cut was instituted in 1963, along with an "Adaptation Plan" to help Irish firms adapt to the changed trade circumstances. Another tariff cut came the next year, and in 1965 the Irish government signed the Anglo-Irish Free Trade Agreement. This provided for successive tariff cuts over 10 years in almost all manufacturing products until the tariffs were virtually eliminated (Telesis, 1984). Finally, in 1973, Ireland joined the EEC, thus introducing free trade with other EEC countries in most manufactured goods.

The export-promotion policies and the removal of protection were indeed successful in opening up the Irish economy and integrating Ireland into the international division of labor. The IDA was extraordinarily successful in attracting manufacturing subsidiaries of overseas companies to Ireland. Manufactured exports grew rapidly during the 1960s and 1970s as Ireland's share of foreign markets increased and
production diversified into a wider range of goods, including technologically advanced products such as computer equipment, fine chemicals and pharmaceuticals. The importance of overseas subsidiaries in advancing industrial growth was in fact much greater than expected. According to Eoin O'Malley of the Economic and Social Research Institute in Dublin, these developments are largely attributable to Ireland's exceptional success in attracting a greatly disproportionate share of mobile industry during this 20-year period (O'Malley, 1985).

Output in indigenous industries grew during the 1960s and 1970s, but experienced declining market shares. O'Malley describes this trend as one of relative decline in Irish industry. The growth of competing imports into Ireland shows the relative decline of the domestic market between 1960 and 1979. The new foreign industries, being almost entirely export oriented, have not accounted for more than 5% of domestic sales. Consequently, increases in imports, due to increasingly open policies, have reduced the market shares of indigenous industries. While one may argue that such import penetration is predictable under open policies, and should be compensated or overcompensated for by accompanying gains in export market shares, in fact Irish industries other than new foreign industries showed no overall gain in export market shares during this period (O'Malley, 1985). In terms of world exports, O'Malley's study shows that Irish industries accounted for about 0.26% of the manufactured exports of all market economies in 1966 and the same percentage in 1976, while during the same period the share of total Irish
manufactured exports (including those from new foreign firms) rose from 0.33% to 0.48% during that period.

These trends suggest that Irish indigenous industry incurred a net loss in market share while losing out in the home market, with no compensating increase abroad. O'Malley argues that little progress was made under the outward-looking policies apart from the development of Ireland as a location for mobile foreign industries. Certain Irish industries did, however, fare reasonably well. These, argues O'Malley, were industries engaged in basic processing of local primary inputs (such as food, drink and tobacco, clay and glass) and in industries not subject to the constraints imposed on latecomers by barriers to entry (O'Malley, 1985). For example, small-scale firms in Metal and Engineering and Wood and Furniture also performed relatively well. Overall employment growth during the period 1973-80 was due almost entirely to small firms (O'Malley, 1985). In 1980, the performance of Irish indigenous industry was not markedly different from 1930.

The rising tide of export production had not substantially lifted any Irish boats. Ireland in 1980 exhibited a strikingly dichotomous industrial structure, both in terms of exports and in terms of sophistication and level of processing in manufacturing. Foreign and Irish companies produced as if in two completely separate worlds, with no institutional or market-based links. The absence of linkage between Irish and foreign industry and its effects on overall economic development in Ireland became the subject for several
important studies (O'Farrell and O'Loughlin, 1980; Stewart, 1976; O hUallachain, 1984).

Towards the late 1970s and early 1980s, Ireland's export-led industrialization path was blocked by several factors. The global market which Irish industry had been successfully penetrating went into prolonged recession. More importantly, it emerged from recession in a very unstable state. This has been well documented by Piore and Sabel (1984) among others. The upshot was that in a world of unpredictable, unstable markets, the formulae for economic success of nations, industries and firms were radically altered. In order to survive amidst such global competition, everyone had to develop a new strategy or rethink existing strategies.

As multinationals were rethinking their global strategies, they were not going out and investing heavily in places like Ireland. In fact, many multinationals emerged with strategies that embodied very different types of investment decisions. For example, many high-technology companies, those especially pursued in Ireland, began to establish alliances with other European companies (Perlmutter and Heenan, 1986; Haklisch, 1986). The motivation behind these new strategies were quite different than those manifested in the establishment of branch plants during the 1960s and 1970s.

In the meantime, more countries, struggling in the new globally competitive arena, beefed up efforts to lure multinationals. As a result, Ireland was competing heatedly with places like Scotland and Singapore for a dwindling supply of foreign manufacturing investment. And thus the motor of
export growth in Ireland weakened considerably.

At this point, it also became increasingly clear that indigenous industry had made little progress under the outward policies in overcoming barriers to entry. Balance of payments deficits were large and increasing, to the point that by 1985 Ireland's foreign debt per capita was four times that of Mexico's (Cockburn, 1985). Population was growing rapidly, after almost a century of decline, and nearly half the population was under 25 (McLaughlin, 1984). Unemployment was persistent. Worst of all, Ireland was suffering from a serious "brain drain" of its most educated, professional, and entrepreneurial population (Brady, 1985).

In 1980, Ireland's National Economic and Social Council (NESC) contracted with the Telesis Consulting Group, headed by Ira Magaziner, to conduct a review and evaluation of industrial policy in Ireland. According to Telesis, the objective of the policy review was to "ensure that the Irish government's industrial policy was appropriate to the creation of an internationally competitive industrial base in Ireland which would support increased employment and higher living standards" (Telesis, 1984). The Telesis Report, as this review became popularly known, provoked much controversy within the government and among the business community in Ireland. Its authors criticized grant and tax incentive policies, and argued that Ireland needed to develop its own competitive indigenous industry and to develop linkages between Irish and foreign industry. They criticized the market-pushing practices of the IDA, embodied in the IDA's assessment procedures and
its measures of success (i.e. job approvals).

Since the publication of the Telesis report, the Irish government has shifted its emphasis to developing a competitive industrial structure in Ireland. Part of the strategy aims at increasing industrial interdependence within Ireland, and part aims to add more value to goods produced in Ireland. To facilitate this shift, Policy making institutions, such as the Ministry of Industry, Trade, Commerce and Tourism, The Irish Export Board, the IDA, NESC, and the Confederation of Irish Industry have begun to coordinate activities to alter the structure of industries in Ireland.

**The Importance of Structure: Inter-industry and Inter-firm Relationships**

A shift in emphasis to the structure of industry and the organization of production in Ireland, and in other countries as well, has most likely occurred, then, for three reasons. The first reason relates to the failure of market-based policies to generate high levels of employment and productivity and industrial competitiveness despite large established market shares. Second, the nature of markets has fundamentally changed. Increased globalization means that countries are competing industrially for global market shares, and thus need to ensure that their industrial bases are organized to allow this. Increased instability means that countries must structure their industrial bases so that they can adjust to rapid changes in market conditions. Instead of taking reactive approaches such as diversifying or attempting to create a "risk-free" portfolio of global industries, most
countries are realizing that the nature of the instability requires a more proactive approach. This means developing an industrial structure in which production can shift between industries and can do so without adversely affecting the overall system of production.

The third reason is a growing appreciation amongst the development community of historical, existing and developing examples of thriving industrial economies in which the growth and competitiveness of local industries have not resulted from the domination of one or several large markets, but rather from their ability to efficiently produce for many different markets (see, for example, Piore and Sabel, 1984 and Sabel and Zeitlin, 1985).

The generation of employment and productivity in Ireland has been divided according to foreign vs. indigenous industry. In the case of foreign industry, recession followed by instability and uncertainty in global markets has in many cases reduced the commitment to Irish production facilities by foreign producers. In the case of Irish industry, O'Malley's analysis shows that Irish industries under the outward-looking policies of the 1960s and 1970s faced significant barriers to entry into international markets as a result of such factors as economies of scale in production, advantages of large established firms in marketing and raising capital and the established technological strength of existing industries in advanced industrial countries. Thus,

Indigenous firms in a late-industrializing country with outward-looking, free-market policies . . . are largely confined to investing in sheltered or non-traded industries,
internationally traded industries with relatively insignificant barriers to entry, or simple, low value-added processing of local primary inputs (O'Malley, 1985, p.142).

Not only were these industries unable to generate productivity gains, but they were unable to generate employment. These industries could not grow enough to absorb a swelling labor force.

Given the existing nature of markets, O'Malley argues that industrial policy should focus on implementing an active, selective and directive approach towards specialized niche industries, rather than on creating the right environment and providing generalized incentives for industry. Given that further growth in such a small economy as Ireland will inevitably continue to depend on a wide array of imports, the development of exports to pay for the necessary imports is the key constraint in promoting economic development. O'Malley concludes,

this would mean that Ireland would have to select quite specialized industries, whether these are specialized by product, customer, geographical area, or a combination of these. Such specialized, or 'niche' industries, have the advantage of avoiding direct competition with very large firms, which are not interested in, or may not be flexible enough to compete in these activities (O'Malley, 1985, p.153).

While his ideas about specialized "niche" industries are probably sound, they are somewhat incongruous with a government policy that selects industries. The ability to serve market niches must be developed from an existing industrial and institutional structure. The government may have an active role in facilitating and encouraging a flexible industrial structure. This has been the basis for development
in Japan and France, for example. In such cases, and there are others well documented by Piore and Sabel (1984) for example, the government has not selected industries at all. Instead it has nurtured an industrial structure that allows for the variable use of increasingly productive and widely applicable technologies, and an institutional structure that "balances cooperation and competition among firms so as to encourage permanent innovation" (Piore and Sabel, 1984, p.29). A case in point is the 19th century industrial district:

These districts were defined by three mutually dependent characteristics. The first, most obvious characteristic, was the districts' relation to the market. The districts produced a wide range of products for the highly differentiated regional markets at home and abroad; but--more important--they also constantly altered the goods, partly in response to changing tastes, partly to change tastes, in order to open new markets (Piore and Sabel, p.29).

The relationship of these districts to the market is contradictory to the traditional market-led view of industrial development, in which the adoption of technology and the organization of production is determined by the nature of market transactions. Piore and Sabel hold this view as untenable, and build an argument against market determinism through a comprehensive analysis of regions and industries in the US, Europe and Japan. The common thread among these examples is the successful development of industrial and institutional cooperation, fostered by local, regional and national governments.

Given the small size of Ireland and the nature of Irish and foreign industry there, one key objective of industrial policy should be to encourage cooperation among firms.
Supplier relationships, R&D, and training are potential outcomes of increased cooperation. As I argued earlier, there are clear signs that the government and business community in Ireland are trying to implement such a policy (whether they fully appreciate its implications or not), and in so doing, are trying to improve Ireland's ability to both develop and compete industrially in an unstable world. These signs are embodied in the White Paper on Industrial Policy, the changes within the IDA, and the numerous institutional developments listed at the beginning of this paper. The Irish are now more focused on their industrial structure rather than on markets.

We have yet to see if and how Ireland can compete and industrialize simultaneously. Much rests on the strength and fluidity of the new institutions in coordinating and supporting a flexible, innovative industrial structure in Ireland. In a country known to many for its dominant, rigid institutions and its lack of entrepreneurship, this may prove to be quite difficult. Nevertheless, the potential is clearly there.
Given the importance of industrial structure in a country's ability to industrialize and to compete, how does one go about assessing structure? More importantly, how does this information become useful for industrial policy? There are undoubtedly countless responses to these questions, with differing emphases on the products and processes associated with assessments and information for policy.

I believe that both are important. Specifically, I would suggest that assessment and policy development should incorporate three elements: 1) analysis of interindustry relationships and structural change in the economy; 2) identification of strengths and vulnerabilities embodied in the industrial structure; and 3) a process of playing out the effects of endogenous and exogenous changes on the whole economy. All of this can be done, albeit very broadly, with input-output tools. In this chapter, I will discuss existing and potential applications of input-output tools.

Input-output analysis has been widely used for intertemporal and international comparisons of industrial structure. Augustinovics (1970) outlined a generalized framework to systematize the possibilities inherent in the input-output model. Through an input approach, the structure of the relationships among participants in the production process may be approached by examining how much is needed of the output of preceding, vertical stages or of the primary inputs for either
final use or for a unit output of some industry. Through an output approach, structure is approached by examining what comes out of something, either of primary inputs or the unit output of some industry, in successive stages or in final use (Augustinovics, 1970).

Carter (1970) used input-output analysis to analyze structural change in the US economy between 1938 and 1961. She examined changes in the intermediate input structure, or the shifting industrial division of labor, and changes in the structure of primary factor requirements. While her analysis is strong and comprehensive, and her conclusions well supported, Carter points out the limitations inherent in the input-output framework (partially embodied in the system and partially in the accounting framework) for analyzing structural change. These limitations will be discussed in detail later.

Simpson and Tsukui (1965) used input-output tables for international comparisons of the structure of production. In comparing input-output tables for the US and Japan, Simpson and Tsukui found a recurrence of the pattern of interindustry relations in both countries in different years. They concluded that there exists a fundamental structure of production in modern economic systems. More recently, Bon and Minami (1986) compared the fundamental structure of the US and Japanese input-output tables in terms of both demand and supply patterns. Their research focusses on the construction sector, and confirms the earlier research concerning the similarities between the fundamental structures of the two economies.
The input-output framework has been useful in analyzing specific structural issues of developing and industrialized economies. For example, Schultz (1974), Panchamukhi (1975), and O hUallachain (1984) have identified key sectors for developing countries, analyzed the impacts of sectoral change on economic growth and impacts of foreign-direct investment, respectively, through linkage analysis. Recently, Leontief and Duchin (1986) have analyzed the impacts of increased automation in production on workers through input-output analysis.

Several analysts have applied input-output analysis for strategic purposes. At the national and international levels, input-output analysis has been used for industrial espionage of sorts. Wiles (1968) has looked at issues of national economic warfare through input-output. Wiles discusses the formation of balance of payments policy and the identification of bottleneck effects through input-output. During the second world war, the 20-sector US input-output table was actually used as a pattern for hypothesizing a 20-sector input-output matrix for Germany. The Office of Strategic Services manipulated the table to guide a variety of its activities directed at crippling the German war economy. The same table was also used later for guidance in determining reparations policies (US Department of Commerce, 1978, p.110).

At the regional level, Stevens et al (1984) have developed an industrial "targeting" system with a multi-regional input-output model. This system was developed for a regional commission of business, labor and community leaders. It
allowed all parties to place weights on a variety of measures of industrial performance in the region, reflecting relative wage, occupational-skill matches, import/export activity, and regional purchase coefficients, etc. This ultimately produced a series of ranked industry lists, from which the regional commission could "select" industries for development and "target" them for development.

At the industry level, Bon (1986a) has analyzed the direct and indirect resource utilization by the U.S. construction sector since the second world war through input-output tools. His analysis showed significant differences between the direct and total resource utilization by the construction sector. It also showed the complex interdependence between the construction sector and its main suppliers and clients.

At the corporate level, Gols (1974) has outlined applications of input-output analysis for industrial planning. He has described four principal types of input-output applications for corporate planning and strategy: forecasting; sensitivity testing; flow and structural analysis of products and materials; and sorting and screening of markets and industries.

More generally, Bon (1986b) has used input-output analysis to examine the way supply and demand forces influence the interaction and direction of development in particular sectors. His findings suggest that industries tend to become more supply-driven as they reach maturity.

Bon (1985a and b) has begun to develop a matrix framework
based on qualitative reasoning that links input-output analysis to scenario development. Such a framework becomes operational through an expert system and other artificial intelligence tools. Bon suggests that through a qualitative input-output analysis, one can study properties of economic systems that are purely topological in character—properties which depend only on the existence of technical coefficients, and not on their magnitude. One can take a given set of relationships between components (sectors) of an economic system (and a set of rules about the properties of those relationships and the behavior of the components) and propagate alternative implications through the entire system via intersectoral links, according to Bon. He further suggests that qualitative input-output analysis is of potential value in evaluating large numbers of alternative changes in key policy and planning variables. Promising alternatives may then be evaluated in detail through quantitative input-output analysis.

One of my objectives here is to explore the potential of input-output tools for the analysis of "1980s-style" industrial policy issues. I see its potential not as a rigid, mathematically complex tool for estimating demand or setting production targets across industries, but as a basis for institutional coordination and for topologically based scenario development. This raises two very important points, that I wish to introduce and briefly discuss here: the tradition of input-output tools in central planning (and thus its ideological connotations); and the distinctions between
industrial "planning" in the 1950s and 1960s and industrial "strategy" or "policy" in the 1980s.

Input-output analysis has of course been widely used in both "market" and "planned" economies. I couch these terms in quotations, because they have become increasingly blurred in practice in recent years (Thurow, 1986). However, centrally planned economies have remained fairly distinct, and it is here that the importance of input-output tables and input-output analysis is reknowned.

Input-output tables are integral to the central planning process in the USSR, for example. A Soviet central plan requires production targets, input requirements, and an internal balance for the plan as a whole (Miernyk, 1965). Given a detailed input-output table, central planners can achieve an internal balance quickly with computers. In a centrally planned system, speed is very important since it permits the development of a series of plans from which planners can choose, rather than the often poorly balanced, late, single-variant often constructed (Miernyk, 1965).

Input-output analysis is applied in centrally planned economies to establish total output targets, whereas in market economies input-output analysis is usually applied to analyze the economy-wide impacts of a given set of final demands. These are very different applications, in terms of the ideology motivating them and the institutional response and implementation of the resulting "plan." Under central planning, enterprises are responsible for meeting the production targets set in the plan. It is in this light that
many business and government executives in market economies, particularly the US, see input-output analysis. They are highly suspicious of it, and view it as a threat to their autonomy. This is reflected in the development of input-output analysis in the United States. Depending on the prevailing political ideology, funding for and interest in input-output research has ranged from little to none.

In fact, input-output applications were developing rapidly in the US from the mid-1930s, beginning with the publication of Wassily Leontief's "Quantitative Input and Output Relations in the Economic System of the US" (1936). The Bureau of Labor Statistics (BLS) maintained a special project for developing input-output applications. After the Korean War, however, business and government leaders were suspicious of input-output applications as a tool of state planning. Partly as a response to the strong opposition of input-output work by executives at General Motors, government funding of this work at BLS was stopped entirely in 1954 (US Department of Commerce, 1978, p.112).

Input-output analysis has been viewed in the US as an inefficient form of government economic intervention, antithetical in many respects to democratic and free market principles. This, however, is simply not the case, and raises the second point concerning traditional economic planning and recent discussions of industrial policy.

Recent discussions of industrial policy in the US and Europe have focussed on the globalization and instability of markets, institutional and technological development,
industrial flexibility and barriers to intra- and inter-industry mobility (Geroski and Jacquemin, 1985; O'Malley, 1985; Piore and Sabel, 1984; Thurow, 1986). Proposals for national and regional industrial strategies vary, but share several characteristics: the espousal of institutional cooperation involving government, the business community, financial institutions, labor, legal and educational institutions; the establishment of a government role in providing a framework that encourages private sector flexibility and facilitates adjustment to shocks; and the importance of identifying and developing inter- and intra-industry buyer/supplier/research links. Most importantly, an attempt to distinguish "new" policy approaches from planning is central to many of these discussions. This is put quite clearly in a recent European policy journal. Geroski and Jacquemin argue that

"policy must aim to enhance market flexibility, reduce barriers to mobility and stimulate adaptability within large corporate bureaucracies. This conception of industrial policy can be quite activist but must not be mistaken for planning. Its object is not to pick winners and choose outcomes, but to reinforce the competitive market process in which European firms must operate (Geroski and Jacquemin, 1985, p.202).

They further argue that in what they call their "infrastructure" approach to industrial policy, the concern is not to make the right choice (as is the case under planning approach, they argue) but to ensure that private agents and markets make choices in the right way. But despite the new emphasis on "infrastructure" and "flexible environments", in many of the recent discussions, the overall process of
strategy and policy formation is strikingly similar to planning, particularly the indicative planning of postwar France.

Stephen Cohen, a student of modern capitalist planning, likens indicative planning to market research. He describes the central focus of indicative planning--to improve the information available for making decisions (Cohen, 1969, p.8), and he explicitly points out that indicative planning does not mean centralized decision making:

"... if (indicative planning) is to operate in an environment of decentralized decision making and dispersed power, where it cannot convey and enforce its decisions by direct command, it must work through the market mechanism" (Cohen, 1969, p.20).

The indicative planning process centered on institutional coordination. Representatives from major industries, the Treasury, financial institutions, unions, and state statistical agencies coordinated efforts to prepare detailed input-output tables which showed sectoral interdependencies in the economy. From these tables, patterns of final demand were estimated. The composition of final demand, however, was assumed to be determined outside the planning process. The information thus provided by the indicative plan was intended to aid decision making in government and business. According to Cohen,

"... indicative planning functions on a purely informational basis. Information is collected, organized, and made available to all. It 'works' because it becomes a universal guide for decision... the information is
better not only because it is more comprehensive, but, crucially, because it is consistent" (Cohen, 1969, p.10)

Cohen points out, however, that in practice, the decisions based on this "guide" were indeed often centralized, and the institutions involved in its formation actually exercised coercion to ensure adherence to it.

In the importance attributed to institutional coordination, the flow of detailed information, and decentralized decision making, planning and the "new" approaches to industrial development are quite similar in theory. We have yet to see the distinct practical differences. What is different, though, is the fundamental problem motivating each: French planning was motivated by postwar opportunities for economic growth, and reflected the desire to find growing markets and develop industries to supply them. New supra-national institutions had recently been established which guaranteed the stability of markets. 1980s-style industrial policy is motivated by heightened national competition in increasingly globalized and unstable markets. The supra-national stabilizing institutions have begun to break down (Piore and Sabel, 1985).

But in both cases, the advocated role of the government is not to make choices but to provide a framework for institutional coordination, industrial cooperation and decentralized decision making. Input-output tools--from the assembly of industrial statistics to the projections of final demands--was a means of coordinating institutions in the French planning process. I would suggest that it could serve a
similar purpose in 1980s-style industrial policy development.

In conclusion, input-output tools can serve two key purposes in developing an industrial policy. First, they can be used to analyze structural change and structural relationships in an economy. Second, they can provide a means for coordinating public and private institutions in the process of policy development and implementation.

To develop this final point, and to examine empirically structural relationships in Ireland, I obtained eight input-output tables for Ireland. In the following two chapters, I will discuss these tables and their application.
In this chapter, I will briefly discuss the fundamentals of input-output analysis and national accounting. Within this context, I will discuss the construction of the Irish input-output tables, and outline how I manipulated the 8 tables for purposes of comparison. Second, I will describe the economic indices on which the structural analysis is based.

The following discussion of input-output is intended only to introduce its essential characteristics, so that the economic indices on which the structural analysis depends can be better understood. For detailed and comprehensive treatments of the theory, mathematics and applications of input-output, the reader is urged to consult Miller and Blair (1985), Miernyk (1965), or Polenske (1974).

The Transactions Table

The basis of input-output analysis is a table of interindustry transactions, or flows. Input-output analysis is often referred to as interindustry analysis. The input-output table can be employed as a descriptive and analytical tool. The transactions table provides a detailed description of the sales and purchases of goods and services within the producing sectors of an economy. The level of detail depends on the aggregation of industrial sectors comprising the table. Tables may include only the basic sectors of an economy—agriculture and mining, manufacturing, construction, trade and transportation, and services—to all classified industrial
sectors for which sales and purchase data are available (in the U.S., this is upwards of 500 sectors). The transactions table is usually square—that is, there are \( n \) rows and \( n \) columns, with sectors of origin listed on the left of the table and the same sectors as destinations, listed from the top. The amount of an industry's sales to other industries is measured along its row, and the amount of its purchases from other industries is measured along its column. In matrix notation, \( x(ij) \) represents the sales of industry \( i \)'s output to industry \( j \) and industry \( j \)'s purchases of industry \( i \)'s output.

What makes the input-output table eventually operational through matrix operations and analytical in terms of economic interpretation is its internal balance. Total inputs of each producing sector must equal that sector's total output. In terms of the transaction table, a sector's column sum must equal its row sum.

The interindustry transactions table measures only intermediate flows in an economy, however. Clearly, industries use inputs other than intermediate products from within the economy. A producing sector makes payments to labor (wages and salaries) and capital (rent and interest) as primary inputs, taxes to the government, and depreciation from its own inventories. All of these together are termed the value added in sector \( i \). Sector \( i \) may also purchase imports as part of its input. Value added and imports are usually lumped together as purchases from the payments sector (row).

At the other end of the production process, the output of producing sectors goes to final uses in addition to
intermediate uses. Final uses include household and government consumption, private investment, and exports. These are grouped together as the final demand sector (column). In keeping with the balance of intermediate transactions (total inputs equal total outputs), the total final demand (column sum) must equal total value added (row sum). In accounting terms, Gross National Income (value added) equals Gross National Product (final demand). The relationship between input-output and national accounting will be discussed further in a later section.

Thus, the input-output table describes production in an economy through primary, intermediate and final flows of factors, goods and services. Figures 1 and 2 illustrate the relationship of these flows in the input-output system. Figure 1 shows three component matrices. Matrix X defines producing sectors, Matrix W defines value added or primary sectors, and matrix Y defines final demand sectors. Viewing these matrices and their sectors together as one table, we can thus interpret the elements of each matrix: the elements of matrix X, $x(ij)$ represent sector i's sales to sector j and sector j's purchases from sector i; the elements of matrix W ($wij$) represent sector j's payment to factor of production i; the elements of matrix Y ($yij$) represent the sale of sector i's output to final user j. Figure 2 shows the input-output table divided into four basic quadrants. Quadrant I describes the intersectoral transactions in the economy. Quadrant II describes the final purchases of the output of producing sectors. Quadrant III describes the payments to factors of
production by producing sectors (value added). Finally, Quadrant IV describes the direct purchases of factors. The components of the input-output table therefore provide a rough description of the markets (embodied in row elements) and production technologies (embodied in column elements) of an economy.

The input-output table becomes an analytical tool when technical coefficients are established. Once these coefficients are derived, input-output relationships can be expressed as a system of linear equations, forming the basis of a model to forecast demand or to measure the economy-wide impact of demand shifts.

**Technical Coefficients**

Technical coefficients are so named because they define the technology involved in producing a particular industry's product in the input-output system. They are also called direct-input coefficients, or "cooking recipes" (Leontief, 1974, p.825). The different input requirements of each industry can be examined more systematically in terms of the purchases per unit of final output. Dividing each element in a column of the transactions table by the total output for a particular industry produces a column of coefficients. Each coefficient shows the amount that an industry purchases directly from another industry per dollar's (or relevant unit of currency) worth of output. A column of direct-input coefficients for a particular industry indicates the technology required to produce its product. The input requirements produce may change over time, and changes in the
structure of production within an industry are reflected by variations in the technical coefficients.

Traditional input-output models are built with direct-input coefficients. Direct-input coefficients reflect the demands of an industry in its production process. By looking at production from the supply side, however, another type of technical coefficient can be derived. Dividing each element in a particular row of the transactions table by the total output for that particular industry yields a row of direct-output coefficients. Each direct-output coefficient represents the amount a sector sells to another sector per dollar's worth of output. Thus, technical coefficients reflect either supply or demand forces in an economy. Direct-input coefficients measure each industry's demands for other industries' products; direct-output coefficients measure each industry's supply to other industries. These coefficients are the basis of Bon's demand- and supply-side models, discussed earlier.

The Inverse

Technical coefficients measure direct input and output relationships between two sectors. When all of these relationships are expressed as a set of simultaneous linear equations and solved (this is the matrix operation of inversion), matrices of total-input and total-output coefficients are obtained. These coefficients measure the direct and indirect flows between industries. Inverting the direct-input matrix (comprising direct-input coefficients) yields the total-input matrix (comprising total-input coefficients). Similarly, inverting the direct-output matrix
(comprising direct-output coefficients) yields the total-output matrix. The total-input matrix shows the total impact of changes in final demand on sectoral output. The total-output matrix shows the total impact of changes in value added (primary resource availability) on sectoral input.

The coefficients in the inverse tables reflect the interdependence that exists within an economy. A direct-input coefficient $a_{ij}$, for example, might show that for every dollar of its output industry $j$ buys a dollar's worth of industry $i$'s output. The coefficient in the same row and column in the total-input matrix is larger than $a_{ij}$, indicating that $a_{ij}$ represents only the direct absorption of industry $i$'s output by industry $j$. Indirectly, a dollar's worth of final demand for industry $j$ requires that additional output of industry $i$ be produced. This is due to an induced demand generated through industry $j$.

The sum of total-input coefficients for a particular sector (the column sum of the total-input matrix) measures that sector's output multiplier. This is the effect of a one dollar change in final demand for that sector's output on the total output of all other sectors. Similarly, the sum of the total-output coefficients for a particular sector (row sum of the total-output matrix) measures that sector's input multiplier. This is the effect of a one dollar change in value added (availability of primary resources) for that sector on the total input of all other sectors.

The inverse matrices are used primarily for forecasting purposes. When final demand or value added is determined
exogenously, total-input and total-output coefficients for a base year are used to forecast total sectoral output and input, respectively, for the chosen year. The sectoral output forecast is thus demand-driven, reflecting the forces of demand in determining output. Similarly, the sectoral input forecast is supply-driven, reflecting the forces of supply in determining input. Together, they reflect the circular flow of a macroeconomic system.

Limitations of Input-output Tables

Several characteristics of input-output tables are potentially problematic, and often limit both the application of input-output analysis to certain policy issues and the interpretation of changes in production analyzed through input-output tables. First, transactions are normally accounted for in producer prices. While it is possible and often desirable to record transactions in physical vs. monetary units, the physical measure introduces enormous consistency problems. Monetary measurement of transactions does introduce problems, however, due to changes in prices that do not reflect actual changes in the use of physical inputs. Second, the industry production function embodied in the input-output system has two limiting features: since technical coefficients are fixed relationships between a sector's output and its inputs, economies of scale (and certainly economies of scope) are ignored, and production is assumed to occur with constant returns to scale; and since technical coefficients imply that inputs are used in fixed proportions, the isoquants (constant output curves) for each
sector are not convex curves (reflecting diminishing marginal productivity) as is the case under classical assumptions of production, but instead they are right-angular. Third, production in an economy as described in the input-output table represents an economy at a particular point in time and in equilibrium. Sectoral inputs equal sectoral output, Gross National Income equals Gross National Product, imports equal exports, and total inputs equal total outputs. Consequently, neither trade deficits nor government debt exists within the system.

Fourth, it is often difficult to determine whether changes in technical coefficients result from the use of new or different production processes (direct-input coefficients) and opening up new markets (direct-output coefficients) or from alterations in the output mix of the sector. Changes in product mix occur when the component industries of an aggregated industry change in relative importance. Any significant change in the relative amounts of products sold causes variation in the inputs purchased and the outputs sold by an industry. Fifth, and finally, industry technologies are often distorted in many tables due to secondary production.

While the existence of secondary production and by-products is an accounting issue (not an input-output issue per se), it becomes problematic in the context of input-output when secondary products and by-products are not allocated accordingly to the industries specified in a particular transactions table. This becomes more problematic the greater the level of industrial disaggregation and in economies with
large, multi-product establishments. It also depends on the way in which industrial data is collected and reported. In the US, for example, industries are classified into Standard Industrial Classification (SIC) codes according to product. Data is collected at the establishment (not the firm) level. Establishments comprise an industry according to their primary product (primary source of revenues). Many establishments, however, produce products that do not belong to the primary industrial classification. In Ireland, for example, a Digital Equipment Corporation plant produces keypunch cards (Paper and Paper Products) and manuals (Printing and Publishing) in addition to computer equipment. And several pharmaceutical establishments produce chemical solvents as by-products of medicines or cosmetics.

There are several methodologies for dealing with secondary products and by-products; for a detailed discussion see Polenske (1974) and Miller and Blair (1985). Each of these is a mechanical means of attempting to transform data that combine primary and secondary products into a matrix in which rows and columns both refer to an individual product or product group. According to Polenske, implementation of the methods requires a considerable amount of intuitive judgment in adjusting the results to maintain plausibility of the input coefficients (Polenske, 1974, p.26). Clearly, secondary production and by-products are less problematic the greater the aggregation of the transactions table.

As the preceding discussion has shown, many limitations and problems of input-output analysis derive from the data and
system of national accounts. Data collection and accounting procedures may change over time, and they often differ from country to country. This is especially important to consider when comparing tables intertemporally or internationally. Since that is the case here, I will briefly discuss the relationship of input-output to national accounts in the context of the Irish input-output tables.

**Input-output and Accounting Conventions**

In most countries, input-output tables are derived primarily from national accounts. The interindustry transactions matrix is usually assembled with industrial census data. Tables may differ according to industry classification and aggregation. And, as discussed above, tables often differ in their accounting for secondary production and by-products.

Each country has its own procedure for collecting data from establishments and publishing these data. Establishments in Japan, for example, are required to submit detailed accounts of the inputs purchased to make each of its products. The Japanese have therefore been able to assemble these data into pure-product input-output tables (Polenske, 1974). In the US, the Office of Business Economics (now the Bureau of Economic Analysis) developed a technique for the assembly of national input-output data using two matrices—a primary matrix and a secondary matrix. The total-flow matrix is then the sum of these two matrices. The primary element, usually the most important component of the total flow, is the amount of purchases of a given good or service required by a
particular establishment to produce its primary and secondary outputs. The secondary element is the amount the industry that is supplying the input produces, as a secondary output, of the purchasing industry's output (Polenske, 1974, p.15).

In the Irish tables, secondary production is accounted for through the United Nations (UN) system. This system also depends on the construction of a primary and secondary matrix. In this system, the amount of secondary production by a sector of each other sector's output is shifted to the appropriate sector, using the technology of the sector to which it is shifted. So, the amount of output by sector A that is a product classified in sector B is added to column B and subtracted from sector A of the primary matrix, using technology of sector A as the allocation amounts. The assumption is that the technology of secondary products resembles that of the sector whose product is being produced (Polenske, 1974).

The Irish Tables

In the Irish tables, secondary production is not as much of an issue as by-products. By-products accounted for 53.5m of production in 1964 and 66.6m in 1969 (Central Statistical Office, 1970 and 1978). By-products also undergo special treatment in the Irish tables. By-products (mostly agricultural), such as hides and fats are transferred from the sector of origin (agriculture) to the transfer sector (food); grains and carbon dioxide are transferred from Drink and Tobacco to Agriculture. The transfer is made entirely in the column of the producing sector by entering the amount involved
once with a positive sign and once with a negative sign, leaving the sector column total unaltered. The positive entry is in the row for the sector of origin (producing sector) and the negative entry in the row for the transfer sector (receiving sector) (Central Statistics Office, 1970, p.12).

The eight Irish tables differ in sectoral aggregation of the transactions matrices. The 1956 table has 17 sectors; 1976 has 19; 1982 has 20; 1978 has 22; and the 1964, 1968 and 1969 tables each have 33 industrial sectors.

In an initial attempt to establish uniformity across the tables, all but the 1956 tables were aggregated to 17 sectors. These were: Agriculture/forestry/fishing; Mining & Peat; Food; Drink & Tobacco; Textiles, except hosiery; Clothing/hosiery/shoes/leather; Wood & Furniture; Paper & Printing; Chemicals; Clay/cement/glass; Metal/engineering/vehicles; Other manufacturing; New/repair construction; Electricity/gas/water; Services, except government; Government services; and Artificial Sectors, not elsewhere classified. This last category is defined sales by final buyers, materials for repairs, packaging and residual business current expenditure.

The 17-sector tables were further aggregated to 11 sectors. This was done for a variety of reasons, including clarity and ease of presentation. The final aggregation scheme emphasizes manufacturing. This is of primary concern in any effort to analyze industrialization. The following 11 sectors comprise the final tables: Agriculture & Mining; Food; Textiles; Chemicals; Wood & Furniture; Clay/cement/glass;
Value added, or payments to factors, is defined as Gross National Income (GNI) in most national accounts. Its components, in most accounts, are wages and salaries, profits and rent, interest and dividends, taxes, and imports. Many tables, however, account for each component of GNI as a specific payments sector. Miernyk (1965), for example, distinguishes the payments sector clearly from the processing sector (industries producing goods and services). These sectors are 1) gross inventory depletion, 2) imports, 3) payments to government 4) depreciation allowances, and 5) households. Thus, total gross outlays (or inputs) for a particular industry is the (column) sum of its intermediate outlays (purchases from the processing sector) and its value added (purchases from the payments sector).

The Irish tables vary in the accounting of value added. Five of the tables (1964, 1968, 1974, 1978 and 1982) account for value added as 4 income sectors: household income, government income, savings and imports. Value added is accounted for in 1956, 1969 and 1976 tables as 1) indirect taxes, 2) less subsidies (a negative entry), 3) wages, 4) profits, 5) depreciation and 6) imports. Imports in the 1956 table are disaggregated into competing and non-competing imports. Imports in the 1969 table, however, are disaggregated into similar (competing) and complementary (non-competing) imports, and similar imports are further disaggregated into 16 sectors.
These differences, especially the income vs. value added accounting of GNI in 5 of the tables limit the detail of cross-table comparisions of value added. For this analysis, therefore, GNI components of each table were aggregated into a value added sector and an imports sector.

Final demand is defined as Gross National Product (GNP) in most national accounts. It is generally made up of 5 components: gross inventory accumulation, household purchases, government purchases, gross fixed private capital formation (GFPCF), and exports. Most changes in the input-output table are transmitted through these sectors, which are generally treated as exogenous in input-output models. Some input-output models however, are "closed"--in these models, the household sector is endogenous to the input-output system.

The GFPCF component of GNP is frequently treated differently among different countries, depending on accounting convention. All transactions in the input-output table are on a nation's current account, except those in the GFPCF column, which are on capital account. Purchases by all buyers (final and intermediate) for the replacement of or addition to plant and equipment (and any other purchases entered on capital account) are summarized by the entries in this column. In the US tables, for example, the new construction sector (vs. repair and maintenance construction) sells all of its output to GFPCF. But in tables for other countries, new construction output may go to intermediate purchases or to other final demand sectors.

GNP in the 8 Irish tables is for the most part
comparable. In 4 of the tables (1968, 1974, 1978 and 1982), GNP is comprised simply of household consumption, government expenditures, GFPCF, and exports. The other 4 tables contain these 4 components plus stock changes, and 2 of these tables contain disaggregated government and export sectors. Given the requirement for a square matrix and the aggregation of value added into 2 components, it was necessary to aggregate, correspondingly, the final demand sector into 2 components. The final demand sector is thus comprised of a final demand column and an export column. And thus the final form of the 8 tables for purposes of comparative analysis: 11 interindustry sectors, value added, imports, final demand, and exports.

Comparative Indices

Figure 3 shows the structure of the tables and the definitions of their individual elements. Given this structure, a number of economic indicators were derived for comparative analysis. These indicators measure structural relationships in an economy: interindustry relationships; relationships between primary and intermediate production; relationships between intermediate and final consumption. An intertemporal comparison of these indicators reveals generalized patterns of industrialization in an economy.

The indicators were derived from the transactions table, the direct-input and direct-output matrices, and the direct-input and direct-output inverses. From the transactions table, the following indicators were derived:

- Backward linkage \( (x_{ij} / x_j) \), from Figure X), or the ratio of intermediate inputs to total inputs for sector j.
Forward linkage \((\xi_i/\xi_i)\), or the ratio of intermediate outputs to total output for sector \(i\).

- the ratio of value added to total input \((v_{ij}/x_j)\) for sector \(j\).

- the share of total value added \((v_j/v)\) for sector \(j\).

- the share of total intermediate inputs \((x_{.j}/x_{..})\) for sector \(j\).

- the share of total intermediate outputs \((\xi_i/\xi_{..})\) for sector \(i\).

- the ratio of final demand to total output \((y_i/\xi_i)\) for sector \(i\).

- the share of total final demand \((y_i/y)\) for sector \(i\).

- the ratio of imports to total inputs \((m_j/x_j)\) for sector \(j\).

- the share of total imports \((m_j/m)\) for sector \(j\).

- the ratio of exports to total output \((e_i/\xi_i)\) for sector \(i\).

- the share of total exports \((e_i/e)\) for sector \(i\).

From the direct-input and direct-output matrices, the following indicators may be derived, for each sector.

- Direct-input coefficient (column): the direct-input coefficients along a sector's column in the direct-input matrix measure the direct usage of all other sectors' products as inputs to that sector. These coefficients help to identify the input structure of a particular sector.

- Direct-input coefficient (row): the direct-input coefficients along a sector's row in the direct-input matrix measure the amount of that sector's output required directly by other sectors as inputs. These coefficients help to identify those sectors that purchase proportionally more of the output of the sector in question as direct requirements.

- Direct-output coefficient (row): the direct-output coefficients along a sector's row in the direct-output matrix measure the amount of that sector's output sold directly to each of the other sectors in the matrix. They help to estimate the sectoral composition of a particular sector's output, or what its markets are.

- Direct-output coefficient (column): the direct-output coefficients along a sector's column in the direct-output matrix
matrix measure the amount of all other sectors' output sold directly to the sector in question. They help to identify those sectors selling proportionally more to a particular sector.

Finally, the following measures may be derived for each sector from the direct-input inverse and the direct-output inverse matrices.

- **Total-input coefficient (column):** the total-input coefficients along a particular sector's column in the direct-input inverse matrix measure the total requirement of each sector's output by that sector. In the case of the Food sector, for example, they indicate the impact of a marginal increase in the final demand for the Food sector's output on the output of all other sectors.

- **Total-input coefficient (row):** the total-input coefficients along a particular sector's column in the direct-input inverse matrix measure the total requirements of that sector's output by all other sectors. In the case of the Food sector, they indicate the impact of a marginal increase in final demand for the output of each sector on the output of the Food sector.

- **Total-output coefficient (row):** the total-output coefficients along a particular sector's row in the direct-output inverse matrix measure the total production of that sector as inputs to each other sector. In the case of the Food sector, they indicate the impact of a marginal change in value added (primary resource availability) to the Food sector on the total inputs of each other sector.

- **Total-output coefficient (column):** the total-output coefficients along a particular sector's column in the direct-output inverse matrix measure the total production of each other sector as inputs to the sector in question. In the case of the Food sector, they indicate the impact of a marginal change in value added to each sector on inputs into the Food sector.

Given that these economic indicators are defined as coefficients and ratios, they do not require deflation indices to be analyzed intertemporally. The measures do not, however, account for changes in relative prices of goods and services over the time periods analyzed. In the following chapter, I will present the results of comparative analyses of six
sectors based on these indicators, as part of an overall structural analysis of the Irish economy.
FIGURE 1

Total Output = \( Y + X \)

Total Input = \( X + W \)

FIGURE 2

I: Intermediate Transactions

II: Final Purchases of sectoral output

III: Sectoral payments to factors (value added)

IV: Direct factor purchase
\[
x_{ij} = \text{intermediate flow from sector } i \text{ to sector } j
\]

\[
x.. = \text{total intermediate flows}
\]

\[
v = \text{GNI}
\]

\[
y = \text{GNP}
\]

\[
m = \text{total imports}
\]

\[
e = \text{total exports}
\]

\[
x_j = x.. + v_j + m_j
\]

\[
x_i = x_i. + y_i + e_i
\]

\[
X = x.. + v + m = x.. + y + e
\]
CHAPTER FOUR
Analysis of Ireland's Interindustry Structure, 1956-1982

Comparison of Fundamental Structure

The first part of the structural analysis was based on the 11-sector aggregation of the 1956, 1964, 1968, 1969, 1974, 1976, 1978, and 1982 input-output tables for Ireland described in the last section. The objective was to derive and compare the fundamental structure of the input-output tables. The fundamental structure was approached by first deriving the direct-input and direct-output matrices and then removing all coefficients less than .05 and .10. This effectively eliminated all flows within the tables less than 5 and 10 percent, respectively, of input and output totals of each sector. This method is that used by Bon and Minami (1986) in their comparison of the fundamental input-output structures of the United States and Japan.

The demand patterns in Ireland from 1956 to 1982 are presented in Figure 4. The supply patterns are presented in Figure 5. In both figures, the blank circle represents a flow larger than 5 percent of a sector's total input or total output, and a black circle represents a flow larger than 10 percent of a sector's total input or total output. Demand patterns reflect the degree and magnitude of backward integration among industries in the economy. They also reflect certain technological characteristics, such as the degree of transformation or processing in industrial production and the use of intermediate, rather than primary, inputs into production.
Supply patterns reflect the degree and magnitude of forward integration. They also reflect the degree and strength of producer (intermediate) markets in the economy.

Several observations can be drawn from Figure 4. The most striking observation is the persistence of a main diagonal of black and white circles as the most prominent feature in each matrix. This indicates that the strongest and most consistent input flows in the economy are within, and not between industries. Such a pattern is common to most underdeveloped economies. Industrialized economies would tend to have a more dense triangle of flows formed by the main diagonal (Hirschman, 1958).

The isolation of the main diagonal indicates a lack of interdependence among industries in Ireland. While intraindustry flows constitute strong linkages in an economy, these linkages tend to be less important to the process of industrialization than the joint linkage effects of two industries (Hirschman, 1958). Hirschman argues that the lack of interdependence and linkage is one of the most typical features of underdeveloped economies.

Intra-industry input flows usually stem from what Hirschman calls satellite industries. These industries are usually established in the wake of a particular industry, but are of minor importance in comparison to that industry (Hirschman, 1958, p. 102). Satellite industries have three main features: they enjoy strong locational advantages from proximity to the master industry; they use as their principal input an output or by-product of the master industry or their
principal output is usually a minor input of the master industry; its minimum economic size is smaller than that of the master industry (Hirschman, 1958, p.102). Hirschman emphasizes that while intra-industry linkages or those generated through satellite industries are larger than joint linkages, the latter are far more important to the process of industrialization, which is cumulative.

A second observation from the demand patterns is the continued existence over the 8 years of two complexes of input flows. In the upper-left corner, one complex reflects the strong interdependence between the agriculture and food sectors. Another complex in the lower-right portion (rows 6 to 8, columns 7 to 9) of the tables reflects the strong flows between the Clay/Cement/Glass, Metal/Engineering, Construction, and Transportation sectors. These complexes can be viewed as signs of relative underdevelopment, as they are based upon the input of local materials and are characteristic of early stages of industrialization. On the other hand, they can be viewed with great potential for the industrial development of the economy (e.g., growth poles or industrial complexes).

A third observation is the increasing prominence of the construction and service sectors--specifically, the construction column and service row. This increasing definition of the construction column indicates the increasingly important role of the construction sector in spurring backward linkage in the Irish economy. Similarly, the increasing definition of the service row indicates that
sector's growing importance as an input to all sectors.

Finally, it must be noted that the Other sector was disregarded from the analysis after careful consideration. The Other row and column certainly dominates the tables with strong flows. This was viewed as suspect, given the definition of "artificial sectors, n.e.c." from which "other" was derived. It seems that this sector is a residual sector of sorts, into which uncategorized transactions are "dumped" through the accounting system. While this was impossible to confirm, it was decided simply to disregard the Other category from the analysis.

The supply patterns, shown in Figure 5, indicate several additional developments. The prominent main diagonal is supported by a dense complex in the right-central portion of the tables (rows 4 to 9, columns 8 to 10). This demonstrates the important role that the construction, transportation and service sectors have as markets to the manufacturing sectors. The agricultural-food complex is also evident in the supply patterns.

Perhaps the most important observation from both the supply and demand patterns is the stability of both patterns over the 30-year period represented by the 8 tables. This is remarkable in a small economy that has seen such increasing foreign penetration of foreign industry precisely during this period. Despite the varying presence of some isolated circles in Figures 4 and 5, the well-defined and unsupported main diagonal and the particular complexes essentially unchanged throughout the tables. The proportion of flows larger than 10
percent of total input or total output to flows larger than 5 percent, however, experienced considerable variation. In the case of demand flows, the ratio of 10 percent to 5 percent flows varied from .58 to 1.0. In the case of supply flows, the ratio varied from .68 to 1.13.

Comparison of Economic Indicators

The second part of the analysis was based on 14 of the economic indicators described in the previous section. The initial objective was to compare the 10 sectors in terms of changes in a particular indicator over the 30-year period. This objective was altered slightly, however, due to space limitations and to what appeared to be anomalous results for the years 1968 and 1976.

Due to the space constraints presented by graphical comparison, the number of sectors being compared was reduced to 6. The selection of 6 sectors reflects the importance of particular sectors as seen earlier in the demand and supply patterns (agriculture, food, construction, services) and the concern here with industrial (manufacturing) growth and development in Ireland. The 6 sectors thus comparatively analyzed with the 14 indicators were agriculture/mining, food/drink/tobacco, textiles/clothing, metal/engineering/other manufacturing, construction and services. Hereafter the first four will be referred to as agriculture, food, textiles and metal, respectively.

As the indicators for each sector were calculated for each of the 8 years and then plotted, the data for the years
1968 and 1976 appeared increasingly anomalous. While the volatility of industrial performance and vulnerability to shocks in Ireland also became clear, reverse movements of particular indicators in order of 50 to 60 percent between 1964 and 1968 and between 1974 and 1978 were clearly anomalous. It seemed that the input-output data for these two years were not consistent with the data for the other years. It was later confirmed that the tables for these years were based on forecast data, and not actual survey data. Once these two observations were removed, the plots became more consistent. Thus, the 6 sectors were compared over the same 30-year period, but with only 6 observations—1956, 1964, 1969, 1974, 1978 and 1982. Figures 6-19 show the changes in each indicator over the period for the 6 sectors.

Linkages

Figure 7 shows changes in forward linkages. The most dramatic change occurred in the metal sector, where forward linkage dropped by about 75 percent during the 30-year period. This is most likely due to the promotion of exports in the metal, engineering and other manufacturing sectors, and to the corresponding increase in foreign firms (which produce for export) in these sectors during the period. Such a dramatic drop is somewhat surprising, however, as one would expect the level of forward linkage to receive some upward force as the economy industrializes and local industries demand machinery and engineered goods as inputs to their technologically advancing and larger scale production.

The high level of forward linkage in the agriculture
sector demonstrates that the lion's share of agricultural production is processed in Ireland. This is not surprising, given the importance of the agriculture-food complex identified earlier in the supply and demand patterns. The other 4 sectors exhibit relatively low levels of forward linkage. Forward linkage in the textiles sector dropped during the period, most likely due, as in the case of metal, to export promotion and the increasing penetration of foreign textile firms in Ireland during this period.

Changes in backward linkages, shown in Figure 6, are much less dramatic. Backward linkages appear to be relatively stable during the period as compared to forward linkages. The food sector exhibits the highest degree of backward linkage throughout the period. This is not surprising, given the strength and stability of the agriculture-food complex observed in the supply and demand patterns. The lowest levels of backward linkage are in the service and metal sectors. In the case of services, this is not surprising as most inputs to services come from the value added sectors (primarily labor). In the case of the metal sector, the consistently low level of backward linkage may be viewed from two perspectives. On the one hand, weak backward linkage is not unusual, given the lack of resource-based industries, specifically mining, in Ireland. On the other hand, one might expect increasing and stronger backward linkages in the metal sector due to intra-industry flows stemming from the transfer of machinery, advanced manufactured goods and engineered products between firms in the metal, engineering and other manufacturing industries as
the economy industrializes. This has apparently not been the experience in Ireland. The construction sector, not surprisingly, shows relatively strong backward linkages. The textile sector begins the period with relatively strong backward linkages, which weaken considerably throughout the period.

**Sectoral Shares of Intermediate Flows**

Figure 9 shows changes in the sectoral shares of total intermediate inputs, or shares of total backward linkage, in Ireland for the 30-year period. The food sector overwhelmingly dominates throughout the period at about a 12% share. The agricultural sector's share diminishes from about 11% to 5% during the period. The service sector also experience a decline in its share of backward linkage, while the construction sector's share is small but clearly increasing. The metal sector's share shows a slight increase in its relatively tiny share of backward linkage. Given this information, the food and construction sectors are clearly the ones on which to concentrate development in Ireland, if the stimulation of backward linkage is considered to be (as Hirschman argues) the driving force of industrial development.

Figure 8 shows changes in sectoral shares of total output, or shares in total forward linkage. The two dominant sectors, agriculture and services, are actually declining in their share of forward linkage throughout the period. The food sector's share is steady at roughly 4% throughout the period, while the metal sector's share is tiny and becomes insignificant. The construction and textile sectors have
insignificant shares throughout the period. The most troublesome aspect of these shares with respect to the industrialization process is the metal sector's small and declining share of forward linkage. This corroborates the point made earlier that machinery, engineered products and other manufactured goods have not been developing to support the industrialization or technological development of other sectors, not to mention the metal sector in Ireland.

Imports and Exports

Figure 10 shows the ratio of imports to total inputs. The metal and textile sectors stand out as consistently high importers, with the former sector importing about 40 percent of its inputs on average throughout the period, and the latter sector averaging about 30 percent. The high import bill in the metal sector is not too surprising, given Ireland's limited energy and ore resources. In the case of textiles, though, the high import bill reflects a persistent lack of integration into the economy, and a continued labor intensity in textile production (high imports, low interindustry linkage). The other 4 sectors show import bills ranging between 5 and 15 percent of total inputs. The agriculture and service sectors show overall increases in import ratios during this period.

Changes in sectoral shares of total imports, shown in Figure 11, appear much more volatile than sectoral import bills. The metal sector clearly dominates the total import bill although its share peaks and then diminishes between 1969 and 1982. Interestingly, the agriculture sector's share of imports seems to move in the mirror image of the metal sector,
decreasing and then increasing. Both sectors undergo extreme shifts in 1974, recovering in the opposite direction in the later two years. This may be due to tariff changes incurred by Ireland's entrance into the EEC in 1973. The food and textiles sectors exhibit downward movement until 1969, when both sectors begin to steadily increase their share of total imports.

Figure 12 shows changes in sectoral ratios of exports to total output. Not surprisingly, the food, metal and textiles sectors show generally high rates of growth in exports, although in the case of the metal and food sectors export ratios actually decline in the 1974-1978 and 1978-1982 periods, respectively. This is most likely related to EEC policy during the respective period in the case of the food sector, and a drop on foreign investment into the metal sector in Ireland coupled in world recession in the case of the metal sector. The other 3 sectors exhibit low and slightly declining export ratios. In the construction sector, this is not unusual, as in a small country such as Ireland the construction sector would normally be locally based. It is somewhat surprising, however, that the agriculture and service sectors have such low and declining export ratios; given the importance of these sectors demonstrated in the supply and demand patterns, it would seem plausible that they would increasingly contribute more to foreign exchange earnings.

Changes in sectoral shares of exports are shown in Figure 13. Shares increased during the period in the food and metal sectors, and decreased in the agriculture and service sectors.
The textile sector's share of exports was relatively stable during the period. The dramatic shifts in the food sector's share of exports between 1974 and 1982 is most likely related to EEC policy toward that sector during the period, as most of Ireland's food exports are directed at the EEC market. The changes in the export shares of other sectors, while occurring at a high rate, are relatively steady.

Value Added (Gross National Income)

Figure 14 shows changes in the sectoral ratios of value added to total inputs. These ratios appear remarkably stable compared to changes in the linkage, import and export indicators. Not surprisingly, the service sector exhibits the highest ratio of value added to total input. During this period, value added constituted between 75 and 80 percent of total input to the service sector. Service inputs are predominantly wages and salaries (labor). In fact, labor is the primary component of value added in each sector, especially in the export-oriented sectors (where export policy has made taxes low and foreign domination has made retained profits low). The food sector is clearly the least labor intensive--value added is consistently less than 20 percent of total input to that sector. Construction and agriculture are, not surprisingly, high in value added, although value added as a percent of total input to construction decreases by about 10 percent during the period.

Changes in sectoral shares of value added, or shares in Gross National Income, are shown in Figure 15. The shares of construction, textiles, metal and food in total value added
are remarkably small and unchanging throughout the period. While the agriculture and service sectors clearly dominate total value added in the economy, their relative shares are also declining throughout the 30-year period. This may be viewed from two perspectives. On the one hand, wages in these two sectors have traditionally been the lowest of all sectors, so it may be a positive sign that these sectors are decreasing their domination of value added in Ireland. On the other hand, there does not appear to be a corresponding increase in shares of value added by high-wage sectors, such as the manufacturing sectors. Even the textiles sector's share of value added is low, and not increasing during the period.

Final Demand (Gross National Product)

Figure 16 shows changes in sectoral ratios of GNP to total outlays. The construction and service sectors, which produce primarily for final (and local) consumption, naturally exhibit the highest ratios. These are unchanged throughout the 30-year period. The other 4 sectors show declining ratios, reflecting increases in intermediate output in agriculture and export growth in the food, textiles and metal sectors. It becomes clear from this figure and from figure 8 that manufactured goods were increasingly flowing out of Ireland during this 30-year period, and were not transformed, consumed or invested in Ireland.

Figure 17 shows a clear grouping of sectoral shares in GNP throughout the period. At the upper level is the service sector, which consistently contributed about 30% to total GNP. In the middle level are the construction and food sectors, and
at the lower level are the metal, agriculture and textile sectors. In other words, the domestic final markets in Ireland only directly absorb service, construction and food production. Agriculture, textile and metal production is predominantly directed at intermediate (in the case of agriculture) and foreign markets. The fact that GNP in Ireland is driven mostly by service consumption is quite significant. Considering the relatively underdeveloped elements (e.g., low forward linkages) of the manufacturing sectors in Ireland, service-sector domination is a "pre-industrial" phenomenon. But considering the declining elements of these sectors (e.g., declining backward linkages), service sector domination is more "post-industrial." This is yet another sign of Ireland's unusual developmental state. In any case, it is clear that the service sector and the construction and food sectors have consistently been the ones through which demand is stimulated in Ireland.

Multipliers

Figure 18 shows changes in sectoral output multipliers, or total (direct and indirect) backward linkage. The food sector, not surprisingly, maintains the highest output multiplier throughout the period. The relative changes in output multipliers among the 6 sectors mirror almost exactly the relative changes in (direct) backward linkage seen in figure 7. This implies that the network of links among sectors in Ireland has remained very direct and the overall topography of sectoral linkages uncomplicated. The supply and demand patterns certainly show this. This is another sign of
Ireland's relative underdevelopment. From Figures 7 and 18, it is clear that the characteristics and density of industrial flows in Ireland are essentially the same in 1982 as in 1956.

The input multipliers (total forward linkage indicators) shown in Figure 19 further corroborate this last point. The similarity between relative changes in input multipliers and relative changes in direct forward linkages shown in Figure 6 reflects the starkness of linkage networks in Ireland. And the dramatic drop in the metal sector's input multiplier reflects a loss of any intermediate market for machinery and engineered goods. This further indicates this sector's lack of support to the process of industrialization in Ireland.

What comes out of the foregoing analysis is the variation among sectors in generating linkage and value added, contributing to GNP, and generating or draining Ireland of foreign exchange. The tradeoffs between certain indicators is also made clear. Backward linkages and value added, for example, are mirror images of each other—together they add to an industry's total outlays. Similarly, forward linkage and GNP add to total outlays—if policy is aimed at stimulating forward linkage, GNP is sacrificed.

**Interdependence of Manufacturing Sectors**

Given the concern here with development of industry in Ireland, the final part of this analysis focuses on the three manufacturing sectors—food, textiles and metal. Direct- and total-input and output coefficients for each of these sectors were calculated and plotted. The objective was to analyze the
characteristics of and changes in each of these sectors' interdependence among all 6 sectors.

The Food Sector

Figures 20 and 21 show that both direct- and total-input (column) coefficients of the food sector exhibited relative stability. That is, outputs from the food, agriculture and construction sectors are consistently the only significant requirements of the food sector. This suggests that technology in the food sector has not changed significantly during the 30-year period studied. A more disaggregated input-output table would most likely show more variation. Interestingly, the construction sector increased its direct inputs to the food sector from a negligible amount to about 5% of the food sector's intermediate inputs. This is most likely the maintenance and repair component of the construction sector, since the outputs of new construction are sold not to intermediate buyers but to final investors (as was pointed out earlier in the discussion of capital vs. current accounts). Total inputs of construction to the food sector were relatively steady throughout the period, at about 5%.

Figures 22 and 23 show the food sector's rows in the direct- and total-input matrices. Figure 22 shows changes in the food sector's share in the direct requirements of other sectors, and Figure 23 shows changes in the share of the food sector in the total requirements of all other sectors. In terms of direct requirements, the food sector clearly provides the lion's share of its own requirements and the requirements of the agriculture sector. The textiles sector shows small but
increasing direct requirements from the food sector. Shares of food sector output in the total requirements of other sectors are stable, suggesting that intermediate food markets in Ireland have been relatively unchanged during the 30-year period, and that most likely products produced in the food sector have remained relatively unchanged.

Figures 26 and 27 show the food sector's columns of direct- and total-output matrices. Figure 26 shows the shares of other sectors' output required directly by the food sector, and figure 27 shows the shares required directly and indirectly by the food sector. In both cases, agriculture and food are the sectors which sell the bulk of their output to the food sector. One might expect to observe an increasing share of the metal or even service sector going into food production over the 30-year period, which would be the case if the food sector was developing competitively and advancing technologically. Clearly, however, the food sector in Ireland relies on large shares of its own output and that of the agriculture sector, as well as imports.

Finally, Figures 24 and 25 show the food sector's rows from the direct- and total-output matrices. Figure 26 shows the share of food output sold directly to other sectors, and Figure 27 shows the share of food sold directly to other sectors, and Figure 27 shows the share of food sold directly and indirectly to other sectors. Clearly, the agriculture and food sectors are the only significant intermediate markets for food production in Ireland. This supports the earlier suggestion that markets for food production in Ireland have
remained unchanged and that the food sector has remained a producer of basic products which undergo very limited processing.

The Textile Sector

From the textile sector's columns of direct- and total-input coefficients shown in Figures 28 and 29, it is clear that this sector in Ireland fulfills practically all of its direct and total intermediate requirements from itself. In the case of direct requirements, however, the textile sector's self-input has declined dramatically over the 30-year period. This indicates that imports and/or other value added have become increasingly important to textile production in Ireland. As seen earlier, imports as a percent of total input of the textile sector increased substantially during this period. As in the case of the food sector, one might expect to see an increase in the textile sector's requirements from the metal sector, which would indicate that the Irish textile sector was advancing technologically and developing competitively. Inputs into the textile sector from metal are, however, negligible at best, directly and indirectly.

The story is essentially the same in terms of the textile sector's intermediate markets in Ireland. Figures 30 and 31 show that the textile sector's share of other sectors' direct and total requirements is insignificant. Its share of its own requirements is also declining. Figures 32 and 33, show the insignificance of all other sector in absorbing the textile sector's output. Again we see a decline in the textile sector as its own market. This is due, as we saw earlier, to this
sector's increase in export shares. But it is indeed striking that the textile sector remained so isolated in Ireland throughout this 30-year period.

Figures 34 and 35 show that the textile sector has served as a significant intermediate market only to itself. The textile sector absorbs negligible shares of other sectors' output. Its role as an intermediate market in Ireland is insignificant.

The Metal Sector

Finally, the metal sector shows remarkable differences between direct and total requirements and markets. Figures 36-39 show changes in the direct and total input coefficients of the metal sector during the 30-year period. The metal sector's own direct input into its production, shown in figure 36, shows a cyclical pattern. It clearly dominates direct inputs for most of the period, although it is declining between 1964 and 1978. The metal sector's direct requirement from the construction sector, insignificant until 1974, increases rapidly and substantially after that point. Direct requirements from the other sectors are relatively insignificant. The metal sector, like the textile sector, relies heavily on imports for its direct requirements.

The total requirements of the metal sector are very different. Metal dominates, construction is very small, and all other sectors are insignificant. Each of these patterns is remarkably stable throughout the period--there is nothing cyclical about them. This distinction between direct and total requirements suggests that metal production in Ireland has
developed quite independently. Any interdependence has been based upon small, cyclical direct flows, which have been generally weakening over time.

Looking at the row coefficients, a similar pattern emerges. As a share of inputs to each other sector, the metal sector contributes most directly to itself and to the construction sector, while indirectly and directly it contributes most to itself and more to the service sector than to all other sectors, to which it appears to contribute negligibly. Again, the cyclical pattern emerges in the direct flows. We also see that the metal sector contributes a small share of inputs into the agriculture, textile and service sectors. This suggests that the metal sector is very weakly integrated into intermediate markets in Ireland. As the total-input (row) coefficients imply, the only significant intermediate market for the metal sector is itself.

Figures 40-43 show direct- and total-output coefficients for the metal sector. Looking at row coefficients in figures 40 and 41, we see that the metal sector's direct intermediate markets have been declining and relatively unstable. Total intermediate markets are very different, dominated by the metal sector itself. Finally, the column coefficients show that the sector whose greatest share of output is sold to the metal sector is far and away the metal sector itself. Direct shares have been cyclical, while total shares quite stable.

All three of the manufacturing sectors showed a considerable lack of interdependence in Ireland during the period 1956-1982. Total requirements and markets do not
differ appreciably from direct ones, except in the case of the metal sector, where the difference highlights that sector's weak and variable direct integration and minimal total integration into the economy.
FIGURE 4
DEMAND PATTERNS

1  Agriculture/Mining
2  Food/Drink/Tobacco
3  Textiles/Clothing
4  Chemicals
5  Wood/Furniture
6  Clay/Cement/Glass
7  Metal/Engineering/Other Mfg.
8  Construction
9  Transportation
10  Trade/Service
FIGURE 5
SUPPLY PATTERNS

SECTORS

1 Agriculture/Mining
2 Food/Drink/Tobacco
3 Textiles/Clothing
4 Chemicals
5 Wood/Furniture
6 Clay/Cement/Glass
7 Metal/Engineering/Other Mfg.
8 Construction
9 Transportation
10 Trade/Services
11 Other
FIGURE 6
Backward Linkage Ratios

FIGURE 7
Forward Linkage Ratios
FIGURE 8

Sectoral Share of Intermediate Outputs

FIGURE 9

Sectoral Share of Intermediate Inputs
FIGURE 10
Imports to Total Input Ratios

FIGURE 11
Sectoral Share of Total Imports
FIGURE 12

Exports to Total Output Ratios

FIGURE 13

Sectoral Share of Total Exports
FIGURE 14
Value Added to Total Input Ratios

FIGURE 15
Sectoral Share of Total Value Added
FIGURE 16
Final Demand to Total Output Ratios

FIGURE 17
Sectoral Shares of Total Final Demand
FIGURE 18
Output Multipliers

FIGURE 19
Input Multipliers
Figure 24
Direct-output Coefficients (rows)

Figure 25
Total-output Coefficients (rows)

Figure 26
Direct-output Coefficients (column)

Figure 27
Total-output Coefficients (column)
Figure 28
Direct-input Coefficients (column)

Figure 30
Direct-input Coefficients (rows)

Figure 29
Total-input Coefficients (column)

Figure 31
Total-input Coefficients (rows)
Figure 40
Direct-output Coefficients (rows)

Figure 41
Total-output Coefficients (rows)

Figure 42
Direct-output Coefficients (column)

Figure 43
Total-output Coefficients (column)
### 11-SECTOR INPUT-OUTPUT TABLES FOR IRELAND

#### 1966

<table>
<thead>
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<th>Sector</th>
<th>Ag/Min</th>
<th>Food</th>
<th>Textile</th>
<th>Wd/Fur/Pa</th>
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<th>Clay/Cem</th>
<th>Met/Oth</th>
<th>Constr</th>
<th>Trans/Uti</th>
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<th>Other</th>
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<td>39050</td>
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<td></td>
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The preceding analysis begets two levels of implications for industrial policy. On one level, structural characteristics of industries in Ireland, such as sectoral interdependence, linkage and value added, have been broadly identified and comparatively analyzed. This information is potentially quite useful for the development of industrial policy. But the extent of its usefulness depends upon how the analysis—the products as well as the process—is used in the development of industrial policy. On a different level, issues surrounding the process of industrial development—its design and implementation—have been raised through this analysis.

In this final chapter, I will briefly discuss the implications of the preceding analysis on both levels. First I will speak directly to the specific sectoral and intersectoral issues identified in the analysis. Second, I will present my views on the larger, less concrete implications of this analysis for the overall process of industrial development in Ireland.

First of all, there is only so much about sectoral and intersectoral activity that can be identified with input-output tools, even with the most detailed tables. However, input-output tools do allow one to identify broad levels of activity on which one can make hypotheses. The preceding analysis has served just this purpose. We don't know everything about the food, textile and metal sectors but we do know, fundamentally, how production in those sectors relates
to the rest of the economy. Given this information, we can hypothesize about what is happening, and what may happen under certain scenarios. And, as I argued in Chapter One, this information is useful in the initial stages of policy development.

There are three main findings of the analysis: (1) a relatively unchanged topological structure in the Irish economy, characterized by sparse networks of transactions; (2) two complexes of transactions--an agriculture and food sector complex, and a construction complex; and (3) a very low degree of industrialization in the manufacturing sectors. I will consider (1) and (2) in the context of (3).

There are only negligible flows of metal goods, engineered products and other manufactured products into the food, textile and metal sectors. If Ireland is to compete globally, it must develop its own technological capacity. The metal/engineering/other manufacturing sector would need to play a pivotal role here. The agriculture/food and construction complexes embody long-term linkage relationships with other sectors in the economy, and thus can be viewed as opportunities for productive cooperation and potential technological advancement.

In the case of food, for example, Ireland has much to learn from the Danish experience. As in Ireland, the agricultural and food sectors have also been very important to the Danish economy. Given this importance, the machinery and engineering sectors in Denmark have developed very sophisticated and specialized food-processing technology,
initially to serve the needs of the food sector and later for export. And, the process technologies of extraction, purification and fermentation, originally developed for agricultural and food production, have been developed for the production of pharmaceutical and industrial enzyme products. Biotechnology products, such as insulin, and diagnostic equipment have also developed from the basic technology (Novo Industri A/S, 1984).

The construction complex may also be viewed with potential for endogenous technological development. In Japan, for example, manufactured housing has become an increasingly important industry (McKellar, 1985). Like the Danish food-processing equipment developed around indigenous food and agricultural sectors, the Japanese began to produce manufactured housing to serve their own construction sector. They have also developed specialized materials and technologies to produce manufactured housing (McKellar, 1985). The indigenous metal, engineering and other manufacturing sectors in Ireland might develop competitively by cooperating with the construction sector in the development of machinery for the production of manufactured housing or computer-aided design (CAD) equipment for building.

The textile sector offers another opportunity for technological advancement and further industrial integration. Ireland is renowned for its high-quality, specialized linen and woolen fabrics and its traditional clothing designs. The metal, engineering and other manufacturing sector might develop competitively through the production of CAD equipment
and software for the textile sector. This could lead, like the Danish food-processing technology, to export production and to further technological advancement.

The underlying logic to these strategies does not rest on the immediacy of a market for any particular product. It rests on the existing potential for institutional cooperation in production, and on the ability of Irish industries to adapt to shifts in markets and to produce for many different potential markets. The recent institutional developments in Ireland, discussed in Chapter One, reflect certain elements of this logic.

On a different level, the analysis raises issues of process and implementation in developing a national industrial strategy. As described in Chapter 3, the regular and frequent construction of detailed, national input-output tables requires a high degree of institutional coordination. Businesses, the Central Statistics Office, the Ministry of Industry, Trade, Commerce and Tourism, the IDA, several banks, and academic and research institutions have all been involved at various stages in the construction of the Irish tables.

Unlike the French indicative planning process, however, the institutional coordination involved in the construction of national input-output tables in Ireland does not result in the formation of a plan or national strategy. While I would not argue that Ireland should adopt the French planning model, I would suggest that there are several components of the French planning process that are valuable and applicable to industrial policy in Ireland. These are (1) the construction
of a national input-output table as a process of institutional coordination, (2) the development of demand projections, and (3) the importance of decentralized decision making.

According to Cohen (1969), the French planners viewed the input-output table as a sort of market-research tool. It provided detailed information of industrial activity, but more importantly it provided this information in one place and in such a way that the structure and performance of French industries could be assessed simultaneously. The construction of an input-output table requires a great deal of institutional coordination. The collection and assembly of national statistics such as input-output information in many ways reflects certain political and institutional arrangements in a country.

The Japanese government, for example, constructs frequent and regular input-output tables for Japan and regularly analyzes tables for other competitor nations as a sort of "industrial espionage" (Pleskovic, 1986). In the US, however, the availability of public data on industrial production (such as the Census of Transportation, which provided information on interstate trade) has diminished considerably over the last several years. In fact, a US Department of Commerce study on changes in government statistics from 1926-1976 shows clearly how the collection of statistics reflects political and institutional commitments.

Second, the French planners, together with business and other government interests, worked with the input-output tables to devise a plan. The demand projections that resulted
were a coordinated exercise. This is very important in any policy-making process. While demand projections would not serve a strategic purpose in Ireland, a coordinated exercise to develop scenarios around alternative structural relationships in the economy would be useful. The exercise done here was micro-computer based, using very flexible spreadsheet software. It is relatively easy to manipulate the tables in response to "if this, then what" questions and to present these responses graphically.

Finally, the French plan, at least in theory, encouraged decentralized decision making. Industrialists were cognizant of the plan, but made their own production decisions. This is very important to the kind of industrial development process suggested here, which requires trust, flexibility and institution-building. Centralized decisions or any form of coercion would prevent this from happening.

As argued in Chapter 1, an industrial policy aimed at developing a competitive industrial structure, rather than new markets, requires different institutional arrangements. Changes in supplier-buyer relationships, and relationships of firms to intermediate and final markets must be institutionally fostered. Regular and detailed information about production, and coordinated efforts to understand and to use it, must also be institutionally fostered.

In this exercise, I have attempted to show that input-output tools are useful for making general hypotheses about technological and market relationships in an economy. In the case of Ireland, the input-output tables have been useful in
assessing structural change and identifying topographical networks in the economy. Their potential for coordinating institutions in Ireland remains speculative. Nevertheless, I feel that this exercise has shown that input-output tables and interindustry analysis can provide a useful set of information to guide industrial policy in Ireland.
List of References


The Irish Times. August 20.


Pleskovic, Boris. 1986. Lecture on Building Social Matrices, Department of Urban Studies and Planning, MIT. April.


