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What's Been Happening To Concentration in Irish Industry 1991-2001

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Abstract: This paper estimates concentration in Irish manufacturing industry (1991-2001) by applying the McCloughan and Abounoori technique for calculating the concentration ratio given grouped data. The results suggest high aggregate concentration, which appears less a function of multi-plant operations than in the past, possibly reflecting industrial policy changes. Industrial concentration appears higher on average in Ireland than in other countries and there is a significant relationship between concentration and upper-tail size inequalities, suggesting that it is the top 1 or 2 firms that typically determine concentration. Concentration does not appear to vary with foreign ownership or export activity in Irish industry.

I INTRODUCTION

This paper provides, for the first time in thirty years, estimates of aggregate and industrial (seller) concentration in Irish manufacturing industry. Aggregate concentration refers to the cumulative share of the very largest firms in industry and is relevant to establishing the extent, if any, to which 'big business' dominates a country's industrial sector. Changes in aggregate concentration and in the identities of the largest enterprises over time are of

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interest because they may reflect a dynamic and possibly competitive industrial sector. Aggregate concentration also gives indirect indication of concentration at more disaggregated levels of economic activity since aggregate concentration is a function of industrial concentration and diversification. However, higher aggregate concentration does not necessarily imply higher industrial concentration.

Industrial or market concentration refers to the extent to which the largest firms account for their specific markets. This type of concentration is relevant to competition policy, which is gaining increasing attention in twenty-first-century Ireland. A common perception is that the Irish economy is characterised by high levels of industrial concentration[1] and some commentators are of the view that high industrial concentration (in sheltered markets) may be a factor helping to account for perceived high price levels in Ireland.

This study examines the validity of the belief that industrial concentration is 'high' in Ireland and investigates whether industrial concentration varies with the degree of foreign ownership or the extent of export activity in Irish industry. The paper also identifies the industries that experienced significant change in concentration during the period 1991-2001, which saw unprecedented growth in the economy and rapid industrial change.

The estimates of both aggregate and industrial concentration are derived by applying a technique for calculating the concentration ratio given grouped data, specifically where firms are grouped into size classes and all that is known about them in each category is their number and aggregate size. The firm size distributions published by the Central Statistics Office (CSO) in the *Census of Industrial Production* (CIP) are of this form and constitute the most reliable data with which to estimate Irish industrial concentration in a systematic and large-scale way. Furthermore, the industries reported in the CIP enable comparison of the concentration estimates produced here with estimates available for other countries.[2] We employ the technique – due to McCloughan and Abounoori (2003) – to estimate the share of the 100 largest enterprises in all industry (aggregate concentration) and the five-firm

[1] For instance, according to the Chairman of the Competition Authority, "… an enormous number of markets in the Irish economy are highly concentrated" (Chairman's Foreword, *Annual Report of the Competition Authority*, 2003, p. 3).

[2] It is also relevant to note that the CIP data, despite their aggregated nature, which is discussed in more detail below, have been used in other recent papers to study the 'competitiveness' of Irish industry. Cerra *et al.* (2003) proposes an alternative measure of competitiveness based on the real exchange rate. O'Malley (2004) looks at output, employment and export trends in the Irish industrial sectors relative to those in the rest of the EU during 1991-2001. Using the same data, Boyle (2004) applies Roeger's version of Hall's test of market power (input and output markets).

concentration ratio in disaggregated industries (industrial concentration).

The structure of the paper is as follows. The next section briefly reviews previous research relating to concentration in Irish industry and Section III outlines in more detail the nature of the CIP data, including its limitations. In Section IV, the McCloughan and Abounoori technique is outlined in summary form and in Sections V and VI the estimates of aggregate concentration and industrial concentration during 1991-2001 are presented, respectively. Section VII concludes, highlights the caveats and offers some avenues for future research.

II REVIEW OF PREVIOUS RESEARCH

The last large-scale, systematic study of industrial concentration in Ireland was carried out by the Restrictive Practices Commission (RPC) and published in 1975. (Prior studies were Linehan (1962) and O'Malley (1971).) The data used by the RPC were the extended analyses of the CIP available in 1958, 1963 and 1968. The extended analyses enabled the RPC to estimate product level concentration ratios as well as ratios pertaining to broader industrial groupings and aggregate concentration.

The RPC's main findings in relation to aggregate concentration were as follows. In 1958, the minimum share of the 100 largest industrial establishments by net output was 42 per cent. In 1963, the figure fell to 41 per cent and five years later, the figure was 38 per cent. Interestingly, these figures were in the same ballpark as those reported by Prais (1976) for British industry. The RPC concluded that, whatever the change in the level of aggregate concentration between 1958 and 1968, "… it is still reasonably high for the economy as a whole" (Restrictive Practices Commission, 1975, p. 116).

As regards industrial concentration, the RPC found that "… even at the establishment level concentration is high or rising in many Irish industries, while it is low or falling in others" (p. 37). In particular, in 1968, the RPC found that 13 industries out of 39 (or one-third) had four-firm concentration ratios of 50 per cent or more; 11 further industries with lower levels of concentration showed increased concentration between 1958 and 1968. While the RPC relied on establishment or plant level data, it suggested that: "… concentration among enterprises in more narrowly defined industries is often very high or rising more or less rapidly" (*Ibid.*).

The RPC study employed a variety of measures of concentration, including methods based on the Lorenz curve as well as the concentration ratio. As here, the RPC had to rely on grouped data and to estimate the k-firm concentration ratio they essentially interpolated the size of the kth largest firm. The

McCloughan and Abounoori or MA method effectively formalises and generalises traditional methods of interpolating the concentration ratio given grouped data.

The main caveats of the data used by the RPC were three-fold. First, the industrial groupings were broader than might have been implied by demand-side substitutability and this, the RPC recognised, may have led to underestimation of concentration. Second, the absence of any information on imports into the industries studied may have overstated concentration. Third, the official data used were compiled on the basis of a national geographic market and, to the extent that competition within some of the industries may have been more local, this may have underestimated concentration. These three qualifications are a feature of the data used presently.

The author is unaware of any subsequent studies of concentration in the Irish economy since the RPC study in 1975. Perhaps the best alternative source of information on concentration in Irish industry comes from the merger inquiries undertaken by the Competition Authority. However, since the Authority was only required to publish its merger decisions since January 2003, when the merger provisions of the Competition Act of 2002 took effect, it is too early to construct a picture of concentration in Irish markets from this particular source of information.

III DATA

The Census of Industrial Production (CIP) comprises of two separate but closely related annual inquiries, namely the *Census of Industrial Enterprises* and the *Census of Industrial Local Units*. The latter covers all industrial local units with three or more persons while the former covers those enterprises that are wholly or primarily engaged in industrial production and have three or more persons engaged.

An 'enterprise' in the CIP equates with an independent business unit (e.g. sole trader, partnership or company) and in practice the enterprise is equivalent to a company or firm. A 'local unit' is defined as an enterprise or part thereof situated in a geographically identified place. Thus, if an enterprise conducts industrial activities in different geographical locations, each such activity is treated as a separate local unit. In this way, the local unit equates with an establishment or plant. To the extent that most industrial enterprises operate single plants, the results of the two censuses tend to give broadly similar results.

The difference between the two inquiries may relate to the extent of multi-plant operations among industrial enterprises. This may be more relevant

among larger enterprises and is a possibility we investigate in our analysis of aggregate concentration. If multi-plant operations are widespread at this level, we might expect aggregate concentration to be higher by enterprises than by local units, other things being equal. On the other hand, if both measures of aggregate concentration yield similar results then it may be that the very largest industrial firms tend instead to operate large plants at a single location, *ceteris paribus*.

The key measure of firm size in the *Census of Industrial Local Units* is net output, defined as gross output less industrial input. Gross output represents the selling value of goods actually produced, irrespective of whether they are sold or put into stock. Industrial input is the cost of materials, industrial services, and fuel and power used. In the *Census of Industrial Enterprises*, the variable gross value added (excluding VAT) is production value minus intermediate consumption and is the closest approximation to the concept of net output/value added as given in the local units Census. Another important size variable in the enterprise Census is turnover, which represents revenue received during the year. The estimates of aggregate concentration presented below are based on net output (local units data), turnover and gross value added (both from the enterprise Census). The industrial concentration estimates are derived solely from the local units Census and are based on net output.[3]

The choice of the period 1991-2001 is data driven. A number of conceptual and classification changes were introduced to the CIP with effect from the 1991 Census, affecting comparison with 1990 and earlier years. Because of changes to activity classification and to data collection units, the size distributions from 1991 onwards cannot be directly compared with those of earlier years and this explains why the observation period commences with 1991. The latest year for which the CIP reports (at the time the analysis was undertaken) is 2001.

One of the main limitations of the CIP relates to the aggregated nature of the data. This is to protect business confidentiality and sometimes the CSO amalgamates industries. The aggregated nature of the data implies broad market definitions and this may mean that industrial concentration is underestimated in this paper. Notwithstanding this shortcoming, we would make the following points. First, the CIP data are the only reliable data with which to estimate Irish industrial concentration in a large-scale and systematic way (i.e. across different industries). Second, others have used the CIP data to study the 'competitiveness' of Irish industry (see the studies mentioned in

[3] The enterprise Census does not report size distributions for disaggregated industrial groupings.

footnote 2). Third, the industrial groupings mean that the concentration estimates reported below are comparable with those available for other countries.

The estimates of industrial concentration presented below are for the 2-digit and 3-digit industries that the CSO has not 'amalgamated'.[4] Thus, for example, we provide estimates for NACE 17 (manufacture of textiles) but not for the amalgamated category NACE 15-16 (manufacture of food products; beverages and tobacco). Similarly, we report concentration estimates for NACE 151 (production, processing and preserving of meat and meat products) but not for NACE 153-154 (processing and preserving of fruit and vegetables; manufacture of vegetable and animal oils and fats). This results in industrial concentration estimates for 16 2-digit industries and 5 3-digit (non-overlapping) industries. In 2001, the 21 industries accounted for 4,509 industrial local units or 85 per cent of all industrial local units and an even larger proportion of total net output (namely 96 per cent or €54 billion). Thus, the sample of industries considered in this study is representative of Irish industry.

Finally, the CIP contains other information that may be of use in helping to 'explain' industrial concentration. In what follows, we use the information in the local units Census on foreign ownership and export intensity to examine patterns in concentration across the 21 industries.

IV MCCLOUGHAN AND ABOUNOORI (MA) METHOD

A popular measure of market or industrial concentration is the k-firm concentration ratio, defined as the cumulative share of the k largest firms in the industry or market. By convention, k is taken to be 4 or 5 (e.g. $C5$). Aggregate concentration is traditionally measured using the 100-firm concentration ($C100$), defined as the cumulative share of the very largest 100 firms in a given sector of the economy, such as manufacturing industry. The following outline of the McCloughan and Abounoori or MA method relates to the five-firm concentration ratio ($C5$) and the same principles apply to any other value of k (for market/industrial concentration) and to the aggregate concentration ratio.

Formally, $C5$ is defined as follows:

[4] While the Census of Industrial Local Units gives some information at the 4-digit level of disaggregation, there is no size distribution information at this level and so concentration cannot be accurately estimated at this level.

$$C5 = \sum_{i=1}^{5} s_i \tag{1}$$

where $s_1 \geq s_2 \geq s_3 \geq s_4 \geq s_5$ denote the market shares of the five largest firms in the industry. $C5$ is a positive index of concentration, with values closer to unity or 100 per cent indicating higher industrial concentration. Market share may be measured by net output, turnover, sales or employment.

The MA method enables estimation of the concentration ratio given grouped data, specifically where firms are grouped into size classes and all that is known about them in each category is their number and aggregate size. What follows is a summary outline of the technique; the details are given in McCloughan and Abounoori (2003).[5]

The MA method comprises of an interval estimator of the concentration ratio, with the actual (but unobserved) concentration ratio (i.e. the value that would be yielded by Equation (1) were individual market share data available) generally lying closer to the MA lower estimate than to the MA upper estimate. Both the MA lower and upper estimates are based on applying an alternative theoretical expression for $C5$ in terms of the two firm size distributions underlying the concept of concentration, namely the 'original' and 'first moment' size distributions. The former defines the frequency distribution of firms by size (i.e. the number or proportion of firms by size), while the latter shows the proportion of market/industry size accounted for by firms above a given size. Denoting the cumulative distribution function (cdf) of the original size distribution by $F(\cdot)$ and the cdf of the 1-moment by $F_1(\cdot)$, the alternative expression for $C5$ derived by McCloughan and Abounoori (2003) is:

$$C5 = 1 - F_1\left(F^{-1}\left(1 - \frac{5}{n}\right)\right) \tag{2}$$

where $F^{-1}(\cdot)$ is the inverse of $F(\cdot)$ and n denotes the total number of firms in the market ($n \geq 5$). The graph of the function given by (2), with $C5$ on the ordinate and the ratio $5/n$ on the abscissa, is a complementary Lorenz curve, with the curve lying above the equality diagonal rather than below as in the conventional Lorenz curve.[6] Apart from this feature, the complementary Lorenz curve defined by (2) shares the properties of the standard Lorenz curve and every probability distribution with positive support generates a family of

[5] See also McCloughan (2004), where the MA technique is used to provide estimates of concentration in the British construction sector.
[6] Which plots $F_1(\cdot)$ against $F(\cdot)$.

complementary Lorenz curves, whose position depends essentially on the distribution's shape parameter. A special case is the (single-parameter) exponential distribution, which yields a single complementary Lorenz curve. This is explained by the fact that the skewness of the exponential is constant at the value of 2. Interestingly, the least skew size distribution proposed by Sutton (1998) is equivalent to the exponential form of (2).

The problem in applying Equation (2) to grouped data is that the sample $F(\cdot)$ and $F_1(\cdot)$ are discontinuous functions. McCloughan and Abounoori (2003) outline an interpolation procedure based on the assumption of a uniform distribution describing the micro size distribution relating to the size class in which the 5th largest firm falls. This is a practicable way of applying (2) because, by the very nature of the grouped data, the precise form of the micro size distribution cannot be observed. All that is given, recall, are the number and aggregate size of the firms of the micro size distribution. With the simplifying uniform distribution assumption, McCloughan and Abounoori show that the sample version of Equation (2) for grouped data is:

$$C5 = 1 - \left[F_1(x_{j-1}) + \left\{\left(1 - \frac{5}{n}\right) - F(x_{j-1})\right\}\left\{\frac{F_1(x_j) - F_1(x_{j-1})}{F(x_j) - F(x_{j-1})}\right\}\right] \tag{3}$$

where $F(x_j)$ and $F(x_{j\text{-}1})$ denote the original cdf values at the upper values of size classes j and j–1, and $F_1(x_j)$ and $F_1(x_{j-1})$ give the corresponding 1-moment cdf values ($j = 1,\ldots,J$).

McCloughan and Abounoori (2003) then outline two cases, based on the term $(1 - 5/n)$ in (3). First, where $(1 - 5/n) = F(x_j)$, (3) simplifies to $C5 = 1 - F_1(x_j)$ and $C5$ is predicted exactly. That is, Equation (3) provides the value of $C5$ that would be yielded if the ungrouped data underlying the grouped data were available so that the researcher could readily apply Equation (1). Intuitively, this case captures the situation in which there are exactly 5 (k more generally) firms in the size class in which the fifth (kth) largest firm falls.

The second case is where $F(x_{j-1}) < (1 - 5/n) < F(x_j)$. This is more likely in practice than the first case. Here, application of Equation (3) either predicts concentration exactly, in which case the uniform assumption is correct, or else underestimates concentration. The latter is more likely in practice because the micro size distribution will likely be characterised by skewness. The extent of underestimation of the true $C5$ will depend essentially on the adequacy of the uniform assumption in relation to the unobserved micro distribution. The less skewed the micro distribution, the more robust will be the uniform assumption and the closer the value yielded by (3) will be to the true (but unobserved) concentration ratio. As shown by McCloughan and Abounoori (2003) using computer simulations, the uniform assumption is likely to be

more relevant, and thus equation (3) more accurate, where upper-tail size inequalities (i.e. size differences between the market's top 5 firms) are less pronounced. Nevertheless, where upper-tail size inequalities are high, the authors show how to construct an interval estimate of the concentration ratio. This relies on a further case.

The third case is where $F(x_{j-1}) < (1 - 5/n) < F(x_j)$ and defines the level of concentration corresponding to $(1 - 5/n) = F(x_{j-1})$ (i.e. $C5 = 1 - F_1(x_{j-1})$). This level constitutes the maximum possible value that $C5$ can take given the grouped data.[7] This case defines the MA upper estimate.

Summarising, the interval estimator of the concentration ratio is:

$$(C5_{lower}, C5_{upper}) = \left(1 - \left[F_1(x_{j-1}) + \left\{\left(1 - \frac{5}{n}\right) - F(x_{j-1})\right\}\left\{\frac{F_1(x_j) - F_1(x_{j-1})}{F(x_j) - F(x_{j-1})}\right\}\right], \quad 1 - F_1(x_{j-1})\right) \tag{4}$$

The true, but unobserved, concentration ratio will generally be closer to the lower estimate than to the upper estimate. The shorter the distance between the lower and upper estimates (i.e. the shorter the length of the interval estimate), the more accurate the MA method and where the concentration ratio is predicted exactly, the lower and upper values coincide.[8] Conversely, the larger the length of the MA interval, the less robust is the uniform interpolation procedure and the greater are upper-tail firm size inequalities. Thus, the MA method provides very useful information about the degree of size inequalities within the top five firms as well as about the level of concentration. In the following results for both aggregate and market concentration, we report both the MA upper and lower estimates. We also report a third value, capturing the feature that the true value of the concentration ratio is generally expected to be closer to the MA lower value than to the MA upper value. This third value, which will serve as a 'point' estimate, is the lognormal median of the MA lower and upper estimates.[9]

[7] The intuition is that we force the micro size distribution (i.e. the size class in which the fifth firm falls) to be completely concentrated.

[8] To be clear, there are two ways in which the MA method will predict the concentration ratio exactly: one is where the uniform interpolation procedure is correct and the other is where there are exactly 5 firms in the size class in which the fifth largest firm falls. Instances of both cases are reported in the note to Table 3 below.

[9] That is, as $\exp(\mu)$, where μ is the average of the natural logs of the MA lower and upper estimates of the concentration ratio.

V AGGREGATE CONCENTRATION IN IRISH INDUSTRY

5.1 Results for Industrial Local Units and Industrial Enterprises

The aggregate concentration estimates are presented in Table 1 and illustrated in Figure 1. The estimates are for three bases as follows:

- Percentage share of the 100 largest industrial *local units* by *net output*;
- Percentage share of the 100 largest industrial *enterprises* by *turnover*;
- Percentage share of the 100 largest industrial *enterprises* by *gross value added*.

Not surprisingly, the estimates based on the Census of Industrial Enterprises give a very similar picture of the trend in aggregate concentration and in size differences among the very largest industrial firms since 1991. On the other hand, the estimates based on the Census of Industrial Local Units data reveal a somewhat different picture of the trend in aggregate concentration.

Both the local units and enterprises censuses indicate that the top 100 firms accounted for the majority of Irish manufacturing industry in 2001. In particular, using the 'point' estimate of aggregate concentration between the MA lower and upper estimates, the top 100 industrial local units accounted for 56 per cent of all manufacturing net output in that year. According to the analysis based on the Census of Industrial Enterprises, the top 100 firms accounted for 52 per cent of all manufacturing turnover and the same proportion of gross value added in 2001.

That the 100 largest industrial firms account for most of manufacturing industry suggests that Irish industry is characterised by relatively high aggregate concentration. Available figures for other countries indicate an aggregate concentration ratio of 35-40 per cent for British industry (Office for National Statistics) and a ratio of 30-35 per cent in US industry (O'Neill, 1996). However, one would expect aggregate concentration to be lower in these countries owing to the much larger size of their industrial sectors. Unfortunately, aggregate concentration figures for countries of a similar size to Ireland are unavailable.

Turning to trends, the results based on the Census of Industrial Local Units suggest that aggregate concentration increased steadily during 1991-2001. In particular, according to the 'point' estimates, the *C*100 rose from 40 per cent in 1991 to over 56 per cent in 2001. The estimate for 1991 suggests that there was little change in the level of aggregation concentration from earlier years, because the RPC (1975) estimate of aggregate concentration among establishments by net output was approximately 40 per cent as far

back as 1968. However, according to the present estimates, there was an increase in the level of aggregate concentration by net output during 1991-2001, as illustrated in the first panel of Figure 1 below. The graph also shows that there was an increase in size differences among the top 100 industrial local units during the period because the length of the interval between the MA upper and lower estimates widened.

In contrast to the industrial local units results, aggregate concentration by enterprises does not appear to have risen since 1991, whether measured by turnover or gross value added, as the second and third panels of Figure 1 illustrate. The most striking feature of the enterprise estimates is the increase in size differences among the top 100 Irish industrial enterprises during 1991-2001. In 1991, the length of the interval between the MA upper and lower estimates is small, suggesting that there were relatively small differences in size among Ireland's largest 100 companies (whether by turnover or gross value added) in that year. However, during the 1990s, size differences among the top 100 industrial enterprises increased so that by 2001 the largest members would dwarf the smaller members of the top 100.

5.2 Analysis of the Top 100 Industrial Enterprises in 1991 and 2001 using Micro Data

To further examine the apparent rapid rise in size differences among the top 100 industrial enterprises in Ireland during 1991-2001, a separate analysis of the identities and sizes (by turnover) of the top 100 in these years was carried out.[10] The results are summarised in Table 2 below and the values reported are in constant 2001 prices.

In 1991, the average level of turnover among the top 100 industrial enterprises was €247.52 million and the standard deviation was €312.21 million (constant 2001 prices). The corresponding figures for 2001 were €709.5 million and €1,795 million. The substantial increase in the standard deviation supports the widening of the gap between the MA upper and lower estimates illustrated in the second and third panels of Figure 1.

To probe beneath the growth in size differences among the top 100, the companies were separated into two groups – Irish-owned and foreign-owned firms. In 1991, 49 of the top 100 industrial enterprises were indigenously owned and in 2001 the figure fell to 41. The average turnover (constant 2001

[10] Using the *Business and Finance* Top 1,000 Companies Survey for 1992 and 2003. In this annual publication, which is a well-recognised guide to the largest companies in Ireland, companies are ranked by turnover in their latest financial year. In the 1992 survey, the latest financial year reported was mostly 1991; in the 2003 survey, the latest financial year reported was mostly 2001. The Top 1,000 includes data on construction firms and services enterprises *inter alia*, although here the focus is on the top 100 manufacturing/industrial firms.

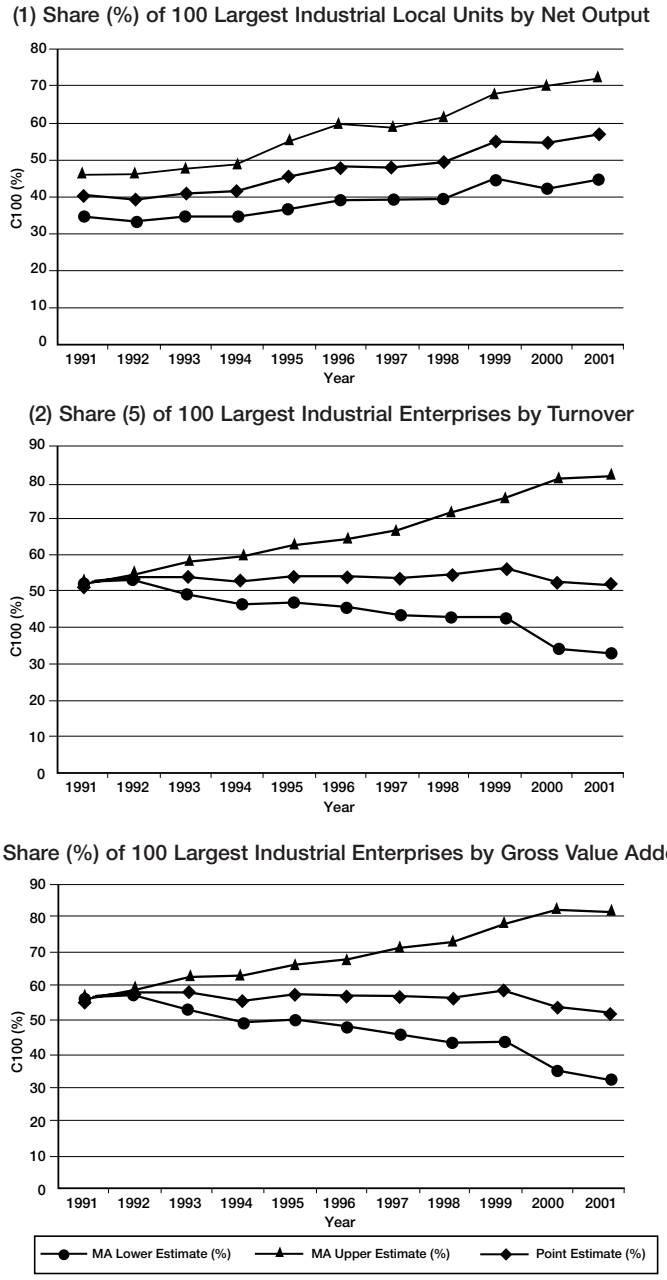
Table 1: *Aggregate Concentration in Irish Industry by (1) Net Output, (2) Turnover and (3) Gross Value Added 1991-2001*

	(1) Share (%) of 100 Largest Industrial Local Units by Net Output			*(2) Share (%) of 100 Largest Industrial Enterprises by Turnover*			*(3) Share (%) of 100 Largest Industrial Enterprises by Gross Value Added*		
	MA Lower Estimate (%)	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*
1991	34.46	45.87	39.76	51.33	52.36	51.84	54.65	55.74	55.19
1992	33.15	46.25	39.15	52.69	54.8	53.74	56.66	58.93	57.78
1993	34.51	47.73	40.59	49.58	58.01	53.63	52.92	61.91	57.24
1994	34.59	48.53	40.97	46.88	59.54	52.83	49.26	62.56	55.51
1995	36.29	55.02	44.68	47.41	62.58	54.47	49.83	65.77	57.25
1996	38.55	59.51	47.9	45.5	64.15	54.02	47.8	67.4	56.76
1997	38.77	58.93	47.8	43.17	67.34	53.91	45.33	70.71	56.62
1998	39.44	61.07	49.08	42.2	71.32	54.86	43.22	73.04	56.19
1999	44.41	67.54	54.77	42.37	75.85	56.69	43.63	78.1	58.37
2000	42.46	70.07	54.55	34.54	81.51	53.06	34.95	82.48	53.69
2001	44.25	71.94	56.42	32.82	82.38	52.00	32.68	82.01	51.77

Source: MA (McCloughan and Abounoori) estimator applied to Census of Industrial Production data 1991-2001.

Notes: (1) Census of Industrial Local Units data used to provide aggregate concentration estimates reported under (1). Size distributions grouped by persons engaged, NACE 1-4.
(2) Census of Industrial Enterprises data used to provide aggregate concentration estimates reported under (2) and (3). Size distributions grouped by turnover per enterprise (excluding VAT), NACE 1-4.
(3) Point estimate based on lognormal median of MA lower and MA upper estimates.

Figure 1: *Aggregate Concentration in Irish Industry by (1) Net Output, (2) Turnover and (3) Gross Value Added 1991-2001*



Source and *Notes:* See Table 1 above

prices) among the Irish-owned contingent of the top 100 grew by 180 per cent from €352.78 million in 1991 to €986.95 million in 2001. The corresponding rate of increase in average turnover among the foreign-owned members of the top 100 was even higher at 253 per cent (from €146.39 million in 1991 to €516.61 million in 2001). The standard deviation in turnover among the foreign-owned enterprises increased substantially from €139.82 million in 1991 to €1,735.53 million in 2001 (an increase of 1,141 per cent). The increase in the standard deviation among the Irish-owned members of the top 100 was also large (368 per cent) but less dramatic than that among the foreign-owned contingent.

The changes in the standard deviations apparent in Table 2 are consistent with the widening of the gap between the MA upper and lower estimates in Figure 1, and the analysis points to an especially rapid rise in size differences among the largest foreign-owned industrial enterprises in Ireland during the period.

Further examination of the micro data reveals that there was significant 'entry' of 'new' foreign members of the top 100 in 2001 that were not present in 1991 and this may have driven the significant increase in the standard

Table 2: *Analysis of Top 100 in 1991 and 2001*

	1991	*2001*
Average turnover (€m, constant 2001 prices)	247.52	709.50
St. Dev. in turnover (€m, constant 2001 prices)	312.21	1,795
Number of Irish companies	49	41
Number of foreign companies	51	59
Average turnover (Irish companies) (€m, constant 2001 prices)	352.78	986.95
Average turnover (foreign companies) (€m, constant 2001 prices)	146.39	516.61
St. Dev. in turnover (Irish companies) (€m, constant 2001 prices)	398.12	1,863.63
St. Dev. in turnover (foreign companies) (€m, constant 2001 prices)	139.82	1,735.53
'Entrants' to top 100 in 2001	–	64
Of which:		
Irish companies	–	20
Foreign companies	–	44

Source: Own calculations using *Business and Finance* 'Top 1,000' 1992 and 2003.

deviation among the foreign-owned segment during the period. As shown in Table 2, of the top 100 in 2001, 64 enterprises were not present in the top 100 in 1991 and 44 of these were foreign-owned 'entrants' to the top 100. These 'entrants' comprised of (i) greenfield entrants (i.e. new foreign firms that arrived in Ireland in the interim) and (ii) foreign firms present in Ireland in 1991 but not in the top 100.

Viewed in this way, it may be concluded that despite aggregate concentration appearing 'high' in Ireland, analysis of micro data within the top 100 reveals a strong sense of dynamic change among the identities of the largest Irish and foreign industrial firms in Ireland, particularly among the latter.

5.3 Comparison of Aggregation Concentration by Industrial Local Units and by Enterprises: Indication of Extent of Multi-Plant Operations

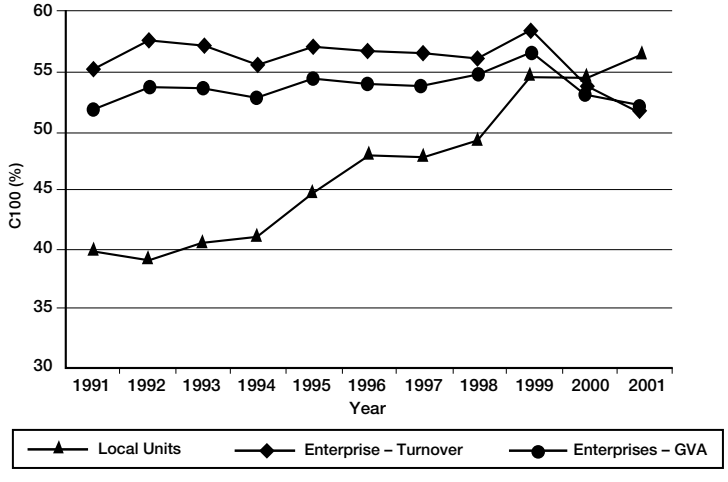
In describing the two inquiries reported within the CIP in the data section above, we surmised that if multi-plant operations were widespread among the very largest industrial firms then we might expect aggregate concentration to be higher by enterprises than by local units, *ceteris paribus*. On the other hand, if both measures of aggregate concentration yield similar results or if the opposite pattern then it might be that the very largest firms tend instead to operate large plants at a single location, other things being equal.

In Figure 2 below, we compare the three measures of aggregation concentration (point estimates) reported in Table 1, namely that based on the Census of Industrial Local Units (net output) with those based on the Census of Industrial Enterprises (by turnover and gross value added or GVA). Up until 1999, aggregate concentration by enterprises was higher than that by industrial local units, suggesting that multi-plant operations were more important among the very largest industrial firms. However, since 1999, aggregate concentration by industrial local units has exceeded the two measures by industrial enterprises, suggesting that the largest industrial firms of today may operate large plants at a single geographical location rather than multi-plant operations throughout the country.

Part of the explanation of this trend may come from the development of industrial policy, particularly initiatives regarding inward direct investment. It has been observed that, faced with increasing competition for mobile international investment, including from the Accession States of the EU as well as from Northern Ireland, Scotland, Wales and the English regions, which have been given greater autonomy in terms of FDI, the authorities in Ireland have become more focused on developing the foreign firms already present in Ireland, particularly as regards encouraging greater R&D in key areas (including electronics and health care). This may have resulted in relatively

rapid growth of existing foreign subsidiaries' plants (on average) and may be in evidence here by the increase in size differences among the top 100.

Figure 2: *Aggregate Concentration in Irish Industry for Industrial Local Units (Net Output) and Industrial Enterprises (Turnover and Gross Value Added) 1991-2001*



Source: See Table 1 above.
Note: Aggregate concentration figures are the 'point' estimates reported in Table 1.

VI INDUSTRIAL CONCENTRATION

6.1 Industrial Concentration in 2001

Table 3 presents the estimates of the five-firm concentration ratio (*C*5) by net output in 21 non-amalgamated industries for 1991, 1996 and 2001 (based on the Census of Industrial Local Units). In the latest year, the top five firms together accounted for, on average, 35.5 per cent of their industry. However, this mean figure belies considerable variation in concentration among industries. The most concentrated industries in 2001 were ('point' estimates of *C*5): leather and leather products (67.7 per cent); office machinery and computers (62.6 per cent); other transport equipment (53.2 per cent); and radio, television and communication equipment (52.6 per cent). On the other hand, chemicals, chemical products and man-made fibres (8.1 per cent), rubber and plastic products (13.6 per cent), fish and fish products (16 per cent) and meat and meat products (20.4 per cent) were the least concentrated industries in 2001.[11]

[11] The note to Table 3 identifies the industries in which the MA method predicts the concentration ratio exactly and why.

Using the information on upper-tail size inequalities (i.e. size differences among the top five firms) provided by the MA method, we may examine the relationship, if any, between the point estimate of $C5$ and upper-tail size inequalities, given as the absolute difference between the MA upper and lower levels of concentration. The figures are contained in the second and third columns of Table 4 below. As might be expected, the relationship between $C5$ and upper-tail size inequalities is appreciably strong (correlation coefficient of 0.59), so that relatively concentrated industries are also industries in which size differences within the leading five firms are relatively high too. This is consistent with previous research, which suggests that it is often the top one or two firms that govern the level of concentration.[12]

We may also examine whether the level of concentration varies according to the degree of foreign ownership in Irish industry. We may examine the extent of foreign ownership in two ways: first by establishing the proportion of all firms in each industry that are foreign-owned and second (and perhaps more appropriately) by ascertaining the proportion of net output accounted for by foreign-owned firms. Both measures of foreign ownership are reported in the fourth and fifth columns of Table 4. When measured by the proportion of firms that are foreign-owned, there does not appear to be any statistically significant relationship between foreign ownership and concentration (the correlation coefficient is only 0.12). Of the four most concentrated industries in 2001, two (namely leather and leather products, and other transport equipment) had no foreign firms, while in the other two industries (office machinery and computers, and radio, television and communication equipment) the proportion of foreign firms was appreciably high (44.74 per cent and 50 per cent respectively). At the other end of the concentration scale, the least concentrated industry (chemicals, chemical products and man-made fibres) was one in which foreign firms accounted for 49.17 per cent of all firms in 2001. When measured by the proportion of industry net output accounted for by foreign firms, the relationship between concentration and foreign ownership is even weaker (correlation coefficient of 0.09). Thus, the analysis of the present sample of 21 industries in 2001 suggests that the level of concentration does not vary by the extent of foreign ownership in Irish industry.

We may also investigate whether concentration varies by the extent of export activity in Irish industry. It might be that scale is a prerequisite for competing internationally, in which case we would expect there to be a positive association between concentration and export activity. The CIP provides data on the value of gross output exported by industry, from which may be

[12] See, for example, Davies *et al.* (1991).

Table 3: *Share (%) of the Five Largest Firms in Irish Industries by Net Output 1991, 1996 and 2001*

	1991			*1996*			*2001*		
	MA Lower Estimate (%)	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*
Meat and meat products	11.75	25.84	17.42	10.58	23.27	15.69	12.67	32.94	20.43
Fish and fish products	17.20	34.41	24.33	23.86	23.86	23.86	8.68	29.52	16.01
Dairy products	22.95	45.89	32.45	23.28	46.56	32.92	27.95	44.72	35.36
Other food products	27.68	56.96	39.71	31.89	63.79	45.11	16.97	88.23	38.69
Textiles	14.11	59.25	28.91	18.04	21.65	19.76	20.89	50.14	32.36
Wearing apparel, dressing and dyeing of fur	14.30	25.74	19.18	23.64	37.82	29.90	35.22	56.36	44.56
Leather and leather products	30.06	54.12	40.34	50.54	50.54	50.54	50.48	90.86	67.72
Wood and wood products	31.79	31.79	31.79	27.72	33.27	30.37	21.69	30.36	25.66
Pulp, paper and paper products	18.67	44.81	28.93	21.29	51.11	32.99	19.58	58.73	33.91
Publishing, printing and reproduction of recorded media	15.25	69.83	32.63	24.00	62.39	38.69	12.64	85.92	32.95
Chemicals, chemical products and man-made fibres	13.99	36.38	22.56	10.54	73.42	27.81	6.40	10.23	8.09
Pharmaceuticals, medicinal chemicals and botanical products	35.53	66.43	48.58	45.21	63.29	53.49	27.32	71.03	44.05
Rubber and plastic products	24.81	48.75	34.78	17.68	21.22	19.37	12.43	14.92	13.62
Other non-metallic mineral products	25.15	40.24	31.82	26.05	36.47	30.83	25.00	35.00	29.58
Machinery and equipment nec	30.45	39.41	34.64	26.83	41.92	33.54	17.45	38.39	25.88
Office machinery and computers	59.79	69.54	64.48	38.37	53.72	45.40	46.63	83.93	62.56

Table 3: *Share (%) of the Five Largest Firms in Irish Industries by Net Output 1991, 1996 and 2001 (contd.)*

	1991			*1996*			*2001*		
	MA Lower Estimate (%)	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*	*MA Lower Estimate (%)*	*MA Upper Estimate (%)*	*Point Estimate (%)*
Electrical machinery and apparatus nec	24.53	53.96	36.38	18.25	54.75	31.61	22.38	67.15	38.77
Radio, television and communication equipment	52.09	74.22	62.18	43.87	78.97	58.86	29.43	94.17	52.64
Medical, precision and optical instruments, watches and clocks	66.36	66.36	66.36	26.43	42.29	33.43	24.77	49.54	35.03
Motor vehicles, trailers and semi-trailers	37.57	52.59	44.45	20.19	72.70	38.32	19.58	58.73	33.91
Other transport equipment	80.19	91.54	85.68	74.96	74.96	74.96	30.74	92.21	53.24
Mean	31.15	51.81	39.41	28.73	48.95	36.55	23.28	56.34	35.48

Source: MA (McCloughan and Abounoori) estimator applied to Census of Industrial Production data 1991, 1996 and 2001, specifically Table 3 of the Census of Industrial Local Units.

Note: Five-firm concentration ratio predicted exactly in (NACE): wood and wood products (20) 1991; medical, precision and optical instruments, watches and clocks (33) 1991; fish and fish products (152) 1996; leather and leather products (19) 1996; and other transport equipment (35) 1996. In all cases, except for medical, precision and optical instruments, watches and clocks, where the concentration ratio is predicted exactly because the uniform assumption about the micro size distribution is correct, the concentration ratio is predicted exactly because there are exactly five firms in the size class into which the 5th largest firm falls.

Table 4: *Share (%) of the Five Largest Firms by Net Output, Degree of Size Inequalities Among Five Largest Firms, Degree of Foreign Ownership and Degree of Export Intensity in Irish Industries 2001*

Industry	*Five-Firm Concentration Ratio (%)*	*Upper-tail Size Inequalities*	*% Foreign Firms*	*% Net Output by Foreign Firms*	*% Gross Output Exported*
Leather and leather products	67.72	40.38	0.00	0.00	88.53
Office machinery and computers	62.56	37.30	44.74	94.79	92.56
Other transport equipment	53.24	61.47	0.00	0.00	85.52
Radio, television and communication equipment	52.64	64.74	50.00	97.44	94.68
Wearing apparel, dressing and dyeing of fur	44.56	21.13	6.35	52.18	76.11
Pharmaceuticals, medicinal chemicals and botanical products	44.05	43.71	67.69	98.49	98.47
Electrical machinery and apparatus nec	38.77	44.77	32.80	88.00	92.07
Other food products	38.69	71.26	10.00	92.65	90.79
Dairy products	35.36	16.77	0.00	0.00	55.58
Medical, precision and optical instruments, watches anf clocks	35.03	24.77	48.92	93.97	97.48
Pulp, paper and paper products	33.91	39.15	14.05	48.67	46.76
Motor vehicles, trailers and semi-trailers	33.91	39.15	0.00	0.00	84.01
Publishing, printing and reproduction of recorded media	32.95	73.29	7.51	89.42	92.82
Textiles	32.36	29.25	11.90	48.30	78.99
Other non-metallic mineral products	29.58	10.00	8.43	19.65	39.73
Machinery and equipment nec	25.88	20.94	16.62	55.07	82.46
Wood and wood products	25.66	8.67	2.70	26.27	43.40
Meat and meat products	20.43	20.27	0.00	0.00	48.57
Fish and fish products	16.01	20.84	0.00	0.00	78.63
Rubber and plastic products	13.62	2.49	18.68	42.21	60.36
Chemicals, chemical products and man-made fibres	8.09	3.84	49.17	97.94	97.99
Mean	35.48	33.06	18.55	49.76	77.41

Source: Five-firm concentration ratios are the point estimates reported in Table 3; upper-tail size inequalities are given as the difference between the MA lower and upper estimates in Table 3; percentage of foreign firm ownership and percentage of gross output exported are own calculations using Census of Industrial Production data 2001, specifically Table 6 and Table 9 respectively of the *Census of Industrial Local Units.*

calculated the proportion of gross output exported by industry. We may use this to measure the degree of export activity by industry. The export intensities for the 21 industries are reported in the final column of Table 4. The correlation coefficient between $C5$ and export activity is 0.36, which suggests that industries with higher concentration may also have higher levels of export intensity, although the relation appears to be weak.

We decided to bring the potential effects together and analyse the roles of upper-tail size inequalities, foreign ownership and export activity on concentration in a regression context. The results are summarised in the two estimated regression equations below, in which the variable *Sigma* denotes upper-tail size inequalities, *Foreignown1* is the proportion of firms that are foreign owned, *Foreignown2* is the proportion of net output due to foreign owned firms and *Export* is the proportion of gross output exported. The unit of observation (t) is industry and the numbers in parentheses are absolute t-ratios. The only significant explanatory variable in accounting for differences in industrial concentration in 2001 is upper-tail size inequalities; foreign ownership or export activity does not have any significant bearing on concentration.

$$\hat{Conc}_t = \underset{(1.45)}{19.23} + \underset{(2.35)^*}{0.40}\, Sigma_t + \underset{(0.23)}{0.04}\, Foreignown1_t + \underset{(0.13)}{0.03}\, Export_t \qquad (5)$$

$$R^2 = 0.35 \quad N = 21$$

$$\hat{Conc}_t = \underset{(1.17)}{14.72} + \underset{(2.45)^*}{0.39}\, Sigma_t - \underset{(0.83)}{0.08}\, Foreignown2_t + \underset{(0.73)}{0.15}\, Export_t \qquad (6)$$

$$R^2 = 0.38 \quad N = 21$$

6.2 Changes in Industrial Concentration

The changes that have taken place in Irish industrial concentration during 1991-2001 are summarised in Table 5 below. The second column reports the percentage point change in $C5$ between 1991 and 2001, and the corresponding figures for 1996 and 2001 are given in the third column of Table 5. Overall, industrial concentration has fallen in Ireland, although by a small amount on average. Between 1991 and 2001, $C5$ by net output fell by almost 4 percentage points on average. Between 1996 and 2001, the corresponding drop in $C5$ was a little over 1 percentage point.

However, some very dramatic changes in concentration have occurred within certain industries. In particular, leather and leather products, and wearing apparel, dressing and dyeing of fur experienced the largest growth in concentration since 1991, as the figures in Table 5 reveal. Textiles has also

become more concentrated, especially in the sub-period 1996-2001, when the share of the top five firms by net output increased from 19.76 per cent to 32.36 per cent (an absolute change of 12.6 percentage points). Another case of note is office machinery and computers, where the five-firm concentration ratio increased by 17.16 percentage points between 1996 and 2001.

On the other hand, a number of industries experienced appreciable 'de-concentration' since 1991 (percentage point drop in *C*5 by net output), notably other transport equipment (32.44), medical, precision and optical instruments, watches and clocks (31.33), rubber and plastic products (21.16) and chemicals, chemical products and man-made fibres (14.47). Fish and fish products has

Table 5: Change in the Share (per cent) of the Five Largest Firms by Net Output in Irish Industries 2001

	% Point Change in Five-Firm Concentration Ratio	
Industry	*2001-1991*	*2001-1996*
Leather and leather products	27.39	17.19
Wearing apparel, dressing and dyeing of fur	25.37	14.66
Pulp, paper and paper products	4.98	0.92
Textiles	3.45	12.60
Meat and meat products	3.01	4.74
Dairy products	2.91	2.43
Electrical machinery and apparatus nec	2.39	7.16
Publishing, printing and reproduction of recorded media	0.32	–5.74
Other food products	–1.02	–6.42
Office machinery and computers	–1.92	17.16
Other non-metallic mineral products	–2.23	–1.24
Pharmaceuticals, medicinal chemicals and botanical products	–4.53	–9.44
Wood and wood products	–6.13	–4.71
Fish and fish products	–8.32	–7.85
Machinery and equipment nec	–8.76	–7.65
Radio, television and communication equipment	–9.53	–6.22
Motor vehicles, trailers and semi-trailers	–10.54	–4.41
Chemicals, chemical products and man-made fibres	–14.47	–19.72
Rubber and plastic products	–21.16	–5.75
Medical, precision and optical instruments, watches and clocks	–31.33	1.60
Other transport equipment	–32.44	–21.72
Mean	–3.93	–1.07

Source: Own calculations using the point estimates reported in Table 3.
Note: Industries ranked according to percentage point change 2001-1991.

also experienced dramatic falls in concentration during 1991-2001 and 1996-2001, of 8.32 and 7.85 percentage points respectively. Pharmaceutical, medicinal chemicals and botanical products also saw falls in concentration, especially between 1996 and 2001, when $C5$ by net output fell by 9.44 percentage points.

6.3 International Comparison

To give international perspective to the analysis, we may compare the 'point' estimates here with concentration figures available for other countries on comparable industries.[13] The results of the comparison exercise are given in Tables 6 and 7 below. The comparison between Ireland and the other countries relates to another measure of concentration, the Herfindahl-Hirschman index (HHI), defined as the sum of the squares of the market shares of all firms in the industry. In order to make the comparison, we converted the point estimates of $C5$ derived here into HHI equivalents for Ireland, as the other countries' figures are only available in HHI form.

The relationship between the concentration ratio and HHI generally is not a simple one. At best, we can convert $C5$ into a range for the HHI, by deriving the minimum and maximum values of the HHI corresponding with $C5$. Sleuwagen and Dehandschutter (1986) show that, for any given $C5$, the minimum value of the HHI is:

$$HHI_{min} = \frac{(C5)^2}{5} \tag{7}$$

On the other hand, the maximum value of the HHI may be linear or quadratic depending upon the relative sizes of $C5$ and 1/5, *viz.*:

$$HHI_{max} = \begin{cases} (C5)^2 \text{ if } C5 > \dfrac{1}{5} \\ \dfrac{C5}{5} \text{ if } C5 \leq \dfrac{1}{5} \end{cases} \tag{8}$$

Applying the formulae given in (7) and (8), we may derive HHI ranges for Irish industries and compare the results with the HHIs available for other countries. In Table 6, the minimum and maximum HHI values derived for Irish industries are compared with HHI values for the same or similar industries relating to Austria (1997), Belgium (1997), Finland (1997), Italy

[13] The other countries' concentration estimates are reported in Gjersem (2004).

(1996) and the US (1997). Owing to the fact that the other countries' figures pertain to 1996/97, the HHI values for Ireland are based on applying (7) and (8) to the point estimates of $C5$ for 1996 given in Table 3 (for clarity, the point estimates of $C5$ as well as the derived HHI_{min} and HHI_{max} figures for Ireland are reported in Table 6). Similarly, in Table 7, the comparison is between Sweden (1999), UK (2000) and Japan (1999) with Ireland (2001). In each of Tables 6 and 7, the industries are grouped according to R&D intensity and whether they are 'fragmented' or 'segmented'.[14]

Looking first at the comparison between Ireland and other countries in 1996/97, Table 6 reveals that for the fragmented, low R&D category of industries, concentration in Irish industry may have been relatively high, with the possible exception of Belgium. However, in the single segmented, low R&D industry with which we can compare (namely rubber), the industry in Ireland may have been less concentrated. With respect to the fragmented, high R&D category and the segmented, high R&D category, the evidence in Table 6 suggests that, like the first category, Irish industry may have been relatively concentrated in 1996. A similar pattern appears to be evident in Table 7, namely that concentration may have been relatively high in three of the four categories of industry (apart from rubber) in 2001.

Although the list of industries and countries in Tables 6 and 7 is not comprehensive, and bearing in mind that the HHI range estimates for Ireland are based on range estimates of the concentration ratio, it nevertheless appears that industry is relatively concentrated in Ireland. This may reflect the relatively small size of the domestic market in Ireland and other factors, possibly the legacy of supplier-oriented policies since the foundation of the State in 1922 and the relatively recent arrival of competition policy in Ireland. It is the author's view that the results are sufficiently interesting to merit further research, ideally using more disaggregated data.

[14] According to Oliveira Martins *et al.* (2002), 'fragmented' market structures are characterised by small firms and low sunk costs and entry barriers. 'Segmented' market structures on the other hand are characterised by larger average firm sizes and significant entry barriers associated with high sunk costs.

Table 6: *Comparison of Industrial Concentration in Ireland with that in Other Countries 1996/97*

	Herfindahl-Hirschman Index (HHI)							*Five-Firm Concentration Ratio (%)*
Industry	*Aut 1997*	*Bel 1997*	*Fin 1997*	*Italy 1996*	*US 1997*	*Ireland 1996 (HHI Min)*	*Ireland 1996 (HHI Max)*	*Ireland 1996*
Fragmented, Low R&D								
Textiles	88	54	443	7	7	78	395	19.76
Wearing apparel	131	493	341	14	9	179	894	29.90
Leather products	553	2,566	263	22	65	511	2,554	50.54
Wood products	58	87	167	4	4	184	922	30.37
Paper and pulp products	160	185	352	75	14	218	1,088	32.99
Publishing and printing	49	40	99	43	3	299	1,497	38.69
Average	*173*	*571*	*278*	*28*	*17*	*245*	*1,225*	
Segmented. Low R&D								
Rubber products	790	745	775	291	–	75	387	19.37
Fragmented, High R&D								
Medical appliances		76	269	31	–	224	1,118	33.43
Segmented, High R&D								
Chemical products	207	75	284	44	14	155	773	27.81
Drugs and medicines	490	551	2,175	137	–	572	2,861	53.49
Office and computing machinery	792	387	–	2,208	18	412	2,061	45.40
Electrical machinery	92	209	323	26	14	200	999	31.61
Motor vehicles	476	363	429	238	24	294	1,468	38.32
Other transport equipment	553	903	753	297	–	1,124	5,619	74.96
Average	*435*	*415*	*793*	*492*	*18*	*459*	*2,297*	

Source: Other countries' HHIs reproduced from Gjersem (2004). Irish HHIs derived by applying Sleuwagen and Dehandschutter's (1986) formula to the point estimates by net output of the five-firm concentration ratio reported in Table 3, which, for the sub-sample of industries in this table, are reproduced in the final column.
Note: European countries' HHI estimates based on enterprise data; US estimates based on establishment data.

Table 7: *Comparison of Industrial Concentration in Ireland with that in Other Countries 1999-2001*

	Herfindahl-Hirschman Index (HHI)					*Five-Firm Concentration Ratio (%)*
Industry	*Sweden 1999*	*UK 2000*	*Japan 1999*	*Ireland 2001 (HHI Min)*	*Ireland 2001 (HHI Max)*	*Ireland 1996*
Fragmented, Low R&D						
Textiles	125	19	3	209	1,047	32.36
Wearing apparel	244	29	4	397	1,986	44.56
Leather products	360	134	46	917	4,586	67.72
Wood products	76	16	5	132	658	25.66
Paper and pulp products	218	79	23	230	1,150	33.91
Publishing and printing	39	14	18	217	1,086	32.95
Average	*177*	*49*	*17*	*350*	*1,752*	
Segmented. Low R&D						
Rubber products	515	–	75	37	272	13.62
Fragmented, High R&D						
Medical appliances	321	43	48	245	1,227	35.03
Segmented, High R&D						
Chemical products	375	44	15	13	162	8.09
Drugs and medicines	2,042		51	388	1,940	44.05
Office and computing machinery	367	285	84	783	3,914	62.56
Electrical machinery	129	31	22	301	1,503	38.77
Motor vehicles	446	90	49	230	1,150	33.91
Other transport equipment	663	117	109	567	2,834	53.24
Average	*670*	*113*	*55*	*380*	*1,917*	

Source: Other countries' HHIs reproduced from Gjersem (2004). Irish HHIs derived by applying Sleuwagen and Dehandschutter's (1986) formula to the point estimates by net output of the five-firm concentration ratio reported in Table 3, which, for the sub-sample of industries in this table, are reproduced in the final column.
Note: European countries' HHI estimates based on enterprise data; Japan estimates based on establishment data.

VII CONCLUSIONS

Before summarising the main results, the caveats of the paper are first highlighted. The principal qualification about the estimates relates to the grouping of the data. Changes by the CSO in the way the data are grouped (the number of size classes and/or the widths of the size classes) mean that on occasion there are large differences between the MA upper and lower estimates and the length of the MA interval for a given industry may change dramatically between years. This underlines a general feature of the MA technique, namely that it is sensitive to grouping, which is beyond the researcher's control. To ease the interpretation of the estimates, this paper has also reported 'point' estimates of concentration. Defined as the lognormal median of the MA upper and lower values, the point estimates are designed to capture the property that the true but unobserved level of the concentration ratio will generally lie closer to the lower than to the upper bound.

The second caveat relates to the aggregated nature of the CIP data (to protect business confidentiality). This means that the concentration estimates reported here are almost certainly lower than they would be if we had access to more disaggregated data. A third qualification concerns the general paucity of up-to-date concentration data for countries of a similar size to Ireland (including individual US states), which would be useful in terms of putting the results more directly into international perspective.

Nevertheless, we would emphasise that the CIP data, despite the grouping and aggregation issues, are presently the most reliable source of information for estimating concentration in a large-scale and systematic way for Irish industry.

The main findings are as follows. First, aggregate concentration appears to be high in Ireland. Whether measured by net output (Census of Industrial Local Units), turnover or gross value added (Census of Industrial Enterprises), the 100 largest firms account for over half of all manufacturing industry. Available figures for the US and UK suggest lower levels of aggregate concentration (30-35 per cent in the former and 35-40 per cent in the latter). However, the difference between these economies and Ireland is unsurprising because we would generally expect aggregate concentration to be higher in countries with smaller industrial sectors, other things being equal. Unfortunately, aggregate concentration figures are not widely available for countries of a similar size to Ireland.

Second, there has been a significant increase in size differences among the 100 largest industrial firms during the period. The rise in 'size inequalities' is particularly evident in the results based on the Census of Industrial Enterprises, as manifested in the widening gap between the MA lower and

upper values in the second and third panels of Figure 1. This development implies that the very largest industrial firms are not a homogeneous group in size terms. Furthermore, the period examined witnessed significant changes in the identities of the top 100, especially among the foreign-owned members of the top 100.

Thus, while the level of aggregate concentration may appear high in Ireland, there have been considerable changes in the ranks of the very largest firms and this may reflect the degree of change/opportunities occurring in Irish manufacturing industry during this key period in Ireland's economic development.

Third, since 1999, aggregate concentration by industrial local units has exceeded that by industrial enterprises (Figure 2), suggesting that the very largest industrial enterprises tend to operate large single plants/sites rather than multi-plant operations. This may reflect industrial policy during the period: for instance, the authorities appear to have focused on certain industries (such as electronics and health/medical supply) and assisted existing multinationals to grow their subsidiaries with the view to stimulating more higher value functions (such as R&D) in Ireland.

Fourth, turning to industrial concentration, there is substantial variation in concentration across industries. Among the most concentrated industries in 2001 were leather and leather products, office machinery and computers, other transport equipment, and radio, television and communication equipment. In stark contrast, in each of chemicals, chemical products and man-made fibres, rubber and plastic products, fish and fish products, and meat and meat products, the level of concentration is low.

Fifth, the more concentrated industries tend to be those in which size inequalities within the top five firms are relatively high. This reflects previous research, which suggests that it is the top one or two firms that typically govern industrial or market concentration.

Sixth, the level of concentration does not appear to vary with the extent of foreign ownership or export activity in Irish industry. Thus, industries with above-average foreign ownership do not exhibit significantly higher or lower concentration and similarly for industries with above-average activity in terms of exporting.

Seventh, a number of industries have experienced an increase in concentration since 1991, while others have exhibited 'de-concentration'. The declines and rises identified here may reflect the dynamic nature of Irish industry and may in turn suggest dynamic competition, even though some industries may show high concentration in a given year.

Finally, our international comparison of the same industries in different countries (despite data limitations) suggests that Irish industry is comparably concentrated.

As regards future research, one possibility would be to look at the dynamics of industry leadership in Irish industry, using a combination of the CIP and the sort of micro data examined in this paper. A second possibility relates to a potentially rich data source coming on stream in the next few years, namely the Phase 2 merger enquiries conducted by the Competition Authority. Using the published reports, one could examine, for example, the predictability or otherwise of merger decisions taking account of traditional and/or novel (market-specific) measures of competition. A third possible topic concerns establishing concentration in other smaller countries and in individual US states, which would facilitate a clearer international perspective of the level of aggregate and industrial concentration in Ireland.

REFERENCES

BOYLE, G. E., 2004. "Hall-Roeger Tests of Market Power in Irish Manufacturing Industries", *The Economic and Social Review*, Vol. 35, No. 3, pp. 289-304.

CASWELL, J. A., 1987. "Aggregate Concentration: Significance, Trends and Causes" in R. L. Wills, J. A. Caswell, and J. D. Culbertson, *Issues After a Century of Federal Competition Policy*, Lexington, Mass. and Toronto, Lexington Books, pp. 237-249.

CENTRAL STATISTICS OFFICE, 1991-2001. *Census of Industrial Production*, Dublin: Stationery Office.

CERRA, V., J. SOIKKELI and S. C. SAXENA, 2003. "How Competitive is Irish Manufacturing?", *The Economic and Social Review*, Vol. 34, No. 2, pp. 173-193.

COMPETITION AUTHORITY, 2003. *Annual Report of the Competition Authority*, Dublin: Stationery Office.

DAVIES, S. W., P. A. GEROSKI, M. LUND, and A. VLASSOPOULOS, 1991. *The Dynamics of Market Leadership in the UK Manufacturing Industry 1979-1986*, Centre for Business Strategy Report Series: London Business School.

GJERSEM, C., 2004. "Policies Bearing on Product Market Competition and Growth in Europe", OECD Economics Department Working Papers No. 378.

LINEHAN, T. P., 1962. "The Structure of Irish Industry", *Journal of the Statistical and Social Inquiry Society of Ireland*, Vol. XX, part V, pp. 220-246.

MCCLOUGHAN, P., 2004. "Construction Sector Concentration: Evidence from Britain 1971-1999", *Construction Management and Economics*, Vol. 22, No. 9, pp. 979-990.

MCCLOUGHAN, P. and E. ABOUNOORI, 2003. "How to Estimate Market Concentration given Grouped Data", *Applied Economics*, Vol. 35, pp. 973-83.

OLIVEIRA MARTINS, J., T. PRICE and N. MULDER, 2002. "A Taxonomy of Market Structure Cluster", OECD Economics Department Working Papers.

O'MALLEY, E., 2004. "Competitive Performance in Irish Industry", *ESRI Quarterly Economic Commentary* (Winter), pp. 66-101. Dublin: The Economic and Social Research Institute.

O'MALLEY, P., 1971. *Irish Industry: Structure and Performance*, Dublin: Gill and Macmillan.

O'NEIL, P. B., 1996. "The Trend of Aggregate Concentration in the United States: Problems of Scope and Measurement", *American Journal of Economics and Sociology*, Vol. 55, pp. 197-211.

PRAIS, S. J., 1976. *The Evolution of Giant Firms in Britain*, Cambridge: Cambridge University Press.

RESTRICTIVE PRACTICES COMMISSION, 1975. *Report of Studies into Industrial Concentration and Mergers in Ireland*, Dublin: Stationery Office.

SLEUWAGEN, L. and W. DEHANDSCHUTTER, 1986. "The Critical Choice between the Concentration Ratio and the H-Index in Assessing Industry Performance, *The Journal of Industrial Economics*, Vol. XXXV, pp. 193-208.

SUTTON, J. 1998. *Technology and Market Structure: Theory and History*, Cambridge, Mass: MIT Press.