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Structural Economic Change in Ireland 1957-2006: Statistics, Context and Analysis

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***Abstract*:** The fifty years since the publication of *Economic Development* has been a time of change and growth for Ireland. Analysis of the development of the structural composition of the economy in this period requires a consistent and comprehensive dataset from the late 1950s onwards. The national income and expenditure tables have changed over time and a consistent set of historical tables is only available from 1970 onwards. Gross value added by sector in the official historical series is given for only a small number of sectors. In this paper the tables of gross value added by sector in current and in constant prices, are extended backwards to 1957 and expanded to include fifteen industry groupings. A new comprehensive and consistent dataset spanning fifty years of the Irish economy is thus constructed. Details of the methods and sources used to develop these series are presented. A context for analysis is set out based on the framework or model developed by Professor Carlota Perez in a series of publications since 1983 and most notably in her 2002 book *Technological Revolutions and Financial Capital*. Structural changes of the economy over the period are analysed. The analysis shows how different sectors have contributed to the economy over time. It also reveals, in the Irish case, that structural change can be independent of economic growth. The Irish economy is set in the context of the Perez model of technological revolutions and Ireland's place in current and past technological revolutions is evaluated.

Keywords: economic development, structural change, historical data
JEL Classifications: E01, L16, O11

1.INTRODUCTION

This paper develops a set of statistics so as to identify the structural composition of the Irish economy from 1957 to 2006. The decline of some sectors and growth of others over the 50 year span in Ireland is examined within the framework or model of technological revolutions set out by Professor Carlota Perez in a series of publications over the years since 1983 and most notably in her book *Technological Revolutions and Financial Capital* [14].

To analyse structural economic change requires detailed statistics over a long time period and a context within which to analyse that change. Developing the statistics for gross value added in current and constant prices for the fifty years since 1957, outlining a context based on the Perez model and analysing the statistics in that context are the subjects of this paper.

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The paper is in seven sections

- This introduction
- The 5-sector extended historical series 1957-2006
- Constructing a 15-sector series
- The context which outlines the Perez approach and how it is relevant to the Irish case
- The main results and analysis
- The Irish Experience in the context of the Perez model
- Conclusions, some policy implications and future work.

The value of the work presented in the paper is twofold: the series developed stand on their own as an important extension of those currently available both in terms of the length of the series and of the sectoral coverage now available; the analysis is a first step in understanding how technology impacts not just on individual sectors such as computers, chemicals or software but on the entire economy and provides thinking on how policy should be advanced so that Ireland might benefit from opportunities which will arise in the years ahead. Additionally the paper provides the basis for further work described in Section 7.

The series produced is an extension of the national accounts series of gross value added by sector. A long series makes different types of analysis possible. Time series decompositions are best performed using a long dataset - over 20 data points are recommended. Due to inconsistencies over time of the official national accounts series, analysis that depends on longitudinal data is not always possible. The UK suffers from the same breaks in some of their time series as we do, due to changes in national accounting introduced in 1997 and Martin [10] recently produced methods for constructing a historical series of the institutional sector accounts for the UK.

This is also the most detailed series of GDP by sectoral composition available. The significance of structural factors in understanding the Irish economy is demonstrated by Keating [6], who warns against examining productivity and economic growth without regard to the effect of the increasing importance of some sectors and the corresponding decline in the importance of others.

The data assembled thus stand alone as a new and useful dataset. It is of obvious interest to macroeconomists, but it is also likely to be of use in, for example, environmental economics for relating sectoral emissions to output. The authors hope that it may be used as such. The complete set of tables is available on request from the authors and is presented in Excel format on the Statistical and Social Inquiry Society of Ireland (SSISI) website. It provides a sound basis for discussion of the structural changes in the Irish economy over the last 50 years. The figures are derived mainly from data which are publicly available either in hard copy as in the case of the older series or in electronic form on the CSO website. The data however are not a replacement for official published statistics.

Using the Perez technological approach in the analysis is a first step in understanding how technology has impacted on Irish structural change.[2] There are two broad existing perspectives on how structural change, especially recent rapid change, has been influenced in the Irish case. Many economists including Patrick Honohan and Brendan Walsh [5] and Cormac Ó Gráda [13] view the recent boom as delayed convergence that made up for lost ground caused by macroeconomic, especially public financial, mismanagement. Frank Barry [10] in a perspective closer to the present paper and referencing Krugman argues that the increased foreign direct investment inflows represented the one essential condition accounting for the strength of the boom. Clearly public policy and foreign direct investment are both important. Technology is recognised to be important at a general level. Arguably, however, understanding the impact of technology from a global perspective and how that impact diffuses from leading countries to a follower country such as Ireland can be equally important, especially in providing thinking on how supply side policy should have been and should be advanced to gain from the challenges and opportunities Ireland has faced and will encounter in the years ahead and in understanding how structural change takes place in different phases of foreign direct investment and in different domestic macroeconomic conditions.[3]

[2] Professor Perez, who has read a draft of this paper, writes in private correspondence with the authors that it is 'courageous attempt at using statistics to explain and illustrate the Irish experience.'

[3] Joe Lee [9] is perhaps forceful when he refers to the danger of embracing 'the ideology of high technology with little grasp of the criteria' by which to 'assess and control the performance of this new wonder drug'. Lee does set out an interesting historical view on technology in Ireland and concludes quoting D. Bell that if 'the true locus of the problem in economically-advanced societies is not in the technology per se but in the social system in which

Review of some related literature and commentary

Structural change in the Irish economy has been considered in some recent articles. Sexton [19] considers changes over the period 1995 to 2005. His article looks at the broad economic sectors presented in tables 3 and 4 of the current National Income and Expenditure (NIE) publication with the industry sector broadened out to include the modern sectors of software reproduction, chemicals and electronics. Sexton presents constant price tables of gross value added for 7 sectors in the economy. A large part of his discussion is a comparison of productivity across the sectors over time. Our paper expands the work done by Sexton. We concentrate also on the presentation of the economy in table 3 and 4 of the NIE. Our tables increase the sectors considered to fifteen and the series extends backwards to 1957. Our main interest is in the changes in the shares of sectors and their contributions to economic growth. Although productivity is readily derived from the constant price tables by using estimates of employment, we do not deal with it in this article.

McCarthy and O'Leary [11] look at structural drivers of economic growth. Their work considers a series, in current prices, over the period 1995-2000. Eight sectors and their contribution to GNP are considered. Industry is treated as one sector. One decision that McCarthy and O'Leary make is to omit the value added from rent and imputed rent from the calculations. This may have been worthwhile in their consideration of productivity. In the current paper we include rent as a component of GDP. In doing so, our tables are fully compatible with the national accounts. In fact we have chosen to amalgamate construction with real estate, rent and imputed rent, to be able to identify as a whole the contribution of property related activities to growth in the Irish economy. Another aspect of the McCarthy and O'Leary article is that, after apportioning net factor income, estimates of GNP by component sector are derived. Our paper concentrates only on the components of GDP, by sector.

2. THE 5-SECTOR HISTORICAL SERIES 1957-2006

Background

In 2005 the national accounts division of the Central Statistics Office produced a revised historical series for the National Income and Expenditure (NIE). This historical series is available on the CSO website and contains a complete and consistent set of NIE tables showing all national accounts aggregates from 1970 to the present. The only exception to the consistency of the tables is that aggregates before 1995 are shown without financial intermediary services indirectly measured (FISIM) whereas those since 1995 are with FISIM causing a break in the series. (The concept of FISIM is explained briefly in the next section.)

Tables 3 and 4 of this series present GDP broken down by broad economic sector in current and chain-linked constant prices. The contribution to GDP by a given sector is called its gross value added (GVA). GDP is comprised of the sum of all sectors' GVA plus taxes less subsidies. The national accounts historical series identifies five sectors' GVA (more recent years of the national accounts constant price series broaden to ten sectors). In this section we extend the tables of GVA by sector backwards to 1957.

Our sources are: Appendix 4 of NIE1977 which contains tables for 1960 to 1970; NIE1965 containing tables of GDP for the years 1958 to 1960; and NIE1961 with tables for the expenditure, but not the income, components for 1957. The main issue here is that accounting practices have changed over time. Two significant changes to the accounting principles used in national accounts were the introduction of the European System of Accounts of 1995 (ESA95) in 1998 and the introduction of FISIM in 2003. The historical tables on the CSO website are compiled according to ESA95 rules but do not include FISIM for years before 1995. To extend the whole series back to 1957, we make estimates of the effect of these accounting principles on published data based on both accounting practices. We compare, for example, published versions of GVA with FISIM with published versions of GVA without FISIM. These findings are used to correct the full series without FISIM to account for the changes that the introduction of FISIM imposes upon them. In the more detailed tables we scale the sub-sectors' GVA up to the corrected broad sectors GVA.

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that technology is embedded' then serious social thought becomes all the more necessary. Arguably whether the thought is social or economic or a combination of both, the need for context in a wide perspective is undeniable.

A second issue for years before 1970 is converting base year constant prices to a constant price series in previous years' prices. This is done by assuming for each broad sector that the two types of constant price series are equivalent.

Methodology - current prices
The classifications at broad sectoral level comprise five sectors: Agriculture forestry and fishing; industry including building; distribution, transport and communication; public administration; and other services. This classification system has been in place since 1958. We link the older table to the historical series at current prices by making estimates of the effect of the transition to ESA95 accounting and the introduction of FISIM.

To convert to ESA95 proceed as follows: The components of the current price series are adjusted individually according to the following factors found in the historical series (at ESA95) and the NIE 1977 (which is compiled pre ESA95):

$$\frac{\text{weighted average component value (1970 - 1974) hist NIE}}{\text{weighted average component value (1970 - 1974) NIE1977}}$$

(where the weights 16:8:4:2:1 are applied to the years 1970 to 1974 respectively).

FISIM (financial intermediary services indirectly measured) was first used in the national accounts in NIE2005. FISIM measures the value gained by banks and lending institutions through lending and borrowing with ordinary customers at a different rate of interest than with financial institutions. Before the introduction of FISIM into national accounting the banking sector's GVA from this activity was not recognised. For this reason CSO attributed a value added to these institutions in the sectoral breakdown in NIE table 3. This attributed value added is the 'adjustment for financial services' that was then deducted from the calculation of GDP. It follows that we are on firm footing if we use the adjustment for financial services as an indication of FISIM.

Financial institutions, within the other services sector, are receivers of FISIM. All other sectors as well as households pay FISIM (FISIM is also imported and exported). We consider the NIE tables for 1995 to 2005 with FISIM and the same tables without FISIM. For each sector we calculate the average, over 1995 to 1999, of the ratio of the effect of FISIM from the former table with the adjustment for financial services in the latter. Since all preceding years after 1959 have an adjustment for financial services, we use this ratio to adjust the five sectors for the effect of FISIM. The effect is as follows: The GVA of the other services sector's (which includes banks) is increased as it is a net recipient of FISIM, whereas all other sectors' GVA is reduced as FISIM is added to each industry's costs. The total GVA is increased. This is because some of the FISIM is paid by households and government.

It appears that the tables for 1957-1959 are presented with FISIM (see note (i) on page 4 of NIE 1976). So there is no work to do in this case.

We note in passing that CSO's historical series though in line with ESA95 is without FISIM for 1970 - 1995. Our historical series as well as being longer also contain FISIM and are thus more up-to-date. Caution is advised though at this stage. We are remarking recent patterns in the financial activities to make conclusions about a time when the interactions between business and banks may have been very different. The current price series is presented in Table 2.1. For economy of space, every second year is printed.

Table 2.1 Extended Historical Series, Current Prices:
GVA by sector of origin at current market prices 1958 -2006 (€m)

	Agriculture	Industry & construction	Distribution	Public admin	Other sectors	Total GVA[4]
1958	160	182	113	35	148	639
1960	177	215	135	38	165	731
1962	193	270	164	45	191	862
1964	221	324	200	59	238	1,042
1966	216	379	224	66	270	1,155
1968	264	492	267	76	333	1,431
1970	295	637	365	106	437	1,923
1972	442	894	478	146	618	2,679
1974	534	1,199	718	212	885	3,673
1976	891	1,807	1,012	345	1,398	5,680
1978	1,369	2,871	1,601	457	2,180	8,659
1980	1,245	4,035	2,106	729	3,474	11,987
1982	1,741	5,546	2,971	1,066	4,843	16,780
1984	2,270	6,889	3,371	1,262	6,210	20,533
1986	2,062	8,155	4,203	1,466	7,616	23,951
1988	2,778	9,315	4,994	1,535	8,666	27,560
1990	2,958	11,231	6,107	1,788	10,569	33,049
1992	3,197	12,557	5,664	2,039	12,708	36,436
1994	3,366	14,702	6,463	2,252	14,946	42,087
1996	3,596	19,252	8,715	2,443	18,277	52,800
1998	3,495	28,309	11,215	2,824	25,150	70,115
2000	3,504	38,339	14,611	3,258	33,853	92,902
2002	3,428	47,571	17,211	4,098	43,526	116,702
2004	3,552	47,120	20,564	4,845	54,966	131,882
2006	3,812	52,610	25,258	5,396	69,097	154,899

Methodology – constant prices
Traditionally national accounts constant price series were constructed as Laspeyre's volume indices with base weights updated every 5 years, or more. This was the practice in most statistical offices. In recent times, especially since the impact of hi-tech industry and globalisation, it is found unsatisfactory to use prices fixed for long periods and statistics offices have switched to using chain-linked constant price series with goods valued at previous years' prices (see Sexton [18] for a discussion of this point).
To convert the base year constant price series, as published, to ESA95 accounting, we adjust each constant price component by the ratio of the current price component in ESA95 to the same component in current prices pre ESA95.

To convert from tables in base year prices to tables in chain linked previous year prices, we make the following assumption: *For each sector, the ratio of the GVA of this year to that of last year, measured in last year's prices, is equal to the ratio of the GVA of this year to that of last year measured in the base year's prices*. This assumption, which implies no difference between the prevailing convention of constructing constant price series (in previous year prices) and that used before 2003 (using a base year) is necessary to maintain the growth rates presented in the official national accounts. As we are dealing with historical, pre-electronic age data, there are grounds for accepting the assumption, as changes in prices are likely to have been relatively homogeneous at this time across the different sectors.

[4] There is no statistical discrepancy before 1970. Consequently for the years 1957-1969 the components add exactly to total GVA.

Converting the constant price series for 1960-1995 to a series with FISIM is done in the same way as the current price series.

This concludes the work done to extend the constant price historical series. Growth rates in the extended historical series are close to growth rates in the official statistics (after 1995 the growth rates are equal to the growth rates in table 4 of NIE 07). Any differences are due to the effects of transition to ESA95 accounting with FISIM. Every second year of the series is presented in Table 2.2.

Table 2.2 Extended Historical Series, Constant Prices: Sectoral GVA at previous year's prices, chained, referenced to 2006

	Agriculture	Industry & construction	Distribution	Public admin	Other sectors	Total GVA
1958	1,514	2,777	2,724	1,967	10,255	15,950
1960	1,727	3,200	2,967	2,009	10,908	17,711
1962	1,758	3,700	3,286	2,092	11,372	19,162
1964	1,807	4,244	3,587	2,167	12,142	20,818
1966	1,737	4,521	3,751	2,205	12,294	21,329
1968	1,890	5,364	4,272	2,315	13,089	23,939
1970	1,902	5,825	4,814	2,495	13,976	25,717
1972	2,172	6,469	5,251	2,770	15,713	28,778
1974	2,264	7,121	5,799	3,118	16,898	31,229
1976	2,235	7,284	5,847	3,324	18,263	32,583
1978	2,491	8,569	6,770	3,546	20,338	37,204
1980	2,349	9,370	7,322	3,881	22,123	40,812
1982	2,512	9,781	7,177	4,058	23,049	42,902
1984	2,887	10,608	7,083	4,066	24,515	45,016
1986	2,616	11,252	7,215	4,201	25,263	46,448
1988	2,927	13,006	7,846	4,046	26,102	49,509
1990	3,428	15,315	10,560	4,210	27,511	57,582
1992	3,627	16,633	9,621	4,278	29,756	60,017
1994	3,253	18,795	10,512	4,235	31,636	64,862
1996	3,570	23,927	13,372	4,367	34,370	77,781
1998	3,670	31,658	15,993	4,490	39,617	93,489
2000	3,564	38,970	19,558	4,681	46,066	112,020
2002	3,523	45,268	21,972	5,019	52,455	127,857
2004	3,728	47,895	22,967	5,249	60,436	139,480
2006	3,812	52,610	25,258	5,396	69,097	154,899

3. CONSTRUCTING A 15-SECTOR SERIES

In this section we expand the tables of GVA in current and constant prices to 15 sectors. The general approach used to disaggregate the 5-sector tables of GVA to 15 sectors is introduced. The method of constructing chain-linked constant price tables in previous years' prices is explained. Details of the sources and techniques used for each of the 15 sectors are given. We present our process in detail to give users the opportunity of assessing the quality of the tables provided.

Classifications
The 15 industry groupings are chosen to best represent, in summary form, the sectors of significance to the Irish economy and the sectors of significant change in the period. They are as follows:

Code	NACE	Description
1	01, 02, 05	Agriculture, forestry, fishing
2	15	Food products
3	24	Chemicals
4	30 - 33	Electronics
5	10-21,23,25-29, 34-41	Other industry
6	40	Energy
7	45, 70	Building, real estate, rent and imputed rent
8	50-52	Distribution
9	55	Hotel & restaurant
10	60-63	Transport
11	64	Communications
12	65-67	Financial
13	22 & 72	Printing, software and computers (IT)
14	71-74, 91-95	Other services
15	75 - 90	Public services

We disaggregate distribution, transport and communications. Hotel and restaurant services are isolated specifically as a barometer of the tourism industry. As mentioned above, in order to better examine the effect of property on the economy, we amalgamate construction with real estate and rent of dwellings (real and imputed). We use the name 'electronics' to cover the manufacture of office machinery, computers, processing chips and communication, medical and precision instruments, this is NACE 30-33. NACE 22 (printing, reproduction of recorded media including software) is amalgamated with NACE 72 (computer services). Here we combine a manufacturing activity with a service. This is in line with the forthcoming NACE Rev 2 where all computer related activities are classified together. Education, health and public administration are combined being for the most part non-market government sponsored activities.

Methods used to compile a current price series
Most statistics compiled by the CSO are in current prices so constructing a current price series is, in theory, a straightforward task. A long series has, however, two particular difficulties: the classifications and groupings of industries used to compile the statistics do not stay fixed over time; and the level of detail is uneven across different sectors. For the purposes of comparing data from different years, these issues – classification and varying levels of detail - are addressed.

The NACE coding is an international classification of industries which was adopted by the CSO in compiling 1973 statistics. The original NACE coding was replaced by NACE Rev1 in 1995. Before NACE, it appears each country had its own individual classification of industries. Thus there are three different classifications used by CSO in the period from 1957 to the present. In Part 1 of the paper we construct the tables according to prevailing NACE Rev 1 classification (with amalgamations). For earlier classifications we compile data at the highest level of detail possible. The accounts are then reassembled to NACE Rev 1 groupings.

The Census of Industrial Production has existed in roughly its present form since 1926 when it was compiled by the Department of Industry and Commerce. Up until the start of the Annual Services Inquiry (in 1991) the level of detail and availability of data for the manufacturing industries far outweigh that of services. The examination of the development of services is integral to a discussion of the changes of our economy in the last 50 years. There remains a need therefore for service level statistics for the period. We use a number of approaches. Seven sets of official input-output tables are available for the period. Keogh & Quill [7] have converted the tables for 1975, 1985 and 1990 to

ESA95 with FISIM tables exactly compatible with later tables. In the input-output tables data are available at a good level of detail. The *Statistical Abstract* has data on tourism, education, health, and public administration (also for construction up to 1973). The CSO website makes available in electronic form most CSO published statistics in *Database Direct*. Publications from various external sources such as the Department of Environment and Bord Fáilte are also used. Although many of these sources do not present GVA for the whole sector we have been able to adapt them to our needs to produce the tables.

Methods used to compile a constant price series
We extend the historical national accounts series of GVA at chain linked constant market prices (table 4 of NIE) backwards to 1957. We further expand the series so as to include the GVA of a wider range of industries. Chain linking requires compiling accounts at a high level of detail in current prices and in prices of the previous year. We outline the method in the following paragraphs.

Using indicators of year-on-year volume growth or otherwise, each sub-industry's GVA is expressed in previous years' prices. These accounts are aggregated to industry, industry-group or sector level giving again the value of GVA for the aggregation in previous years' prices. Indices of the ratio of each year's GVA in previous years prices to the GVA of the previous year (in current prices) are found. These indices are linked by multiplication. Once this series of indices is made, a reference year is chosen. All years' GVA are expressed in terms of the prices of the reference year. The process is presented symbolically as follows:

Let $s_1, s_2, s_3, \ldots$ be an industry's sub-components with gross value added for year *t* given as $gva_1^{\,t}, gva_2^{\,t}, gva_3^{\,t}, \ldots$ where $0 \le t \le n$ (where there are *n + 1* years in our series).

For each sub-component s_i, let $gva\_pyp_i^{\,r}$ be the GVA in year *r* expressed in previous year's prices.

We find the ratio of the sum of the GVA's in previous years' prices on the sum of the previous years' GVA's:

$$I_r = \frac{\sum_i gva\_pyp_i^{\,r}}{\sum_i gva_i^{\,r-1}} \qquad (1)$$

where the sum is over the sub-components.
The indices are next linked by multiplication.

Given indices $I_1, I_2, I_3, \ldots$ then $I_1, I_1 \times I_2, I_1 \times I_2 \times I_3, \ldots$ is the chain-linked series. The process is done for each component and for GDP itself. For this reason the components do not generally add exactly to GDP.

In summary, to construct a constant price series in previous year prices, we need a set of accounts in current prices as well as a method of compiling these accounts in previous years' prices. Two methods are used: volume indices can be used to project forward the GVA of last year or price indices can be used to deflate this year's GVA to last years' prices.

In our work, we generally project forward GVA using volumes of production. The formula above is used to construct indices for each industry. The industries are then summed to each broad economic sector and scaled to the constant price series so that the year on year growth of the whole sector matches that of the five-sector historical series. That is, we start the work from first principles using detailed accounts of output, GVA and volume. Indices are constructed but adjusted so that, at the broad economic sector level, the growth rate presented in the official national accounts is maintained.

Ideally the method of double deflation, where both outputs and inputs are expressed in previous years' prices, is used to express GVA in previous years' prices. The limitations of using volume of production indices is dealt with by scaling each industry's GVA to the GVA in the constant price tables in the official statistics.

Where higher level detail is unavailable then a constant price series valued at a given base year's prices are used for the whole industry group. This is valid if the industry's components' prices are relatively stable over the period of the index. It is also valid if the price structure of the industry is relatively homogeneous i.e. that there is a good positive correlation between the individual products' prices. Furthermore in the case of a short index of volume, the ratio of successive years' constant prices is likely to be close to the year-on-year volume growth. In this case, however, the series produced is equivalent to the original constant price series.

Details by sector of methods used with reference to sources
In this section we present an inventory of the sources and methods used to produce the 15 sector disaggregation of the tables of GVA in current and constant prices for the years 1957 to 2006. The main sources are: the CSO's *Statistical Abstracts* for early years and *Database Direct* for later years, Censuses of Distribution and Censuses of Population as well as input-output tables. Briefly our method is as follows. For the current price tables we assemble GVA at the highest level of detail possible and re-aggregate to sector level. For the constant price tables we again assemble data at the highest level of detail and use volume indicators to express accounts in previous years' prices. Formula (1) is then used to construct the chain-linked series.

NACE 1-5 Agriculture
Value added of the agriculture, forestry and fishing sector at current and constant prices are already provided in the extended historical series.

NACE 10-14 Manufacturing and energy
1957-1972
The CSO's *Statistical Abstract* for the years 1960 to 1974 contains the table 'Industrial Production: Output, Cost of Materials, Salaries and Wages and Persons Engaged in each Industry'. This table presents gross output, cost of materials and net output for 47 industrial sectors as well as for construction, energy production and local government. *Net output* is the difference between the gross output and the cost of materials used (including fuel). Net output for an industry type is greater than value added by the cost of services purchased by that industry.

Input-output tables give details of all inputs into each industry type. The service inputs omitted from the industrial production tables can be estimated using the input-output tables. Published input-output tables are available for 1964, 1969 and 1975. Tables for 1956 and 1960, constructed by Eamon Henry [4], are also available. For these benchmark years, the ratio of service inputs to material inputs is available. In the case of other years we estimate the ratio of service to goods inputs using the benchmark ratios and straight line methods.

By combining these ratios with data in the industrial production table, service inputs and GVA by industry type can be derived. We note that the inputs given in the input-output tables are domestic inputs with imports shown separately. We can assume however that there are no service imports of any significance in this time period so that the method employed here to estimate services is acceptable.
We aggregate GVA by detailed industry type to NACE groupings and scale to the manufacturing and construction sector of the historical current price table already constructed. This gives a table of current price GVA by NACE groupings consistent with the historical series. Construction is scaled to the input-output value for construction (see below) and industry is scaled to the remainder of the 'industry' category in the historical current price tables.

A further table in the same section of the *Statistical Abstract* provides the same industries' volume of output at 1953 prices. This is a rather long series at constant prices (running to 1973), but is adequate to calculate the year-on-year change at a detail needed to construct the chain-linked series. The chain linked series is constructed using the method outlined in section 2. (This is the method used throughout this section: For each NACE grouping we have GVA in current prices and the GVA in previous years' prices. Indices are found for each industry grouping using Formula 1. Finally, the indices are scaled to the 5-sector indices derived from the extended historical series.)

1973-1990
For 1973 to 1990, tables from the Census of Industrial Production are available on the CSO's *Database Direct*. These tables use the original NACE classification. We distinguish between net output and GVA and make adjustments to the local unit results by examination of the enterprise file which gives a truer

indication of GVA but is not as complete in the coverage as the local unit file. Tables of volume of output are also available. For each industry type at a detailed sectoral level we compile GVA and GVA in previous years' prices. Each of the detailed sectors maps into a 2-digit NACE Rev1 code.

As a control total, we check that the GVA of manufacturing industry plus construction equals the GVA of 'Industry' in the historical series. When construction as calculated below is subtracted from the total for industry in the (revised for FISIM) historical series we found that the remainder of industry had to be adjusted by an average of -8%. We can expect some divergence between GVA derived directly from the industry survey and GVA presented in the national accounts, which is compiled using different data sources. Allowing for the further effect of FISIM, which reduces GVA, this seems satisfactory.

1990 onwards
Industry data on GVA and volume of production at 2-digit NACE level are available on CSO's website in *Database Direct*. This is used as before to construct the current and constant price series. For years since 1995, the NIE has detail of the reproduction of recorded media, chemicals and electronics which we use directly. In our classification system we consider reproduction of recorded media (NACE 22) and computer services (NACE 72) together. As regards computer related services, there is no computer industry identified in the censuses of population in the years 1981 and 1986. There are some data from the Census of Services 1988. The CSO begins publication of the Annual Services Inquiry for 1991 and in the 1992 publication 304 such enterprises are identified. We use growth rates of other services in the 5-sector historical series to trend the GVA of computer related activities starting in 1985. From 1998 onwards we use 2-digit NACE data on GVA available in the input-output tables and national accounts Output and Value Added by Activity 2002-2006 to estimate GVA. The latter is a new source of data available from the CSO at a high level of detail.

NACE45 &70 Construction & Rent of dwellings
Construction
For 1957 to 1972 the industrial production and volume of production tables from the *Statistical Abstract* are used again, as well as the input-output tables, to derive GVA and growth rates of construction. After 1972 output and volume of production are taken from the Department of Environment annual reports 1983 to 1988. These data extend back only as far as 1980. To fill in for missing years we use the 1975 input-output tables and the *Statistical Abstract* tables for output of large firms in the 1970's. In fact the only sources for actual GVA are in the input-output tables of 1975 and 1985. These values are used to benchmark the ratio of GVA to output for these years and to derive GVA for the other years. From 1986 to 1994 we use the Department of Environment *Review and Outlook* publications of output and volume of output of the construction industry. From 1995 onwards, the historical tables have details of construction in current and chain linked constant prices.

Real estate and rent of dwellings
Regarding rent, we combine the value of net operating surplus from real and imputed rent in table 1 of the NIE available for all years with the values of GVA for real estate and rent of dwellings from the input-output tables to estimate the current price GVA of rent over the period. We use population values as an indicator of growth in the rental sector to construct GVA in previous years' prices.

NACE 50-52, 60-64 Distribution, transport and communication
Distribution, transport and communication is one of the categories used by national accounts in the broad sectoral division. In this paper we separate out the three sectors. One issue however is the inclusion of public houses within distribution in the NIE. According to NACE Rev1, public houses are classified with hotels and restaurants in NACE 55. We follow the NACE classification in this paper. Our first step is to produce a series of value added for public houses. This is not straightforward as the value added is not identified in any publication for any year up to the 1990s, as far as we know. One approach is to consider the *gross margin* (gross margin = total sales less purchases for direct resale plus changes in stocks) which is available in the Census of Distribution and later in the Census of Services. These publications for 1956, 1966, 1971, 1977 and 1988 provide the gross margin for public houses. Recent evidence from the 1990's Annual Services Inquiry show that value added is roughly two thirds of gross margin for this sector. We thus estimate value added of public houses in these years. The intervening years are filled using straight line estimation. This is the current price series of GVA of public houses, 1956 to 1971. For 1990-1995 we can use the Annual Services Inquiry directly. After 1995, national accounts tables provided to Eurostat include the value added of bars with hotels and restaurants.

Volume indicators for the output of bars are based on the current price series and the consumer price index for alcohol.

By subtracting public houses from distribution, transport and communication in the extended historical series for the years 1957 to 1995 we have a current price series which we now disaggregate into three parts using the input-output tables and using straight-line estimation for the non input-output years.
Volume indicators for transport are based on length of journey and passenger numbers for land transport and number of pilots for air transport. Volume indicators for communication are based on the mileage of telephone circuit and postal matters delivered. These data are available in the *Statistical Abstract* and the CIE annual reports. Later years' volume of communication is based on deflating using the consumer price index. The extended historical series in constant prices is used to calculate the indices for distribution as a residual after transport, communications and bars are removed. Using these volume indicators we estimate a chain linked series of GVA.

NACE 55: Hotels, restaurants and bars
Using methods outlined in the previous paragraphs for the construction of the current price series for public houses, we construct the equivalent series for hotels and restaurants, that is, using a combination of input-output and Census of Distribution data with straight line methods. For restaurants we base the volume measure on numbers employed in restaurants and cafes from the Industry volumes of the Census of Distribution. In the case of hotels, we use Bord Fáilte's figures of inland tourism as a volume indicator. This is an improvement on using census figures of employment because the data are available annually since 1960. The three parts of each of the current price and the previous years' prices series are aggregated and a chain-linked series is found for the sector.

NACE 65-67: The financial sector
For the years 1995 to 2006 the value added of financial services is given directly in the national accounts tables provided to Eurostat. We calculate the ratio of GVA to the adjustment for financial services for the years 1995 to 2000 as roughly 1.84. (We allow this to decrease by .5% going backwards to allow for the fact that older input-output tables have a lower GVA than the ratio suggests.) We derive the GVA for all years based on the adjustment for financial services in the current price tables and the ratios above, trending for the years 1957-59. Volume indicators are based on employment numbers from the census.

NACE 75-85: Public Admin, Education and Health
The net value added for public administration is available already as one of the main sub-sectors of the extended historical series. Depreciation for 1957 to 1995 is estimated based on values in the input-output tables. Gross value added is found in the national accounts tables sent to Eurostat for the years 1995-2006.

A current price series for education is estimated as wages and salaries of teachers and lecturers plus 75% of pensions paid, benchmarked to input-output values. The former data are in the *Statistical Abstract* up to 1999. The 75% is rather arbitrary but the total comes to roughly 94% of the total spend on education (from NIE) and is acceptable as there are no profits and little depreciation of machinery in the sector. Also the value agrees well with the input-output value for GVA of education. Volume indicators are based on a fixed weighted average of numbers of teachers and students in the four main strands of education (including VEC and C&C) is found. Using the current price series with the volume series, the series at previous years' prices is constructed.

The output and value added of health are not so readily available. The input-output tables for 1956 and 1960 present health and education together. We subtract the education current GVA calculated above from this combined figure to get a current price GVA for health. The 92-sector versions of input-output tables for 1964 and 1969 have GVA of health. For other years we use estimation. The NIE from 1970 and later years have details of central and local government expenditure on health for 1966 onwards. We use these values and the input-output GVA values to estimate GVA for 1966 to 1990 and use straight line estimation for all other missing years. From 1990, national accounts data are available on the GVA of Health. Indicators of volume are estimated based on numbers employed in the different hospitals available in the censuses of population.

NACE 71-74, 90-95: Other services
The item 'other services' in the 5-sector NIE classification covers all business services including financial, rent, business, other personal services, hotels and restaurants, health and education. We have a current price and a constant price series for this broad sector in the extended historical series. We compile also a series in previous years' prices. From the current and previous years' prices series we subtract respectively the current and previous years' prices values for computer services, real estate and rent, hotels and restaurants, health, education and the financial sector. Thus the required sector is found as a residual. With accounts in current and in previous years' prices for the sector a chain linked series is readily constructed.

4. THE CONTEXT WHICH OUTLINES THE PEREZ APPROACH

The context for the analysis in this paper is based on the work of Professor Carlota Perez. Perez describes her early 1983 paper as starting 'from a somewhat Schumpeterian view of the role of innovation in provoking the cyclical behaviour of the capitalist economy.' In her 2002 book Perez describes her model as proposing a historical structure based on recurrence which can be roughly ranged within evolutionary economics. Andrew Tylecote in *The Long Wave in the World Economy* [20] describes Perez as producing a synthesis between the work of the French regulationists and Christopher Freeman on new technology systems. Perez situated her early work in the field of long wave analysis associated originally with Kondratiev but has in her recent work focussed more on the discontinuity of technical change but the regularity of technological revolutions about every half century and the wider financial, institutional and social context in which they take place. This is well summed up in Brian Arthur's commentary reprinted on the cover of the paperback edition of her book, when he says, 'Carlota Perez shows that historically technological revolutions arrive with remarkable regularity and that economies react to them in predictable phases.'

From the perspective of the present paper in focussing on sectoral economic change Arthur has identified two key thoughts in the Perez approach, namely phases or cycles and regularities. Perez identifies five successive technological revolutions as regularly occurring in cycles of fifty or so years since the 1770s. Cycles are particularly relevant at the present time when many had attempted to convince us that cycles were a thing of the past. As Frances [18] has observed recently, 'Economic cycles are a fact of life….Our experience from time to time of long periods of sustained growth in our major markets such as in the 1990s should not cause us to forget this.' To which we must say, 'But we did forget and at a significant cost.'

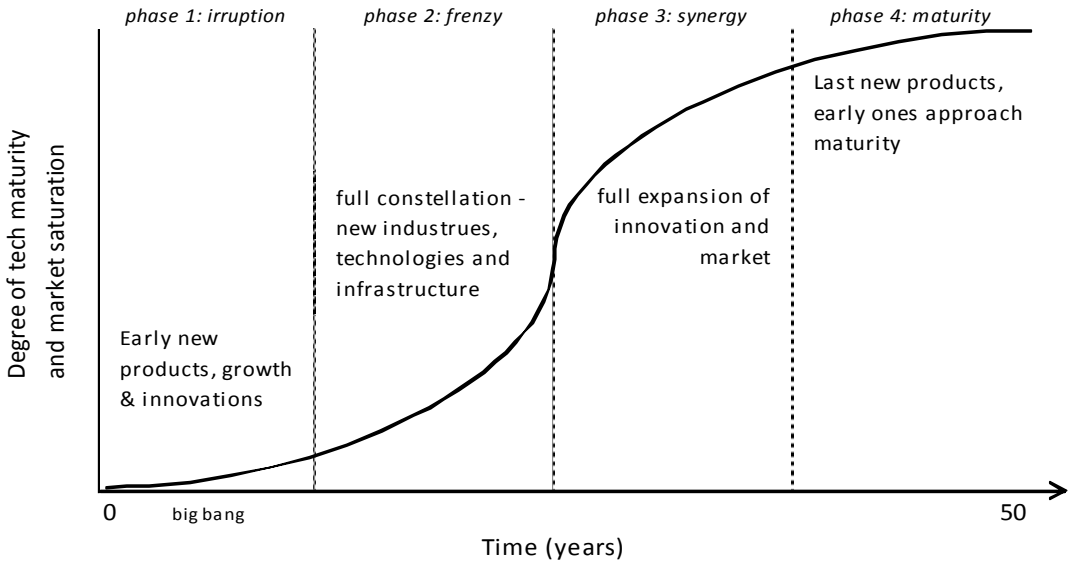
What distinguishes a technological revolution, for Perez, from a random collection of technology systems are two features. These are: the strong interconnectedness and interdependence of the participating systems in their technologies and markets; and their capacity to transform profoundly the rest of the economy.

Perez has identified what she calls 'big bang' dates for the initiation of each revolution being the date of the appearance of 'a highly visible attractor…symbolizing the whole new potential and capable of sparking the technological and business imagination of a cluster of pioneers.' The technological revolutions with their 'big bang' events are : the original 'Industrial Revolution', initiated by the opening of Arkwright's mill in Cromford in 1771; the Age of Steam and Railways initiated by the test of the 'Rocket' steam engine for the Liverpool-Manchester railway in 1829; the Age of Steel, Electricity and Heavy Engineering initiated by the opening of the Carnegie Bessemer steel plant in Pittsburg in 1875; the Age of Oil, the Automobile and Mass Production initiated by the first Model-T coming out of the Ford plant in Detroit in 1908; and the current Age of Information and Telecommunications, the ICT era, initiated by the announcement of the Intel microprocessor in Santa Clara in 1971 and projected by Perez to last at least another 20 years.[5]

[5] In personal communication with the authors Perez suggests that biotechnology may lead the next technology revolution. 'I think biotech is an important radical new technology *in gestation* under the ICT paradigm, just as electronics, computers and control instruments were in gestation in the 1950s and 60s under the mass production paradigm. No revolution appears like a thunderbolt; each has been around with some astounding successes (IBM, for instance) decades before. It is when a breakthrough appears that makes them all-pervasive and cheap that they can become a proper revolution and generate their own techno-economic paradigm. I don't think we lose anything by recognizing the importance of biotech as a radical technology system that is likely to lead the next revolution (and is therefore super-important for any country that wants to be in the front ranks in the medium and long term).'

She has identified four phases and a turning point in each technological revolution. The first phase is *irruption: a time for technology;* the second phase is *frenzy: a time for finance;* next comes the *turning point: rethinking and rerouting development;* the third phase is *synergy: a time for production;* the final phase is *maturity: a time for questioning complacency.* A simplified diagram of the model is set out in figure 4.1. The turning point is at the end of phase 2 and the beginning of phase 3.

Figure 4.1 The life cycle of the technological revolution



Further each revolution had or has a key factor which Perez describes as 'a specific input which plays the role of the low cost key factor' which became widely available. For example as she says, 'it is only in 1971, with the microprocessor, that the vast new potential of cheap microelectronics is made visible.' Perez says that it has often been suggested that the next technological revolution will be formed - arguably as a revolution in the 2030s - from the combination of biotechnology, bioelectronics and nanotechnology - in which we would identify in particular environmental requirements. Perez believes that what would make it revolutionary is a low cost factor 'that would make it cheap to harness the forces of life and the power hidden in the infinitely small' but that this is still unpredictable. She does see meeting the environmental challenges as an important condition favouring the acceptance of significant changes in policy and potentially playing a crucial role in stimulating innovation.

Perez has identified two ways in which her model might apply to follower countries. On the one hand she identifies a final phase in the cycle of diffusion of a technological revolution in which development of mature technologies spreads to peripheral countries. On the other hand she says that follower countries can make significant progress in the early stage of a new technological revolution and in this connection says that 'a key feature of the current Information Age is the establishment of a globalized economy,' where 'the spreading of both production and trade networks across core and peripheral countries began from the early installation period' and suggests that 'this feature is likely to distinguish this surge from all previous ones in terms of the rhythm of propagation to non-core areas.' Perez distinguishes clearly between what can be termed maturity growth and the more positive catching up, reminiscent of Schumpeter's distinction between growth and development.

In analysing the modernisation of the whole productive structure of economies Perez identifies four different types of branch or sector namely: motive sectors which produces the key factor; carrier sectors which are those that make intensive use of the key factor, infrastructural sectors whose impact is felt in shaping and extending the market boundaries for all sectors and induced sectors whose development is both a consequence and complimentary to the growth of the carrier branches.

Perez believes that the interconnection between production and financial capital and the reality that they have different criteria and behaviour in pursuing profits is central to understanding their impact on cyclical development. There is little need to underline that factor in present circumstances.

Perez has set out a description of the key elements of her approach in her 2002 book and in the large number of papers to be found on her web site. In this paper we will deal with the way in which the Perez approach might be applied to Ireland based on our survey of the data over the last 50 years. We discuss technological revolutions and how they impact on a follower or peripheral country. We see how well structural change in the Irish economy fits the Perez model. We consider the branches that Perez isolates in analysing the way in which technological revolutions develop across economies and identify these branches in the Irish case. We also mention the consequences of the different behaviour of financial and production capital.

5. DATA AND ANALYSIS

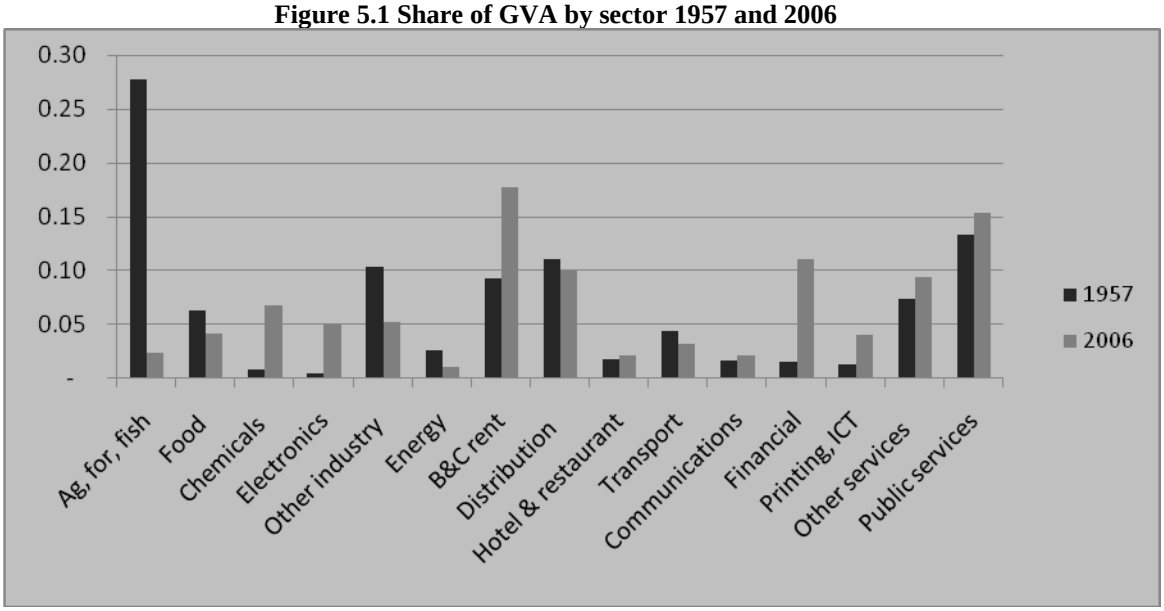
We now examine the statistics to establish the extent and nature of structural economic change in Ireland over the past fifty plus years. We use four time periods or phases to reflect the macro economic development since 1957. First a fifteen year period from 1957 which started from a very traditional agriculture and protected industry base with good overall growth reflecting for many the new policy approach of Whitaker's Economic Development and the Lemass Programmes for Economic Expansion. Then a further fifteen year period to 1986 with good initially but later poor overall growth when we had an oil crisis, a somewhat misguided Keynesian justified policy push for growth which took little account of the open nature of the Irish economy coupled with entry to the then European Community. Next, the ten year period to 1996 when we had a return to good growth following on social partner based policies coupled with rapid global growth but little response from employment. Finally, from 1997 to 2006, when we had a continuation of rapid GDP growth and rapid employment growth in the Celtic Tiger era but headed into fiscal instability and the global financial crisis.

From the perspective of the present paper we will examine how the structure of the economy changed over the entire period and the extent to which this change varied with the macro pattern. We will do this in two ways: first, by identifying the pattern of the growth by sector; and secondly, by outlining the contribution of different sectors to that growth which takes account of the initial size of the sectors.

We present constant price tables in previous years' prices for value added at detailed sectoral level for each of the time periods. In each of the tables a reference year is chosen and the results are shown in the prices of that year. Years for which input-output tables are available are convenient choices as reference years. We choose the latest year in the time period where input-output tables are available. Changing the reference year is very straightforward and it makes sense to think of the tables simply as a set of indices by sector (by dividing the gross value added of each sector and each year by the gross value added of the reference year). For this reason linking the four tables is also straightforward. Thus the four tables together comprise the longest, most detailed, up-to-date and consistent series of its type available for the Irish economy.

We begin by presenting the Irish economy in 1957 and 2006 in Figure 5.1 so as to identify clearly the changes that have occurred in the last 50 years.

Figure 5.1 Share of GVA by sector 1957 and 2006



In summary: there is a substantial decline in agriculture; industry and energy together register a decrease and there is substantial shift within the aggregate from traditional to modern manufacturing; construction and financial services make up most of the fall in agriculture and there is some increase in other services and public services. The shift of the balance to services in the recent times has been remarked by a number of commentators; see for example [3] and McCarthy and O'Leary [11].

Period 1 1957-1971

Table 5.1 shows the GVA in constant previous years' prices at detailed sectoral level, for 1957 to 1971, referenced to 1969 prices. GDP at constant prices is shown at the end of the table and the percentage change over the fifteen years is given in the last column.

Table 5.1 Gross Value Added by sector of origin at constant market prices (chain-linked annually and referenced to year 1969)

Sector	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	change 57-71
Ag, for, fish	235	224	244	255	258	260	256	267	257	257	264	280	274	281	298	27%
Food	74	76	78	79	82	84	84	86	91	96	101	105	105	112	118	59%
Chemicals	10	10	12	13	14	15	15	16	19	22	24	28	31	31	32	211%
Electronics	4	5	6	7	9	11	13	14	15	18	19	19	20	19	17	329%
Other industry	109	109	124	132	142	150	157	173	177	181	196	213	232	239	248	128%
Energy	15	17	18	19	19	22	23	25	27	28	31	34	37	40	42	169%
B&C rent	91	100	103	109	118	127	140	148	154	150	158	181	187	187	207	128%
Distribution	120	118	118	125	133	139	145	150	154	157	162	175	186	194	201	67%
Hotel/ restaurant	22	22	23	24	24	25	25	27	28	28	29	30	31	29	29	34%
Transport	47	46	46	49	52	54	56	59	60	62	66	73	80	85	91	94%
Communications	18	20	24	25	26	28	29	33	33	34	35	35	36	37	37	108%
Financial	35	38	40	43	48	49	51	52	53	54	57	59	61	64	66	86%
Printing, ICT	14	15	15	15	16	17	18	19	17	18	19	20	21	20	21	50%
Other services	66	71	74	76	75	78	83	86	84	85	98	92	97	100	123	87%
Public services	195	194	195	202	202	206	211	217	221	222	226	234	244	253	262	34%
	1,061	1,050	1,111	1,166	1,214	1,261	1,302	1,370	1,385	1,404	1,476	1,576	1,643	1,693	1,775	67%

The table shows that the economy grew by 67% in the fourteen years. This is an average of 3.7% GDP growth per year. The growth from 1960 to 1971 is 52%. This compares well with table 7.1 of the *Statistical Yearbook of Ireland 2004* where GDP growth over the same period is 55%. Our table indicates that the most sustained growth occurred in the period 1959-62 with growth rates ranging from 4% to 6%. Moderate growth occurs for other years except 1968 which peaks again to 7%. In these well performing years, it is other industry and B&C and real estate that contribute most significantly to this growth.

Agriculture holds a leading share of the total GVA for each year, but is the worst performing sector in terms of year-on-year growth. Conversely the volume of chemicals and electronics (office equipment) rise significantly in this period but have a small share of total GVA. It is interesting that these two hi-tech sectors already in the period 1957-71 are showing signs of their future promise. It is a feature of these industries to have a high value added to inputs ratio. This feature has the potential for rapid growth and is evident even when their relative significance is low.

Apart from these extreme sectors (agriculture with low growth but large share and chemicals and office equipment with high growth and small share) the most important sectors are probably other industry (which excludes food products and hi-tech industries) as well as construction and real estate, which have considerable growth over the period and increase their combined share in current prices from 20%

to 24% of the total GDP. This is evidence of the development of Ireland's industrial base in the Lemass years in the periods of the first and second programmes for economic expansion in 1958.
Increase in GVA of public services including health and education is lower than most other sectors. As public services are non-market, the GVA for this sector is calculated as its expenditure on goods and services plus compensation of employees. The series tells us that there was no real increase in public services employment numbers.

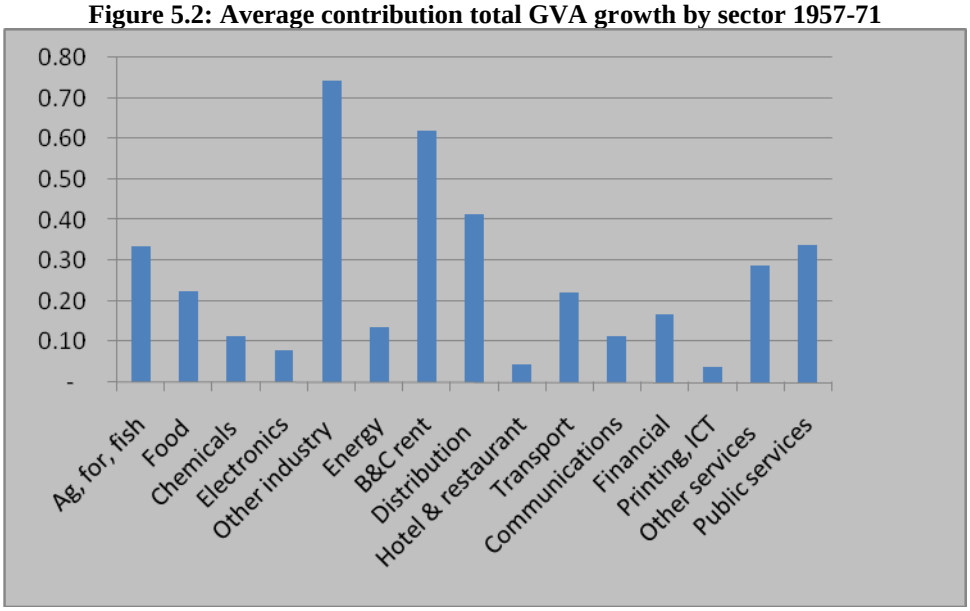
We consider also how much each sector contributes to growth of the whole economy. We measure a sector's contribution to the growth rate as the difference between that sector's contribution to a given year's GVA and its contribution to the GVA in the previous year divided by the total GVA of the previous year. Thus if C^i_t represents the GVA for sector *i*, in year *t*, and G_t the total GVA for the whole economy in year *t*, we consider the factors,

$$(C^i_t - C^i_{t-1})/ G_{t-1}$$

for all *i*, where each measure of GVA is in constant prices.

The chart below shows the average contribution to GVA measured over each year from 1957 to 1971

Figure 5.2: Average contribution total GVA growth by sector 1957-71



We stated above that the average growth of the whole economy is 3.7% per year. Figure 5.2 tells us, for instance, that on average .74 of this growth is due to the 'other industry' sector.

Apart from this sector, it is the relatively large sectors (including agriculture), throughout the full time period, that contribute most to growth. This is as one would expect when development is relatively even across the economy. This set of data is therefore not remarkable. In fact no real shift in structure is emerging. In hindsight, we notice the growth of the chemicals and hi-tech sector. But these are as yet fledgling industries. A commentator in 1972 is likely to have remarked that the analysis and frank self-assessment at the end of the 1950's led to policy decisions that opened up the economy and incentivised industrial development - thus the growth in the 'other industry' sector comprising of clothing, building materials, furniture, etc. Further, although many of the policy decisions following the first economic programme for economic development were aimed at increasing agricultural output, through lowering of barriers to trade, the effect on agricultural development appears to have been negligible.

Period 2 1972-1986
Table 5.2 shows the GVA in constant previous years' prices at detailed sectoral level for the period 1972 -1986 referenced to 1985 prices.

Table 5.2 GVA in constant prices for the years 1972-1986 chain linked annually and referenced to 1985 (€m).

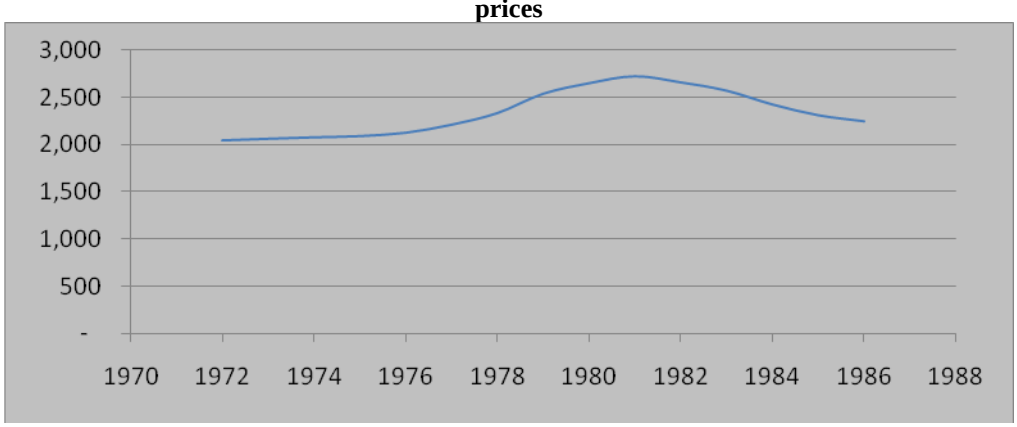
Sector	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	% change
Ag, for, fish	1,635	1,586	1,705	1,891	1,683	1,847	1,876	1,646	1,768	1,690	1,891	1,906	2,174	2,139	1,970	20%
Food	848	986	1,010	972	1,027	1,056	1,140	1,230	1,181	1,201	1,234	1,246	1,338	1,437	1,503	77%
Chemicals	227	279	317	278	353	392	524	627	571	662	632	735	831	996	1,059	366%
Electronics	195	234	258	222	285	421	453	497	550	696	801	977	1,228	1,391	1,551	694%
Other industry	1,549	1,556	1,626	1,530	1,642	1,721	1,830	2,021	1,885	1,886	1,793	1,742	1,849	1,804	1,756	13%
Energy	373	368	372	352	373	390	433	486	465	507	512	518	559	612	561	50%
B&C rent	2,047	2,064	2,079	2,092	2,128	2,211	2,334	2,536	2,646	2,718	2,655	2,568	2,423	2,311	2,247	10%
Distribution	1,907	2,143	2,177	1,936	1,992	2,175	2,412	2,487	2,641	2,667	2,587	2,449	2,426	2,495	2,396	26%
Hotel/ restaurant	331	368	392	384	365	403	457	474	456	436	427	431	467	480	479	45%
Transport	659	703	639	711	729	734	741	738	729	725	728	719	716	728	735	11%
Commun	185	185	218	255	266	299	320	370	399	419	403	453	497	518	568	206%
Financial	1,020	1,089	1,159	1,231	1,303	1,371	1,441	1,511	1,584	1,654	1,678	1,702	1,723	1,746	1,772	74%
Printing, ICT	185	194	194	185	193	192	208	234	232	234	220	210	227	234	249	34%
Other services	458	485	476	432	500	524	658	672	766	788	802	962	1,036	1,136	1,049	129%
Public services	2,835	2,953	3,107	3,309	3,379	3,444	3,581	3,730	3,874	3,930	4,024	3,957	4,048	4,103	4,192	48%
	13,999	14,693	15,191	15,467	15,850	16,947	18,098	19,004	19,853	20,368	20,870	20,862	21,898	22,569	22,595	61%

Table 5.2 shows that the economy increased by 61% in volume terms in the period 1972 to 1986, with an average of 3.4% annual growth. This agrees with the growth in GVA between 1972 and 1986 to be seen on the CSO's historical series of national accounts available on the CSO website. The performance is however very uneven over the years. There is a very healthy period between 1976 and 1980 with an average of 6% growth per year. This is followed by low growth of little over 2% per annum with negative growth in 1983 and almost zero growth in 1986.

We see that not all sectors have performed equally well. Agriculture, forestry and fishing increased by just 20% in these years. Transport, consisting mainly of CIE and Aer Lingus as well as freight is another poor performing sector with growth rate of just under 1% per year over the 14-year span (signifying further cutbacks in rail and bus services after the initial line closures in 1958-62).

The construction and real estate including rent sector shows very interesting trends. Output in the construction industry and real estate appears to be quite strong in the years 1976 to 1982. This suggests investment in infrastructure over this period. The value added of this sector peaks in 1981 and in fact contracts in the years 1982-1986 (see Figure 5.3). These results are supported by examination of trends of house completions available on the Department of Environment website. In terms of growth over the full period this sector is the worst performing with an increase in value added in 1986 of just 10% since 1972. As well as a reduction in real construction output, the decline in the later years may also be due to a slow down in real GVA growth of the rental sector as a result of economic depression and high emigration. On the positive side, B&C adds to the capital stock in the economy. Thus the poor performance in the latter part of the series is offset somewhat by the earlier high output.

Figure 5.3: Value of real output of construction and rental services in €000 referenced to 1985 prices



In the manufacturing industry sector, the 'other industry' sector has performed quite poorly. This sector was starting from a high base, as we noted before. It is primarily non-food traditional manufacturing whose development was quite marked in the previous period. The growth of this sector, however, was not sustained and many of the traditional industry types were disappearing in the 1971-1986 period. Leather and footwear, car manufacturing, shipbuilding and some of the textile industries are all industries which had over 75% less employees at the end of this period than at the beginning. This could partly be attributed to stronger competition from abroad to Ireland's relatively small-scale firms following Ireland's accession into the EC.

On the other hand, the food sector maintained a steady increase of 4% per year. It appears to reflect a move towards softer industries. Developing the point in the previous paragraph, it may be also that Ireland's membership of the EC has opened up markets in the food industry but not in other heavier traditional industries. It suggests also that Ireland is perhaps getting further value added from agricultural produce – that although the growth rate of agriculture since the late 1950s is rather small, the combined agri-food sector begins by the mid-seventies to modernise. See for instance Brendan Riordan [17].

There are some positive comments to be made of the period. The communication sector grows from €181m to €568m, in 1985 prices, as a result of the extension of telephones to all households in the country. This is further evidence of expenditure on capital programmes, which may have borne fruit at a later time. Energy provision also increases by 50% over the 14 years.

Of particular interest are two sectors that are to have such an important effect on the volume of GDP growth in later years – namely chemicals and electronics (office equipment). These industries are grouped along with reproduction of recorded media, in the current national accounts under the heading of modern industries and have a particular importance in our discussion of the Perez model. Chemicals increased by over 350% and electronics by nearly 700%.[6] In the 14 year period these two sectors have moved from having a 4% to 10% share of total GVA. The value added for these sectors increases most spectacularly in the years after 1982, a time of economic depression for the country as a whole. We see here the success of policy decisions for the economy, particularly the decision by the IDA as early as 1972 to focus its attention on chemicals, electronics and other hi-tech industries.

As in the previous discussion we consider how much each sector contributes to growth of the whole economy. Figure 5.4 shows the average contribution by sector to the growth. Factors influencing the height of each bar are the growth rate of the sector and the share of the economy that that sector maintains.

[6] Examination of official volume of production indices for chemicals and electronics reveals an even higher increase than exhibited in our work. Two reasons for the difference can be suggested: These tables purport to represent the growth of GVA whereas the official volume indices are based on gross output at individual industry level (albeit combined using net output weights). There may also be a difference, particularly in the hi-tech sectors, between constant price tables with base year prices and constant tables using chain linked previous years' prices.

Figure 5.4 Average annual contribution to total GVA growth by sector 1972-86

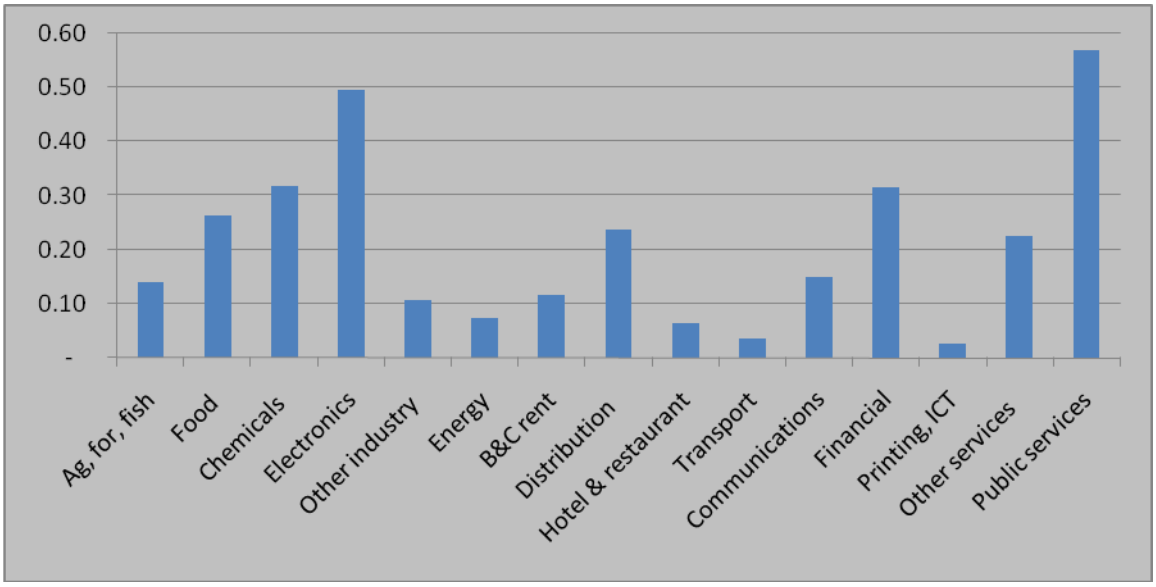


Figure 5.4 is different from the equivalent chart in the previous period. Very definite patterns are emerging. In the current case financial services, other services, public services, chemicals and electronics are the dominant sectors whereas agriculture and other industry sector have been relegated to the background.

The significance of public services (now the largest sector) is notable. The increase is due to expansion in numbers which may have come about after Ireland's entry into the EU. Education is also a factor since the full implementation of free second level education.

The financial and other services sectors contribute significantly to GVA growth between 1972 and 1986. This suggests a move from primary and secondary to tertiary industries. Some of the weight of economic growth moves from manufacturing to services. In this period, service type activities and financial services are on the whole domestically based. The growth of these sectors in a time of economic recession does however provide a sound platform for building a substantial export driven services in coming years.

The dominance of chemicals and electronics represents a significant change in the manufacturing sector. Looking again at table 5.2, food products and other industry are both larger than either chemicals or electronics throughout the period (except 1986, where electronics are greater than food products). It is clear however that traditional manufacturing is now being challenged by modern, hi-tech industries with phenomenal average annual growth of 12% and 16%, for, respectively, chemicals and electronics, over this period.

In figure 5.3, therefore, we witness a sizable shift in the structural composition of the economy. We see the rise of chemical and electronic production, which are for the most part foreign-owned. We see the corresponding decline of importance of traditional domestic manufacturing industries and agriculture. Service industries maintain an important value to the economy. There is evidence too of an element of capital formation.

Period 3 1987-1996
Table 5.3 shows the GVA in constant previous years' prices at detailed sectoral level for the period 1987 -1996 referenced to 1990 prices.

Table 5.3 GVA in constant prices for the years 1987-96 chain linked annually and referenced to 1990 (€m).

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	change 87-96
Sector											
Ag, for, fish	2,397	2,526	2,560	2,958	2,891	3,130	2,876	2,807	2,747	3,081	29%
Food	2,137	2,240	2,364	2,460	2,632	2,847	2,876	3,114	2,955	3,056	43%
Chemicals	1,155	1,194	1,349	1,558	1,740	2,062	2,134	2,536	2,972	3,500	203%
Electronics	1,527	1,955	2,329	2,322	1,996	2,291	2,282	2,791	3,847	3,897	155%
Other industry	1,857	1,963	2,173	2,218	2,271	2,231	2,307	2,396	2,471	2,655	43%
Energy	489	502	536	577	568	584	602	624	566	605	24%
B&C rent	2,840	2,789	2,907	3,178	3,189	3,219	3,309	3,511	3,730	4,094	44%
Distribution	2,550	2,657	3,123	3,929	3,868	3,232	3,608	3,554	4,101	5,003	96%
Hotel & restaurant	585	627	671	693	693	738	784	850	927	1,024	75%
Transport	962	963	1,067	1,114	1,145	1,150	1,136	1,167	1,145	1,143	19%
Communications	719	765	809	856	901	958	989	1,081	1,141	1,262	75%
Financial	1,996	2,077	2,134	2,232	2,287	2,320	2,328	2,359	2,424	2,484	24%
Printing, ICT	335	380	414	424	575	601	612	614	598	627	87%
Other services	2,919	2,615	2,384	2,673	2,883	3,462	3,425	4,087	3,998	5,411	85%
Public services	5,186	5,236	5,313	5,461	5,471	5,525	5,644	5,633	5,685	5,742	11%
	27,716	28,416	30,059	33,049	33,465	34,447	35,275	37,228	40,880	44,643	61%

Table 5.3 shows that the economy increased by 61% between 1987 and 1996. This is an average of 5.4% per annum. The growth is rather uneven. 1990, 1995 and 1996 had growth of over 9% whereas in 1988, 1991 and 1993 growth is less than 3%. In the years of very high growth, the distribution sector contributes significantly to the growth. Table A in the introduction of NIE2006 shows personal consumption of goods and services in constant prices from 1970 to 2006 in constant prices. These years of strong growth also showed higher than usual personal consumption.

Growth in agriculture is 29% for the full period. Half of this growth actually occurs between 1995 and 1996 and is due mainly to changes in the method of paying farm subsidies. Thus the growth in agriculture is not very strong.

GVA of public services increased by just 11% in this period, with growth hovering around zero from 1989 to 1995. This may illustrate efforts by the governments at the time to deal with Ireland's large foreign debt by cutting back on public spending. Public services were the largest contributors to growth in the last period. Here public services contribute very little to GVA growth rates. This illustrates, whether deliberately or not, a Keynesian type relationship between government spending and the economy.

The building and construction and rent of dwellings sector continues, at first, the downward trend exhibited in the previous period but picks up in 1988. From 1993 to 1996 growth averages 7.3% per annum. The growth over the period of building alone is 75%.

Chemicals and electronics are still the best performing sectors with growth of 203% and 155% respectively. By this period chemicals are outperforming electronics reversing the situation in the previous period. These two industries are now the dominant manufacturing industries in magnitude. Recorded media and computer services are beginning to make some impact with growth of 87% for the 10 years. We illustrate the contribution to total GVA growth in the next chart.

Figure 5.4 Average annual contributions to total GVA growth by sector 1987-96

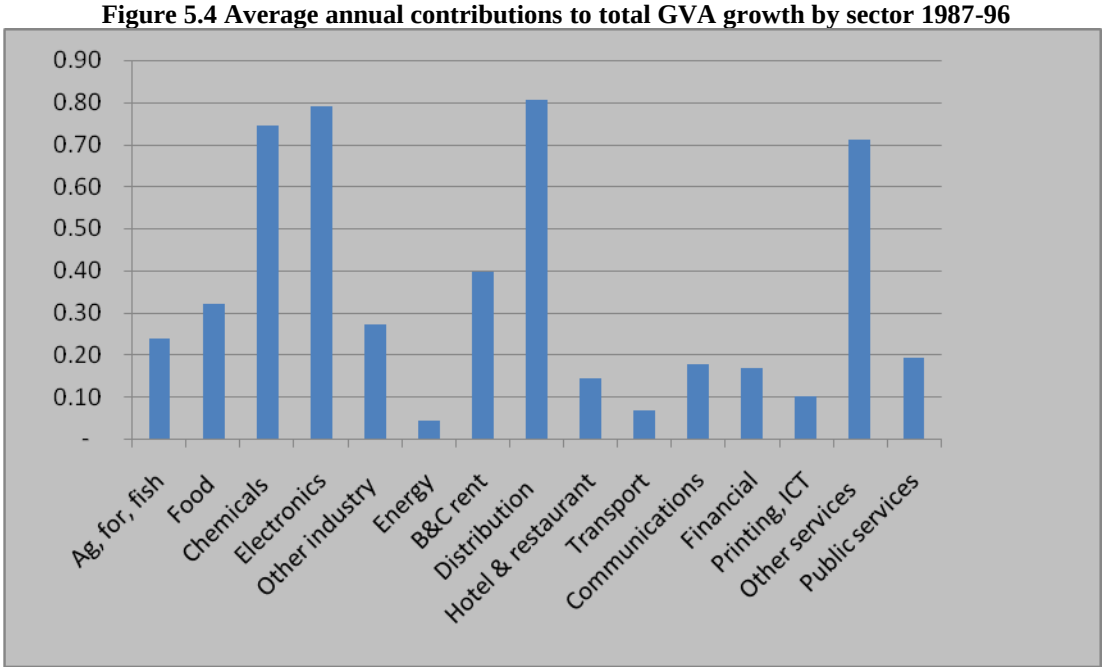


Figure 5.4 shows the contribution to GVA by sector averaged over the years 1987-96. Chemicals and electronics dominate industry as before. The most remarkable sector is distribution, which has come to play a very central role in its contribution to growth in the economy. This is an important shift in the economy, representing to some extent the start of an era of consumption.

Period 4 1997-2006

The results of constructing constant price tables for the 15 sectors for the years 1997-2006 are presented in table 5.4. The tables are referenced to 2006 and are consistent with the equivalent table in NIE2007 of GVA by broad sector at constant prices. (Note however that the NIE item 'reproduction of recorded media' is amalgamated with software in this table in the classification 'printing and IT services'.)

Table 5.4: GVA in constant prices for the years 1997-2006 chain linked annually and referenced to 2006(€m)

Sector	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	change 97-2006
Ag, for, fish	3,737	3,670	3,586	3,564	3,576	3,523	3,648	3,728	4,086	3,812	2%
Food	3,602	4,085	4,471	4,525	4,913	5,376	5,475	6,086	6,151	6,588	83%
Chemicals	4,050	5,255	6,981	7,719	9,046	11,644	12,273	10,533	10,256	10,656	163%
Electronics	4,120	4,290	4,432	6,218	6,322	6,079	6,170	6,976	8,124	7,859	91%
Other industry	6,077	6,727	7,089	7,364	7,312	7,245	7,157	7,649	7,583	8,150	34%
Energy	925	1,025	1,160	1,173	1,273	1,385	1,398	1,541	1,562	1,662	80%
B&C rent	18,301	19,274	20,574	21,341	22,016	22,437	23,369	24,831	26,416	27,721	51%
Distribution	8,724	9,591	10,254	12,086	13,505	13,823	13,937	14,123	14,945	15,598	79%
Hotel & restaurant	2,550	2,779	2,936	2,963	3,083	3,100	3,282	3,268	3,317	3,395	33%
Transport	3,246	3,303	3,645	3,800	3,881	4,279	4,285	4,527	4,762	5,082	57%
Communications	2,050	2,288	2,500	2,781	3,033	2,944	3,288	3,255	3,304	3,426	67%
Financial	12,527	13,682	14,662	15,353	15,928	15,676	15,846	16,211	16,713	17,255	38%
Printing, ICT	2,651	3,087	3,420	3,273	3,658	4,274	3,766	5,132	5,480	6,209	134%
Other services	4,233	4,367	5,097	5,918	6,951	7,913	9,235	11,303	13,416	14,719	248%
Public services	15,060	15,520	16,191	16,909	17,939	19,094	20,005	21,135	22,428	24,042	60%
Total GVA	86,487	93,489	103,081	112,020	119,925	127,857	133,593	139,480	147,351	154,899	79%

The economy has grown by 79% in the years between 1997 and 2006. This is an average of 6.7% per year. From 1997 to 2002 the growth is over 8% per annum and only two years, 2003 and 2004, have growth rate of less than 5%. Of the four periods since 1957, this is thus the one with the highest sustained growth.

Other services is now the leading sector with growth of 248%. A number of activities are involved here. Rent of machinery has grown due in part to aeroplane leasing and also machinery rental connected with the building and construction sector. The number of business firms – legal, accounting, advertising and marketing, recruitment agencies, architects, business consulting and holding companies - has increased significantly (the Annual Services Inquiry has 13,149 business services enterprises in 1999 and 34,698 in 2006). Other activities include all types of recreation and domestic services that have increased their volume of output in the decade of near full employment, easy credit and high consumption.

Chemicals has maintained a central role and is the next best performing sector in terms of GVA growth. Electronics which was once the leading sector in terms of growth rate is now in fifth place. Within the manufacturing sector, the food sector is performing well with a growth of 83% in the ten years. A considerable part of this growth must be attributed to presence of some large multinational drinks manufacturers in Ireland.

Printing, software and IT (which combines printing, publishing and reproduction of recorded media with computer services) is now very present and is the third best performing sector with growth of 134%. In the 1997-2006 period Printing, software and IT is one of the leading sectors of non-financial services that have caused the shift of balance in the economy away from manufacturing in recent times.

As in the previous two periods under scrutiny, it is agriculture and the other industry sector that are the poorest performing sectors. Transport has picked up from before. Growth in this area is probably due to increased freight as a result of the strong distribution sector as well as air transport which by 1996 accounts for nearly one third of the transport sector.

Figure 5.5 Average annual contributions to total GVA growth by sector 1997-2006

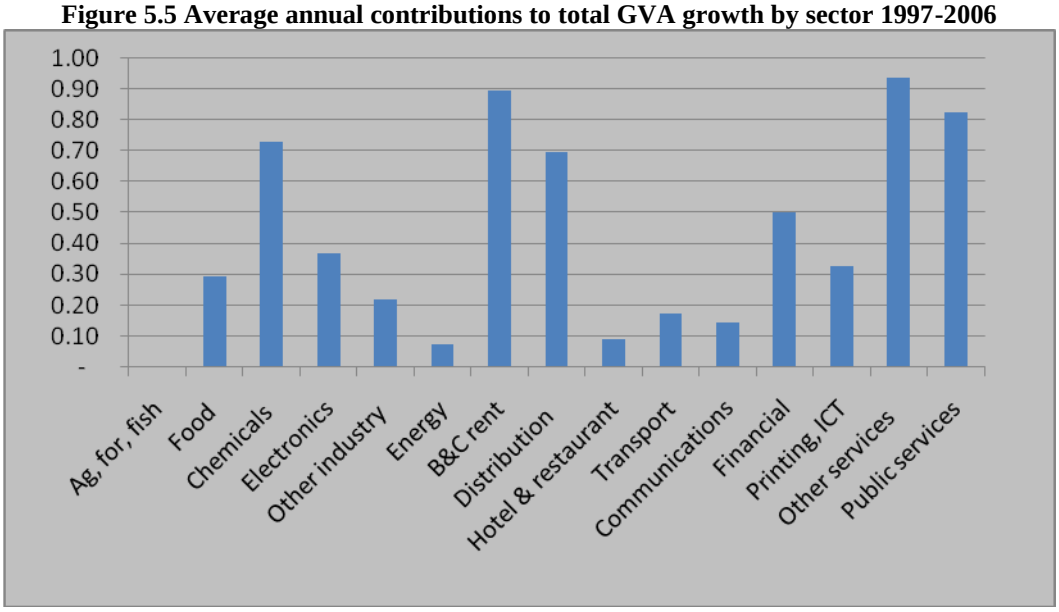


Figure 5.5 contrasts with the equivalent graph of the last period, where the balance was much more in favour of the modern manufacturing industries. Now the greatest contributors to growth come from the services sectors. Apart from the other services sector, the most significant shift in structure during this period comes from the growth in building and rent, financial services, printing (including software) and IT services. These are, with the exception of building but including rent and real estate, service activities. Furthermore, electronics which had contributed 0.80 to average GDP growth in the previous period (see Figure 5.4) contributes only 0.37 in the time from 1997 to 2006 when GDP growth is stronger overall. Even chemicals contribute less in this period than before. Thus, we witness here further shift in the economy from manufacturing towards services.

6. THE IRISH EXPERIENCE IN THE CONTEXT OF THE PEREZ MODEL

We now look again at the four time periods, this time in the context of the Perez framework. The structural changes in the economy are examined by looking at shares of total GVA in current prices. Reference is also made to results and observations of the last section. We consider also different industry branches and their character within the current ICT Era. We discuss foreign direct investment and the relevance of financial and production capital. We begin with a brief look at Ireland's position in 1957.

Irelands position as a peripheral country in 1957

From a technological viewpoint, Ireland in 1957 was an economy that was very much peripheral and was definitely a follower country. As Cormac Ó Gráda [12] has observed, 'Few Irish historians would deny that the Southern Irish economy performed poorly between the 1920s and the late 1950s.' This was to a significant extent a function of Ireland's relationship to our near neighbour, Britain. Arguably Ireland was unfortunate that Britain ceased to be a leading country in technological terms before the turn of the 20th century. This is especially evident in the nature of the agriculture sector - which as Frank Barry has said, 'became an agricultural hinterland of Great Britain' - and of the protected industrial sector.

There are examples of the impact of the three technological revolutions experienced in lead countries. We had canals which were part of the first technological revolution. Of note is that the 'long moribund canal systems' were amalgamated into CIE by Sean Lemass and were used again commercially in the World War 2 period. We had a railway system, part of the second revolution, which was very well developed in the early 20th century. Joe Lee suggests that the railway was, 'the first major modern technological innovation to be widely and rapidly diffused in Ireland.' He refers to work he carried out

on early railways 1830-1855. That date is quite early in the second technological revolution. We also had an electricity network, part of the third revolution, which was a significant early development of an independent Ireland. All three - canals, railways and electricity - are infrastructure branches in Perez terms. There were isolated industrial projects such as the Guinness brewery which were a consequence of our historical links with Britain. From a technology standpoint we see more the absence than the presence of any up-to-date technology.

Growth but not technological development to 1971

The fifteen year period from 1957 showed that growth was possible from a low base without there being any significant technologically based structural change. The Irish economy in the early 1970s was in technological terms structurally similar to that of 1957. Figure 6.1 shows the changes over the period in the shares of the fifteen sectors.

Figure 6.1: Share of GVA by sector in current prices, 1957 and 1971

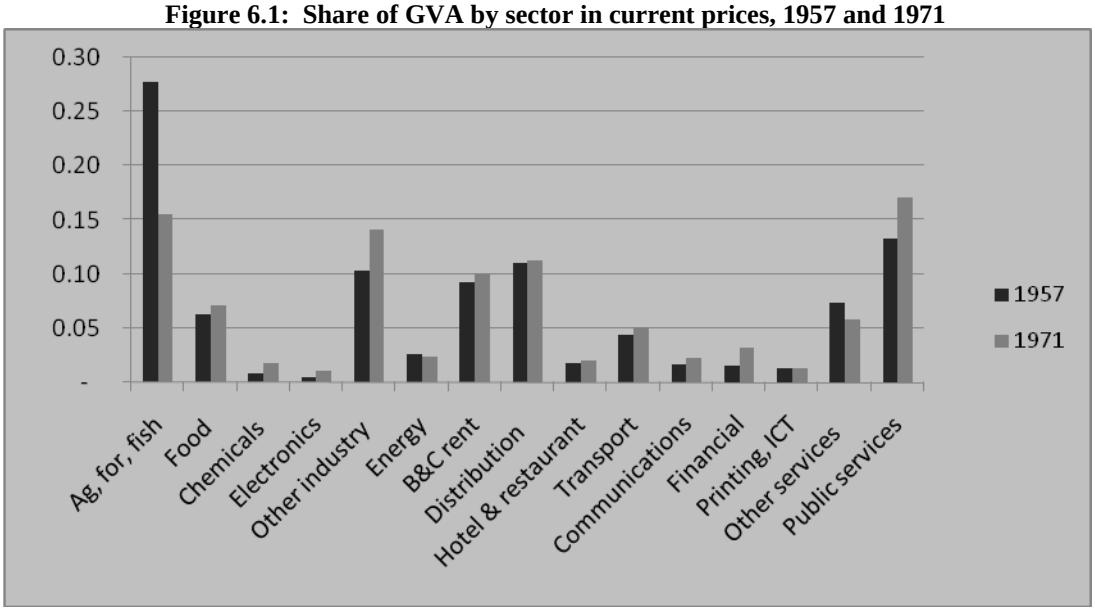


Figure 6.1 shows that agriculture's share of GVA declined significantly from 1957 to 1971. There were small increases in every other sector except the other industry sector, which had a relatively large increase in share. This sector is traditional manufacturing and the increase in this sector is due to an element of foreign direct investment at this time. Barry [2] in a related comment says, 'Had the agency [the IDA] instead [of high tech] tried to target sectors such as aerospace and motor vehicles - sectors found not to have become more mobile- the chances of success would have been very much poorer,' footnoting that the Potez Aerospace company represents a case in point. Arguably even if successful it would have been a much worse result for Ireland in terms of longer term viability.

Cormac Ó Gráda [12] also identifies companies such as Potez Aerospace, Verolme, Westport Textiles and Chipboard Limited as among the first to arrive. The companies involved are examples of a maturity phase development from a Perez viewpoint – that is belonging to the tail-end of the Age of Oil, the Automobile and Mass Production. We would therefore reinterpret Ó Gráda when he says, 'The remarkable transformation of the economy between the late 1950s and the early 1970s may be largely attributed to the arrival of the multinationals' and suggest that while there was industrial growth, there was no transformation in terms of fundamental technological development. Some groundwork had been laid for later change. We see the first evidence of what was to become the fifth technological revolution in the development of the electronics and chemical sectors, which were small but had remarkable growth rates.

Structural change despite macro problems 1972-1986

The period from the early 1970s to the mid 1980s is particularly interesting from a structural change viewpoint in that it shows that there can be significant structural development in a period when there are significant negative macroeconomic, in this case fiscal and industrial relations, problems. Figure 6.2 shows the share of GVA for 1972 and 1986.

Figure 6.2: Share of GVA by sector in current prices, 1972 and 1986

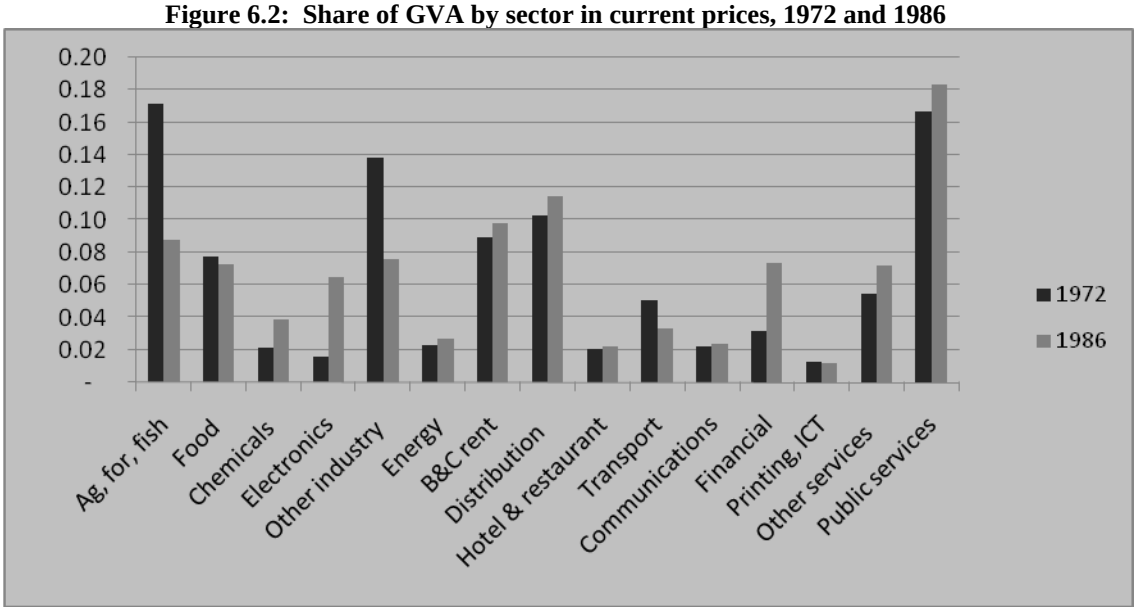
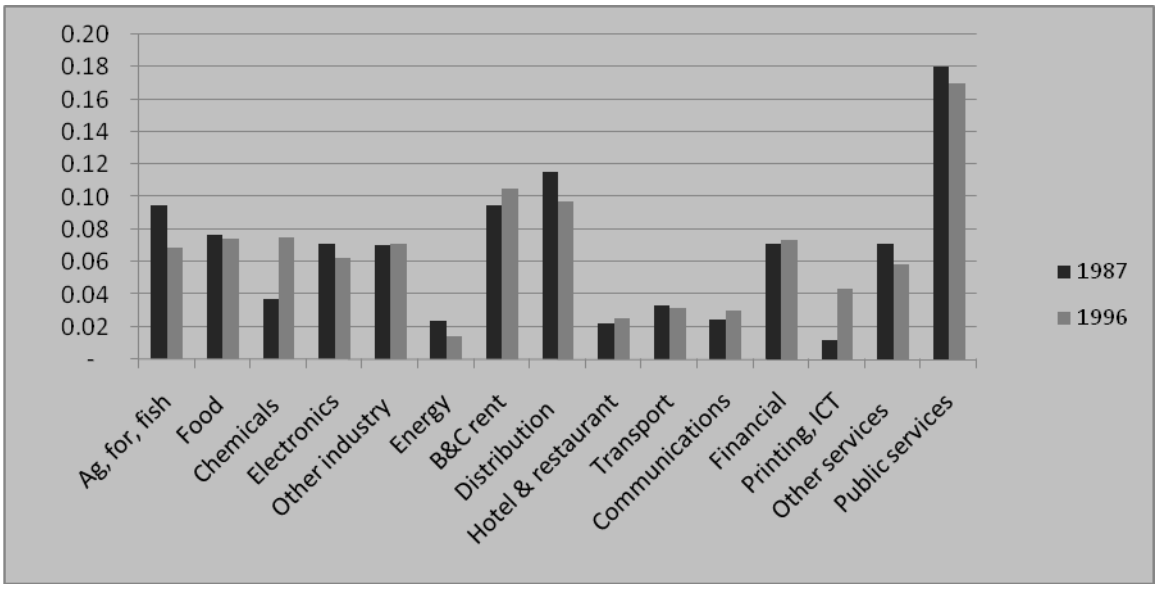


Figure 6.2 shows a further decline in the share agriculture holds of total GVA, but now a decline also in other industry. There are now significant increases in chemicals, electronics and financial services. In the case of chemicals and electronics, the strong growth, in what Perez calls key sectors of the ICT Era, is a special example of positive structural change. It should be borne in mind that, from a foreign direct investment perspective, we still see assembly operations in these industries to some extent. However, these were contributing to the pool of skilled workers that were crucial to taking Ireland to higher levels of achievement in later years. The agri-food sector saw development of the processing sub-sector (identified by a growth of 77% over the period in the food sector – see table 5.2). Furthermore, structural change within processing was increasingly using more effective up to date technology.

Technological development without employment to 1996

The period from 1987 to 1996 saw the beginning of the dramatic structural change in what has come to be known as the Celtic Tiger era. Figure 6.3 shows the sectoral shares.

Figure 6.3: Share of GVA by sector in current prices, 1987 and 1996



The chart shows little change in sectoral shares other than chemicals, electronics and printing and IT. The fall in share of GVA for electronics can only be explained by the increases in the share held by chemicals and IT because electronics has grown 155% in the decade. Healthy but rather uneven growth across the economy as a whole is evident (see Table 5.3). This period represented a fundamental

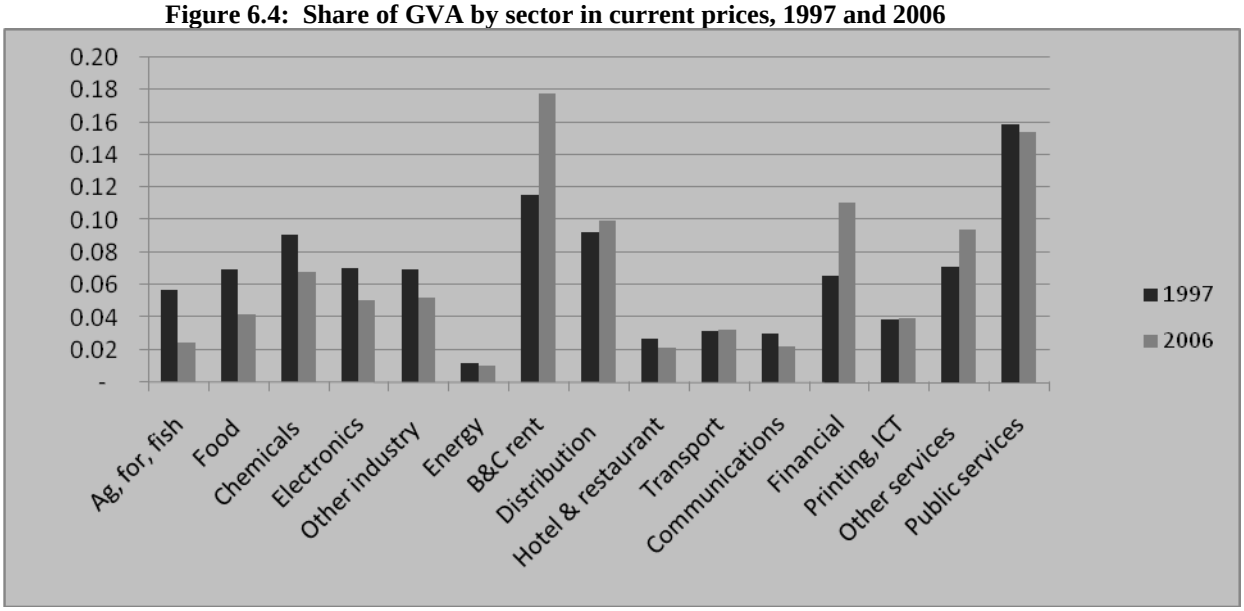
change in the nature of foreign direct investment. It saw the entry of Intel to Ireland in 1989 in what Perez would probably label as a big bang development. It also saw the software sub sector advance both by way of foreign direct investment such as Microsoft and by way of substantial indigenous development to the point where Ireland would become a top exporter of software in absolute size at the global level.

The emergence of the Dublin financial services centre would in a short space rival long established centres such as Luxembourg. Finance is significantly influenced by ICT and is what Perez calls an *induced sector*. From figure 6.3, it appears that the early years of the financial services centre did not result in a marked increase in share of total GVA. Also in terms of induced sectors, this period saw the development of business services and construction (see table 5.3) which would in subsequent years up to 2006 become a central part of Ireland's dramatic increase in employment.

Employment responds to 2006 but trouble looms

The period from 1997 to 2006 saw what can be acknowledged as the best in terms of employment but, in retrospect, the prelude to the least good of Irish structural change. Figure 6.4 shows the sectoral shares.

Figure 6.4: Share of GVA by sector in current prices, 1997 and 2006



In figure 6.4 we see that the financial sector, other services and building have increased their share of GVA significantly in the decade. In fact, well performing sectors such as chemicals and electronics have lost share to these sectors. A significant difference from a decade earlier is that value added growth translated into substantial increases in employment. Despite this the warning signs can, in retrospect, be seen clearly. Growth in the construction sector was at first necessarily rapid, as Ireland had some catching up to do. In retrospect, the construction was overly rapid towards the later the years up to 2006 (see table 5.4). The financial and fiscal instability since 2006 has led to a dramatic reversal of the position of the sector. The extraordinary growth and dominance of the building and financial sectors is the prelude to the current financial crisis. This activity fits the Perez model extraordinarily well in what she terms the *frenzy* at the end of the installation period of the revolutionary cycle. According to Perez we are now at the turning point of the cycle.

Technological Revolutions and Perez Branches

The world is at the present time at a turning point in the current ICT revolution. Because of the way in which the financial crisis diffused across virtually all countries this turning point is common to most countries including Ireland. Countries, of course, have different experiences at this point. Ireland, in particular, because of the impact of developments in property and construction has had more difficulties than others.

The Perez framework suggests that the key in moving beyond the turning point is the way in which financial and production capital interact. Ideally production capital takes control and we have, in Perez terms, a *golden age* until the next tech revolution emerges around 2020-2030. Alternatively if financial capital does not fall into line because regulation is not well implemented, we get a *gilded age*.

There is little argument that Ireland had a dramatic catch up in recent decades as evidenced by income per head at EU level. What may not have been emphasised is the importance in understanding the difference between that performance and the performance of the thirty or so years since 1957 in the course of technological revolutions that did not suit the Irish case.

The earlier technological revolutions impacted to a very limited extent on Ireland. The fifth technological revolution (ICT) has suited the Irish position in many respects. Our membership of the European Union combined with our tax regime meant that Ireland was no longer peripheral. Our approach in seeking foreign direct investment had high dividends in electronics, in chemicals and in software.

Furthermore, within the context of the current technological revolution we can see that Ireland's economy has good examples of all the branch types discussed by Perez. For this reason we can say that Ireland is a good fit of the model.

Perez distinguishes four branches or sector types whose characteristics are directly or indirectly a consequence of the *key factor* (in this case the micro-processor). In Ireland all four branches can be identified.

Perez sees *motive branches* as those which produce the cheap inputs. As the 'chip' is that input or factor, the presence of Intel in Ireland is a fundamental example of a motive branch.

Significant parts of the recorded media, the chemical industry, electronics and finance are sound examples of *carrier* branches. The high value added of the pharmaceutical industry relies critically on testing and precision instruments developed by the technology sector. In the year 2002, to choose the most remarkable example, 13% of Ireland's GDP is due to the chemical industry. The production of precision instruments is another example of a niche sector of major importance to us. The financial sector has transformed from the situation where traditional high-street banking was an important corner of the economy to the current situation in Ireland of international banking with massive flows in and out of the country. This transition is due directly and indirectly to communications, information technology and globalisation - all characteristics of the current technological era. Much of Ireland's sustained economic growth in the period from the early 1990s is due to the presence of these carrier branches and their global importance in the current technological age.

Ireland's rapid infrastructural development (building, which led to the property bubble and other forms of infrastructure such as the DART and Luas systems and the, less rapid, roll out of broadband) are consequences and factors driving economic structural change, and examples of *infrastructural branches.*

The *induced branches* are identified as new industries, or old industries that have adapted, whose make-up takes on the key factor characteristics. We see the communications sector transformed significantly. Arguably what we find in construction and other, primarily business, services are induced sectors which are well based because they are induced by sustainable development in modern manufacturing and parts of modern services and on the other hand induced sectors which are not well based because they were induced by an unsustainable easy liquidity bubble.

Peripherality and foreign direct investment

Again there is little argument that up to our becoming members of the then European Community Ireland was a classic peripheral country and very much a follower in technological terms. Even after that event Ireland made significant use of our peripheral constraint in submissions for European Structural Fund allocations. The reality in retrospect is that peripherality was changing because of EU membership, because of our tax regime, but most particularly, because of the nature of the ICT and revolution. That revolution has made the world more global in a way qualitatively different to any previous globalisation. The Internet knows no geographic boundary - even though not every country yet fully recognises that.

Arguably the most significant impact of the altered peripherality and the current technological revolution in the Irish case is in the changed nature of our foreign direct investment (FDI). In the 1960s FDI increased significantly but was primarily linked to the then mass production revolution and further to the maturity phase of it.[7] The initial evidence of the current revolution was in assembly-type projects still important in improving technological knowledge. There followed some substantial changes in the composition of FDI which had their roots in the current technological revolution. Firstly the IDA in 1972 concentrated their attention on attracting electronic and chemical companies. The second change in the nature of FDI marked a shift from manufacturing to services, even within FDI companies already situated in Ireland. Thirdly, the arrival of Intel to Leixlip in 1989 is particularly significant in that a world leader decided to produce the key factor of the revolution in Ireland.

The outcome is that Ireland's FDI includes examples of world leading companies in the software sector, in electronics, in pharmaceuticals and in ficancial services.

Financial Capital
Looked at from the Perez perspective of the different behaviour of financial and production capital, what took place at the global level in recent years was the result of what Perez describes as the linked double bubble, being the major technology bubble and the related easy liquidity bubble. The technology bubble has regularly occurred midway through the assimilation of each of the five technological revolutions, being the culmination of some twenty five or so years of market development centred on new clusters of technology and spurred by the supernormal profits generated by the production based on them. The easy liquidity bubble was a specific historical event in the present technological revolution which Perez believes to be a function of the failure of regulation although offset in terms of timing by the impact on demand of the rise of emerging countries especially China and India.

In the Irish case there was arguably, in addition, a fiscal bubble that emerged based on the tax receipts flowing from the construction and property sectors, see for instance Philip Lane for a discussion of this point [8]. These sectors grew in a dramatic and ultimately unsustainable way based on the easy liquidity phenomenon exacerbated in the Irish case by a Celtic Tiger mantra that we are masters of the universe.

7. CONCLUSIONS: SOME POLICY IMPLICATIONS AND FUTURE WORK

The paper has set down a new statistical series of gross value added at sectoral level. The data are used to analyse the structural changes in the economy over the period from 1957 to 2006. The first 15 years of this time were a period of good economic growth, largely driven by traditional manufacturing, but not of much structural change. The next 15 years are interesting in that very definite structural change occurred at a time of economic problems. In this period we see the rise of chemicals and electronics and decline of agriculture and traditional forms of manufacturing. From 1987 to 2006, the economy continues to change in a very definite direction. Within industry, chemicals and electronics continue to feature largely, though electronics lose some share of total gross value added towards the end. As a whole, the balance of the economy moves towards services and away from manufacturing. Other services, financial services, software and computer service, and communications all contribute significantly in the last ten years to gross value added. The paper has also presented a first step in an argument that technology, institutions and financial crisis are important in understanding Irish development.

Suggested Policy implications
Had the reality of economic cycles been accepted, arguably the temporary nature of exceptional tax receipts from property and construction could have been recognised and appropriate treatment applied to them. Also regulation especially of the banking sector could have had a clearer basis and been appropriately implemented.

[7] Perez in personal communication with the authors comments on this point. She states that it is precisely because we were at a remove that we see the evidence of the maturity phase of previous revolutions, that is, 'production moves to the periphery at maturity.'

Turning to the present, we still have to see if the challenge to establish a new financial regulatory framework at the global and Irish levels will be met well. Time will tell if policy makers can deal with vested interest and be up to the task.

Looking ahead, through examining the potential for the next twenty years of the present revolution and the likely nature of the coming sixth technological revolution, supply side policy should be oriented to realize the opportunities that will arise in ICT and to follow the emergence of the next revolution. Policy should identify the implementation requirements so as to position Ireland as a leading niche player within both.[8]

Future work

Section 6 identifies some of the features of the Irish experience that fit well with the Perez model. We believe that more in-depth analysis of aspects of this good fit will provide interesting results. Within the model there should be evidence of structural changes within the industries themselves that represent a shedding of old ways to make way for the new. We suggest here that this may be explored using input-output tables. It may be possible to thus trace new sets of inputs into industries and in fact see an element of convergence of inputs into industries across the economy. For example early input-output tables exhibit much activity in the manufacturing industry section of the table. Later tables show transactions between manufacturing and services as manufacturing requires payment of computer services, royalties and software fees. Full examination of this phenomenon is beyond the scope of this paper but is an issue the authors intend pursuing at a later date. Perez mentions the effect of a technological revolution on the input-out table in [15].

Other issues where we believe further work using more detailed sectors and company level information, where available, would bring benefit are:

- Why does the current technological revolution fit for Ireland far better than the previous four and how can Ireland best be positioned as a leading niche player going forward?
- Whether the Perez branches operate differently in follower countries such as Ireland than in leading countries.
- How technology, institutions and financial crisis have co-evolved in the Irish case.

[8] See a discussion of this point in an article by Perez in Open Democracy [16].

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VOTE OF THANKS PROPOSED BY FRANK BARRY, TRINITY COLLEGE DUBLIN

This paper sets itself two tasks. Firstly, it revises the historical data to provide us with a much longer time series, and secondly, it discusses the structural change seen in the Irish economy over this time period in the context of a Schumpeterian framework due to Carlota Perez.

Anything that allows us to examine in a consistent way trends over longer time periods is to be warmly welcomed. The paper employs best practice methods in carrying out this task and I am sure that the new series will be used extensively by those with an interest in economic history. Later researchers might well make further adjustments but firm foundations are laid here.

The present analysis focuses on sectoral GVA, which sums, with some modifications, to GDP. Everyone will be aware of the substantial gap between GDP and GNP in this country because of the substantial profits booked here by the foreign multinational sector. There is a strong suspicion that the GDP measure may be inflated by (legal) manipulation of the transfer prices used to value intra-firm trade, allowing foreign firms to exploit as fully as possible the advantages of Ireland's low corporation tax regime. For this reason, it is common for researchers such as McCarthy and O'Malley (2006) to try to net out foreign profits – i.e. to come up with GNP rather than GDP-consistent measures – in looking at sectoral contributions to growth. Historical data that would allow us to apportion net factor income to this end may not be available. There is the possibility though that transfer pricing may not have been such a big issue the further we go back in time. Balance of payments data for the period may reveal whether or not this is the case. It would be an interesting avenue to explore.

The paper includes some discussion of a *Lemass effect*, e.g. of the industrial 'consequences of the first and second programmes for economic expansion' and of the policy decisions that followed the 'frank self-assessment at the end of the 1950's.' As the authors point out however, in their discussion of Table 5.1, the most sustained growth in this early period occurred from 1959 to 1962. Protectionism only began to be dismantled with the unilateral tariff reductions of 1963 and 1964, though the 1956 introduction of Export Profits Tax Relief under the second inter-party government opened up the economy significantly along another front. Garret FitzGerald (1968) provides a perceptive analysis of what was happening in the 1959-62 period. He writes that 'when demand in Britain began to grow early in 1959, Irish manufactured exports boomed… The incentives introduced several years previously – the new export tax relief and the expanded industrial grants – were starting to work…. And a change in the attitude to foreign investment was starting to show some results in the form of an increase in the number of external industries establishing factories in Ireland'.

Interestingly, though O'Hearn's (1987) estimates of the numbers of jobs in new foreign industry arising as a result of these measures are very low at this time, these jobs were concentrated in the traditional 'other industry' category in which the paper reveals the growth to have been occurring.

Like the authors, I am surprised that EU entry does not appear to have been associated with dramatic increases in agricultural GVA (Tables 2.2 and 5.2). Arnold (2008) pointed out that the transitional arrangements brought Irish farm prices up to Community levels by the end of 1977, while "the combination of output and price increases resulted in real farm incomes doubling between 1970 and 1978". This would seem to warrant further investigation. The same tables do show the advances in the food processing sector over this period however.

It is important to note that growth accounting exercises say nothing about causality. Hence it is incorrect to suggest that any of the results can 'illustrate … a Keynesian type relationship between government spending and the economy.' One would need a theoretical model to be able to test such a relationship. An anti-Keynesian might argue that while high government spending might well account for a high share of output growth in some particular period, the necessity to finance it might mean that overall growth is reduced.

I now turn to the Perez Model that motivates much of the discussion in the paper. The authors criticise Cormac Ó Gráda for referring to the "remarkable transformation of the economy between the late 1950s and the early 1970s". While there was industrial growth, they respond, there was no

transformation in terms of fundamental technological development. Such a transformation they associate with Perez's fifth technological revolution, later manifested in the growth of the electronics and chemical sectors in Ireland. The simple presence of these sectors should not be interpreted as evidence of profound technological development however, since Ireland continues to perform poorly in terms of information-society attributes.[1] Having a preponderance of high-tech sectors is not sufficient to create a high-tech economy.

For the purposes of macroeconomic analysis, I am not sure that the Perez distinction between "motive, carrier, infrastructural and induced branches" is more useful than the distinction between traded and non-traded sectors. And in terms of sectors that industrial policy might usefully have set its sights on targeting, I am not convinced that her categorisation of sectors is as thought-provoking as that of Midelfart-Knarvik et al. (2000). As the Barry (2004) paper that the authors cite illustrates, most of our manufacturing growth since the 1970s was in sectors that Midelfart-Knarvik et al. show to have become more mobile internationally over this period. It is not clear to me, furthermore, that the policy conclusions drawn in the paper necessarily rest on the foundations provided by the Perez framework.

As to whether the Perez model can shine a light on "structural changes within industries that represent a shedding of old ways to make way for the new", I suggest that this remains to be seen. It is unlikely to provide an easy substitute for detailed study of changes in the global geographies of individual sectors. This was the method adopted by Barry and Van Egeraat (2008) to chart the transition from production to services within the foreign-owned ICT sector in Ireland and which allowed them to predict the closure of Dell's manufacturing facilities a year or so before it occurred.[2]

The value of an encompassing framework such as that provided by Perez resides in the extent to which it sparks our imaginations and raises new questions. The final question raised in the present paper asks about the co-evolution of technology, institutions and financial crisis. I'd like to try out one answer that springs to mind when this question is posed. MacSharry and White (2000) noted that part of the reason why the proposals to establish the IFSC were taken up was that "the technology to set up and run international data- and fund-management centres was creating an electronic marketplace, thanks to improvements in international communications". The importance of the IFSC and indeed the importance of the financial services sector to the UK economy then encouraged these jurisdictions to adopt "light-touch" or principles-based regulatory regimes (Reddan, 2008). Here then is one possible link between technology, institutions and financial crisis.

There is another structural-change literature that it might also be useful to mention, though it focuses on exports rather than production. This literature – exemplified by Hausmann, Hwang and Rodrik (2007), Rodrik (2006) and Hausmann and Rodrik (2003) – proposes that a country's specialisation pattern is determined not only by the conventional fundamentals (endowments, institutional quality etc.) but also by the number of entrepreneurs that embark on ventures which, if successful, will generate positive externalities for other potential investors in that sector. This is the idiosyncratic element in a country's export composition. As Hausmann, Hwang and Rodrik put it, "some traded goods are associated with higher productivity levels than others and … countries that latch on to higher productivity goods (through the cost discovery process just described) will perform better."

A tentative connection with the FDI literature suggests itself here. Barry, Görg and Strobl (2003) found evidence of demonstration as well as agglomeration effects in the sectoral pattern of inward FDI in Ireland. The agglomeration effects represent the playing out of Marshallian externalities while the demonstration effects arise because investors, in the presence of uncertainty about the characteristics of particular locations, may exhibit a tendency to imitate each others' location decisions. This suggests a similar idiosyncratic element to a country's industrial structure.

Models that focus on production and/or export structures can throw up interesting questions, while the database provided will assist in allowing new questions to be addressed more comprehensively. It is my pleasure to propose the vote of thanks.

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[1] The Economist Intelligence Unit (2008) ranks Ireland's e-readiness at number 21 of 70 countries, with less than satisfactory performance in terms of the connectivity and technology infrastructure as well as government policy and vision. Similarly, OECD (2006) ranks Ireland 11th out of 25 EU member states, with lacklustre performance primarily due to poor broadband roll-out, an important component in maximising the benefits of ICT use.

[2] http://www.irishtimes.com/newspaper/finance/2008/0317/1205510793343.html

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DISCUSSION

Bill Keating: I would like to congratulate the authors on a very interesting paper. I will concentrate my remarks on the statistical aspects. The authors have done a fine job in developing a long run consistent time series. The paper also illustrates the value of the input-output tables, especially as they have been put on a consistent basis by Keogh and Quill. The input-output (or more correctly Supply and Use) tables are now much more timely than used to be the case but I suspect they are under utilised. Indeed, there are now a range of other data available from CSO about which the same can be said – current price output tables at a detailed sectoral level (these now allow the type of detailed analysis by sector undertaken in this paper), institutional sector accounts and recently new estimates of capital stock.

I should say something about the development of long run time series by CSO. Statistics Offices face a continuing conflict between introducing changes (hopefully improvements) and maintaining time series. This was a problem users of our national accounts were particularly concerned about some years ago. We eventually introduced a continuous series going back to 1970 but then, very soon afterwards, we had to introduce FISIM and so create a new discontinuity.

Users may expect that the work of the authors could now be incorporated as an official series. However, while it is a very worthwhile exercise and absolutely fine for the current purpose, there are some problems with making the results official. For example, as the authors say, the effect of FISIM is estimated in part using relationships for 1995-1999. This would be potentially misleading if used, for example, to specifically study banking output.

Eamon Henry: I thank Patrick and Paddy for their important and interesting paper, spanning 50 years of the Irish economy.

By contrast with the Perez model, an input-output model analysis would be possible only at 4-year or 5-year intervals. A special input-output table is required, nowadays described as a 'symmetric table at basic prices', and with all Imports (of goods and services) deducted from the inter-industry rows across, and listed separately below as several rows similar to Gross Value Added (GVA) row components.

Given such a table at current prices, it is possible to derive direct-plus-indirect GVA and Import components corresponding to each column of Final Demand. These columns comprise Household Consumption Expenditure, Government Current Expenditure on Goods and Services, Capital Formation, and Exports of Goods and Services.

If we had a row or rows of average annual Employment across sectors, a similar direct-plus-indirect Employment analysis could be made. These analyses use the derived Leontief Inverse, which also can provide related sectoral multipliers per unit Final Demand for the output of each listed economic sector.

To obtain a symmetric input-output table at constant prices requires a considerable amount of calculation. I won't give details, but just explain that a weighted-average row of deflators, one for each column, must first be derived for GVA plus Imports. This deflator row is then used with the Leontief Inverse to compute consistent deflators of the inter-industry rows of the table.