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The suitability of concentration measures for EEC competition policy

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The suitability of concentration measures for EEC competition policy

Prof. Walter Piesch
Prof. Ingo Schmidt
Universität Hohenheim
Institut für Volkswirtschaftslehre

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F O R E W O R D

This study is one of a series of sectoral studies on the evolution of concentration in the Member States of the European Community.

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T A B L E O F C O N T E N T S :

Introduction: Outline of the theoretical approach applied[1)]

Competition is a dynamic process characterized by a continuous sequence of what J.M. CLARK terms "moves and responses". This dynamic competitive process represents an anonymous control and guidance mechanism with financial sanctions. Pioneer profits from a temporary lead on the market are both the result and a condition of effective competition; they should not be squeezed immediately but should be made to disappear only gradually, giving the entrepreneur the incentive of a period during which his initiative is not curbed. The speed at which pioneer profits of any kind are eroded is used as a basis for determining the intensity of competition. However, this concept of competition theory, with its focus on market performance, is not easy to apply in practice.

Market imperfections in the shape of product heterogeneity, lack of transparency, inadequate foresight, time lags in the speed of adjustment, etc. are both the result and a condition of enterprising competitive behaviour; according to the dynamic theory of effective competition, market imperfections or monopolistic elements (i.e. departures from the model conditions for perfect competition) are therefore necessary for competition to be effective. The central problem of the theory of effective competition is to distinguish from the competition policy angle between desirable and undesirable market imperfections and thereby to establish the pattern or patterns of factors of imperfection that are to be regarded as a necessary and/or sufficient condition for competition to be effective.

Effective competition is defined and measured by reference to structural, behavioural and market performance characteristics; in most cases, a combination of structural and behavioural characteristics ("market-process definition") is used similar to that advocated by KAYSEN and TURNER in their classic work on

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1) See Ingo SCHMIDT, Wettbewerbstheorie und -politik. Eine Einführung, Stuttgart, 1981, Parts 1 and 2, with further bibliographical references.

antitrust policy:[1)]

> "Antitrust policy, however, cannot operate directly either on performance or on processes: we cannot conceive of an effective order which says, be efficient or, be competitive. Rather, policy operates directly on market structure and on firm conduct in order to affect processes and performance."

Assessing the competitive process by applying a combination of structural and behavioural criteria has become the generally accepted practice in US, German and Community antitrust policy; greater emphasis is placed on the structural approach (e.g. for merger control) or on the behavioural approach (e.g. when dealing with predatory conduct), depending on the rationale of the individual legal provision concerned.[2)] Market performance criteria are not normally used for measuring effective competition, first because they are not sufficiently operational and second because measures that directly influence performance are not sufficiently consistent with the principles of a free economy and a free society.[3)]

In the interests of compatibility with competition policy and competition law, it is therefore proposed that effective competition be equated with the absence of unreasonable market power, defined by reference to structural and behavioural characteristics;

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1) Carl KAYSEN and Donald F. TURNER, Antitrust Policy. An Economic and Legal Analysis, Cambridge, Mass., 1959, p. 59.

2) KAYSEN and TURNER (op. cit., p. 75) say the following about the the relationship between the structural and behavioural approach: " A firm possesses market power when it can behave persistently in a manner different from the behaviour that a competitive market would enforce on a firm facing otherwise similar cost and demand conditions. When the "can" in this definition is emphasized, we see that the concept of market power is basically a structural concept."

3) Joe S. BAIN, Industrial Organization, 2d ed., New York, London, Sydney, 1968, pp. 498 et seq. refer to a severe restriction of the means for pursuing the objectives set:"This restriction is that ... it should be sought in the main through devices that foster and maintain impersonal market processes as the main direct regulators of enterprise activity ... Departing from the axiom, it may be argued substantively that impersonal regulation by the market is preferable to extensive bureaucratic regulation by men, and more consistent with our democratic political system."

these characteristics are investigated by the market structure and market conduct tests. Market power can be exercised either by single firms holding a dominant position or at least enjoying extensive room for manoeuvre vis-a-vis their competitors, or by groups of firms (through tight oligopolies, which are characterized by a high degree of interdependence, or through collective monopolies based on restrictive agreements). Limiting or controlling the market power of such firms is one of the main tasks of competition policy.

The market structure test is concerned with the number of sellers and buyers and their market shares (market monopoly), the degree of homogeneity and market transparency and hence the speed of response to changes in the market situation, the market phase, the type of entrepreneur, the degree of capacity utilization and of integration[1)], and other so-called conditioning factors. The market conduct test examines whether and to what extent the various parameters of action are applied over time, whether they are applied individually or collectively at one and the same time (conscious parallelism) and whether such competitive conduct presents buyers with alternatives.

It follows from this brief description of the design of the concept of effective competition that competition, in addition to being a function of the number of sellers, also depends on a fairly large number of characteristics investigated by the market structure test ("conditioning factors") and on actual market conduct. In this study on the suitability of concentration measures for competition policy a relationship is none the less seen between the market morphology factor and the intensity of competition, because:

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1) Owing to existing integration, the level of concentration derived from industry statistics is in most cases too low.

- In an examination of whether or not effective competition exists, morphology carries a special weight among the conditioning factors (theoretical justification);
- Morphology is that conditioning factor which, as regards its operational and justiciable aspects can most easily be influenced by competition policy and therefore represents the most obvious basis for approaching competition policy (policy justification).[1)]

Part I below discusses the importance of the level of concentration for competitive policy. It is essential, however, to bear in mind the difference that delimitation of the relevant market can make: a very broad definition produces very low levels of concentration, while a very narrow definition inevitably results in very high levels of concentration.

I. A critical level of concentration and the threat to effective competition[2)]

1. The importance of the level of concentration for competition

(i) Before investigating the relationships between the level of concentration and the effectiveness of competition, we must try to establish whether there is an optimum market structure in the narrow sense of the term (= market morphology) that particularly favours attainment of the traditional objectives of income, performance-linked income distribution, optimum allocation of factors of production and technological progress in production and production methods. Specialist literature suggests four possible forms of optimum market structure:

- older literature (e.g. neo-classical and German neo-liberal)

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1) The Commission Decision in Continental Can, which the Court of Justice endorsed at least where the principle was concerned must therefore be seen as a step in the right direction (restoration of competitive structures).

2) See the summary by Hartwig BARTLING, Leitbilder der Wettbewerbspolitik, Munich, 1980, pp. 117-125, and Herbert SCHMID-BAUER, Allokation, technischer Fortschritt und Wettbewerbspolitik, Tübingen, 1974, pp. 154-197.

- regarded polypoly as the optimum form;[1)]
- ALMARIN PHILLIPS and KANTZENBACH consider loose oligopoly, characterized by a moderate degree of interdependence between firms, to be the optimum market form;[2)]
- SCHUMPETER, SALIN and others have described tight oligopoly (monopoly broadly defined) as the optimum form;[3)]
- HAYEK and HOPPMANN take the view that, being process of discovery, competition does not have any optimum market form.[4)]

The KANTZENBACH/HOPPMANN controversy[5)] produced broad agreement on the idea that an optimum market structure with fostered competitive conduct and competitive performance while making allowance for any conflicts between the objectives of maintaining effective competition and achieving economies of scale in the broad sense could be found both in polypoly and in loose oligo-

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1) See Walter EUCKEN, Grundlagen der Nationalökonomie, 8th ed., Berlin, Heidelberg, New York, 1965.

2) See ALMARIN PHILLIPS, Market Structure, Organization and Performance, Cambridge, Mass., 1962, and Erhard KANTZENBACH, Die Funktionsfähigkeit des Wettbewerbs, 2nd ed., Göttingen, 1967.

3) See Edgar SALIN, "Soziologische Aspekte der Konzentration", Die Konzentration in der Wirtschaft, edited by F. NEUMARK, Schriften des Vereins für Socialpolitik, Vol.22, Berlin, 1961, pp. 16-44, and Joseph A. SCHUMPETER, Capitalism, Socialism, and Democracy, New York, 1942.

4) See F.A. VON HAYEK, "Der Wettbewerb als Entdeckungsverfahren", Freiburger Studien, Tübingen, 1969, pp. 249 et seq., and Erich HOPPMANN, "Das Konzept des wirksamen Preiswettbewerbs", Recht und Staat in Geschichte und Gegenwart, Issue 484/485, Tübingen, 1978, pp. 15-20.

5) See Erhard KANTZENBACH, op.cit., Erich HOPPMANN, "Das Konzept der optimalen Wettbewerbsintensität", Jahrbücher für Nationalökonomie und Statistik, Vol. 179 (1966), pp. 286-323; Erhard KANTZENBACH, "Das Konzept der optimalen Wettbewerbsintensität - Eine Erwiderung auf den gleichnamigen Besprechungsaufsatz von Erich HOPPMANN", Jahrbücher für Nationalökonomie und Statistik, Vol. 181 (1967), pp. 193-241, and Erich HOPPMANN, "Die Funkionsfähigkeit des Wettbewerbs - Bemerkungen zu Kantzenbachs Erwiderung", Jahrbücher für Nationalökonomie und Statistik, Vol. 181 (1967), pp. 251-264.

poly. But the controversy also produced broad agreement on the thesis that, typically, the dividing line between a competitive and a non-competitive structure lies between loose oligopoly and tight oligopoly, the latter being characterized by a very high degree of parametric interdependence or mutual reaction that does not normally leave room for individual competitive conduct.

(2) However, the distinction made between competitive polypoly and competitive loose oligopoly, on the one hand and non-competitive tight oligopoly on the other must not be interpreted to mean that competition is merely a function of the number of sellers or buyers. This recognition is already reflected in the definition of oligopoly, which, departing from the literal meaning (oligopoly = few sellers) no longer focuses solely on the number of suppliers but also on the existence of a more or less high degree of interdependence or mutual reaction; this is determined by the other structural characteristics as well as by morphology. The influence of these structural characteristics (the so-called conditioning factors) may therefore mean that competition exists even where there is a high level of concentration (e.g. duopoly on an expanding market) or that it does not exist despite a very low level of concentration (take, for example, the polypolistic markets for doctors and dentists, who do not compete against one another because of an acute sense of status and the consequent absence of a spirit of competition). Consequently, a link can be said to exist between the level of concentration and the effectiveness of competition only to the extent that competition is threatened as concentration increases. This formulation also covers the possibility of distortion in individual cases and focuses only on typical links which, in addition, vary with the branch structure. Under price and competition theory, the significance of a rise in the level of concentration therefore lies in the danger which it poses of an increasing symmetry of interests, prompting economic agents to modify their objectives and behaviour. Empirical studies and theoretical analysis reveal

that, from a specified level of concentration, firms find it advantageous to pursue joint profit maximization rather than individual profit maximization as usually assumed in price theory. There is therefore the danger that, above a specified level of concentration, firms may change their objectives and pursue a joint pricing policy on the basis of a quasi-agreement[1] involving either contract-like obligations falling within Article 85 of the EEC Treaty or actual parallelism of action based on group discipline or price leadership and falling within Article 86 of the EEC Treaty. Any further rise in the level of concentration creates a dominant position for a single firm which has wide room for manoeuvre vis-a-vis its competitors and is no longer controlled by effective competition, the ultimate stage being partial monopoly or complete monopoly. However, the main problem for competition policy today is not dominant positions held by individual firms, but those held by groups of firms which jointly control the market.

Even though the scope for a joint pricing policy of this kind also depends on other factors such as the degree of homogeneity, transparency or the market phase, the level of concentration is a major incentive for the pursuit of such a policy. KAYSEN and

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1) For the objective of joint profit maximization through a joint pricing policy, see in particular William FELLNER, Competition among the Few, New York, 1949. According to this concept, oligopolists seek to maximize profits jointly by fixing a (joint) "monopoly price" and by selling the "monopoly quantity" jointly. The joint profits, which have to be shared out among the individual oligopolists (problem of distribution), are greater than the sum of the individual profits earned through individual profit maximization.

FELLNER, however, qualifies the pure principle of joint profit maximization by allowing for long-term objectives and for the desire to avoid uncertainty, factors which in his view prevent suppliers from fully exploiting the oligopoly situation.

TURNER put this as follows:[1)]

> "To be sure, factors other than the size and character of the rival firms are important in determining the way on oligopolistic market functions - the nature of the product, the technological maturity of the industry, the rate of growth of demand, the cyclical stability of demand, are all important. But within the framework defined by a given set of values of these variables, the larger the number of rival sellers and the smaller the relative size of the largest few, the more likely will it be that no firm and no group exercises much market power."

in view of the influence of the other conditioning factors, the "critical" level of concentration therefore varies upwards or downwards. If we take, say, eight firms operating on a transparent and stagnating market for homogenous products, it is highly likely that, because of the high degree of interdependence, we will have a tight oligopoly and hence a joint pricing policy as described above. If, however, we have the same number of suppliers offering relatively heterogenous products on a non-transparent expanding market, the firms will be only partly interdependent and the situation will be loose oligopoly with presumably effective competition.

These considerations modify the findings on the relationship between effective competition and the level of concentration: in our example with eight firms competition, although threatened, is not in itself eliminated.

These theoretical considerations, which suggest that competition is threatened as concentration increases, have been tested empirically. The studies available (those carried out by BAIN, MANN and WEISS, for example) use only the concentration ratio CR, which is the simplest measure of concentration.[2)]

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1) KAYSEN and TURNER, op. cit., p. 115; William G. SHEPHERD (The Treatment of Market Power. Antitrust, Regulation and Public Enterprise, New York and London, 1975) comments as follows on the significance of market share for the market structure test: "Market share is probably the central element in market structure. Barriers and the oligopoly group are probably secondary." (Chapter 2, p. 61).

2) For a discussion of adequate concentration measures from the angle of competition theory, see F.M. SCHERER, Industrial Market Structure and Economic Performance, 2nd ed., Chicago, 1980, pp. 56-64.

This one-dimensional measure indicates the share of sales (the most commonly used variable) of the k largest firms in a particular branch of industry.

The following summary of the findings of the empirical studies will show whether the concentration ratio CR is an adequate measure of horizontal market power for the purposes of competition policy.

2. Use of concentration ratios and their implications in competition theory

(1) The concentration ratio CR has been used in a large number of investigations into a possible causal relationship between market structure and market performance. These investigations were undertaken to identify the market shares of the k largest enterprises that result in non-competitive market structures, i.e. to establish whether once market shares had reached a specified size, competitors engaged in spontaneous coordination and conscious parallelism (e.g. over price increases) with the result that group discipline stopped any competitive initiative. The investigations started from the test hypothesis that there is a positive correlation between the concentration ratio and profits, in other words that, as market power increases, the level of branch profits increases. Various investigations of this kind have been conducted over the last thirty years.

(2) In a pioneering study conducted in 1951 and covering the period 1936-1940, BAIN[1)] looked at 42 industries and in all 235 firms in an attempt to identify this correlation. Although a positive relationship was seen to exist between the concentration

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1) See Joe S. BAIN, "Relation of Profit Rate to Industry", The Quarterly Journal of Economics, Vol. 65 (1951), pp. 293-324.

ratio and average profit rate,[1] the simple correlation coefficient was only 0.28. When BAIN then split the industries into two homogenous groups, he found that there was a critical concentration ratio above which average profit rates were significantly higher and below which they were significantly lower (dichotomy thesis). The dividing line between the two groups was a market share of around 70% for the eight largest firms in each industry. In other words, from an eight-firm concentration ratio of 70%, poligopolistic interdependence leads to non-competitive behaviour with behaviour patterns between the competitors on a particular market changing abruptly rather than gradually.[2] Such non-competitive behaviour takes the shape of explicit or tacit cooperation between the firms concerned which enables them to fix prices, gives them room for manoeuvre on the price-cost front and, above all, makes it possible for them to raise profit rates from a competitive to a monopolistic level.[3]

BAIN discovered that the average profit rate in industries where the eight largest firms accounted for over 70% of output was 11.7% compared with only 7.7% elsewhere. In a second study covering the period 1948-51, he came to the conclusion that the same general correlation between the concentration ratio and profit rates was also obtained in the post-war period.[4]

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1) BAIN was concerned with possible relationships between the concentration ratio and the average profit rate in specific industries. His focus was fundamentally different from that of the Commission in the Sixth Report on Competition Policy (covering 1976), where the issue was whether, within a specific branch of industry (e.g. the food industry) small, medium-sized or large firms were the most profitable.

2) See SCHMIDBAUER, op. cit., p. 189.

3) See SCHERER, op. cit., Chap. 6: "Conditions Facilitating Oligopolistic Coordination" and Chap. 7: "Conditions Limitating Oligopolistic Coordination".

4) See Joe S. BAIN, Industrial Organization, 2nd ed., New York, London, Sydney, 1968, pp. 445-447.

(3) The most comprehensive investigation was by WEISS,[1] who in 1974 analysed forty-seven studies carried out in the period 1936-74 in the United States, Canada, the United Kingdom and Japan. The studies examined had employed not only the concentration ratios for the eight largest firms but also those of the four, twenty and fifty largest firms. In these alternative studies with four-firm, eight-firm, twenty-firm and fifty-firm concentration ratios, the profits of the fifth to fiftieth largest firms did not appear to have any significant effect on the average profit rate.

The findings of the empirical studies carried out to date corroborate the assumption that profits increase as market power increases even though there is no perfect correlation between the two, something which cannot be expected in any case since there are the other conditioning factors. The so-called critical level of concentration thus varies in either direction on individual markets, and there is no single critical level of concentration for all markets.[2]

(4) It would appear, however, that a critical level of concentration does exist not only for the relationship between concentration and industry profit rate but also for the application of technical progress.

In 1967 SCHERER[3] investigated the link between the level of concentration and technical progress in specific industries. For this, he took the number of scientists employed in an industry, the number of scientists and engineers, and the average number

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1) See Leonard W. WEISS, "The Concentration-Profits Relationship and Antitrust", Industrial Concentration, the New Learning, ed. by Goldschmid, J. Harvey, H. Michael Mann and J. Fred Weston, Boston, Toronto, 1974, pp. 184 et seq.
See also Frederick E. GEITHMAN, Howard P. MARVEL and Leonard W. WEISS, "Concentration, Price and Critical Concentration Ratios", The Review of Economics and Statistics, Vol. 63 (1981), pp. 346 et seq.

2) See also BARTLING, op.cit., p. 123.

3) See F.M. SCHERER, "Market Structure and the Employment of Scientists and Engineers", American Economic Review, Vol. 57 (1967), pp. 524-531.

of those scientists and engineers engaged in R&D as alternative indicators of technical progress. He came to the conclusion that where a threshold of 50-55% is exceeded, a further increase in the concentration ratio (CR_4) results in declining employment in R&D. He also found that it was only above a concentration ratio (CR_4) of around 10-14% that any technical or scientific personnel were employed at all. He thus identified a lower and an upper threshold value.

(5) These empirical studies attracted a fair amount of criticism.[1] The arguments advanced were broadly along the following lines:

- The concentration ratio is an imperfect instrument for measuring market power because, focusing on market shares alone, it disregards other features of market structure. It does not take in such factors as the degree of product homogeneity, market transparency, barriers to entry and hence potential competition, the type of entrepreneur, the scope for inter-firm cooperation, interlocking directorates, the degree of capacity utilization and the impact of other structural characteristics;

- In order to apply the concentration ratio (CR_k), information is needed on the market shares of the k largest firms. For this, however, the relevant market must first be adequately defined. And the broader the definition, the smaller the market shares of the firms to be considered;

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1) See Christian MARFELS, "Erfassung und Darstellung industrieller Konzentration", Wirtschaftsrecht und Wirtschaftspolitik, Vol. 52, Baden-Baden, 1977, and Herbert SCHMIDBAUER, Allokation, technischer Fortschritt und Wettbewerbspolitik, Tübingen, 1975, pp. 154-197.

- Market share is thus established by reference to a particular characteristic assumed to reflect correctly the level of concentration. The variables most commonly used are sales and the number of persons employed. The drawback with sales, however is that prices are included in such a way that, even with the same volume, different levels of sales may be recorded because of differing price structures. The number of persons employed may give a distorted picture of the extent of concentration in that no distinction is made here between capital-intensive and labour-intensive production methods;

- The problem with using the concentration ratio in the case of conglomerate firms is that the sales figues are for total sales of all products, so that sales of products from outside the branch in question are included in market shares;

- The concentration ratio also fails to reflect the extent of vertical integration, that is to say control over appropriate resources;

- The explanatory value of the concentration ratio also depends on the extent to which the dominant firms in a particular branch of industry differ structurally from the other firms in that industry. The concentration ratio overstates the relevant level of concentration where the leading firms export relatively more (with a larger share of the domestic market being left for the smaller firms), supply their own establishments to a relatively greater extent (double counting) or are less specialized than the relevant industry overall;

- Changes over time in the composition of the k largest firms do not show up in the concentration ratio. High concentration ratios may be recorded for years on end even though the k largest firms are constantly changing;

- Lastly, the concentration ratio itself can also be criticized on methodological grounds, since the ratio for the k largest firms does not tell us anything about the distribution as between these k firms and fails to take account of the import-

- ance of the "remaining" firms,. that is to say of their number and distribution. Only the overall concentration curve would provide this information.

(6) In spite of these shortcomings, the following points in particular militate in favour of using concentration ratios for depicting business concentration:[1)]

- Concentration ratios illustrate in exemplary fashion the size of the units in terms of particular variables, with other structural characteristics such as the number of other market participants, concentration ratios permit a separate assessment of the facts relating to concentration. In summary measures of concentration, by contrast, all the structural features are intermingled, so cannot be directly assessed for the purposes of competition policy;
- Concentration ratios express primarily the level of concentration between the largest firms since these are particularly important as regards competition policy;
- Concentration ratios are the measures of concentration most commonly used internationally and therefore permit comparisons between countries;
- Concentration ratios require little statistical material, are easy to handle and can be constructed in such a way that they have a relatively high information content but do not infringe the official rules governing secrecy.

Concentration ratios for the four or eight largest firms are thus used partly for reasons of expediency to do with the statistical data available and partly in view of the empirically determined threshold values. The distribution both within and outside the nucleus must be ascertained using other measures.[2)]

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1) See Monopolkommission, 1. Hauptgutachten 1973/75: Mehr Wettbewerb ist möglich, Baden-Baden,1976, para. 152.

2) See SCHERER, op.cit., pp. 183-186, who analyses number and size distribution as important structural dimensions.

(7) In line with the two concepts of market power outlined in the introduction, the following criteria should be used when attempting to find an adequate concentration measure for identifying, solely on the basis of the morphological factor, market structures that are a threat to competition:

- the market share of the leading firm, the gap between that share and the market shares of the remaining firms and the distribution of market shares among the latter (disparity);
- the market share of the nucleus of four or eight leading firms and the distribution of their market shares as between themselves, and the gap between those shares and the market shares of the remaining firms and the distribution of the latter (disparity).

In an exercise of this kind, the impact of the other conditioning factors and the criteria of market conduct are disregarded.

The extent to which competition is threatened must, however, be assessed differently, depending on the distribution within the nucleus of the four or eight largest firms. The following examples illustrate this point:

- one firm has a 35% market share (dominant) and the other three or the other seven each have a share of 5% (CR_4 or CR_8 respectively;
- all four firms have a market share of around 12% each or all eight firms have a market share of around 9% each (symmetrical distribution);
- four firms have market shares of 20%, 12%, 10% and 8% respectively or eight firms have market shares of 20%, 12% 10%, 8%, 2x6% and 2x4% respectively (asymmetrical distribution with no market dominance).

Other things being equal, the threat to competition will be greater in the first two examples than in the last.

In addition to the distribution of market shares within the nucleus, the following must also be ascertained:

- the rank number of the firm as of which there is a noticeable gap between the oligopolistic nucleus and the remaining firms (a significant drop in the size distribution);
- the number of remaining firms and their distribution in the light of the influence this so-called competitive fringe exerts in partial oligopoly on the nucleus. It can be assumed that the more of them there are and the more uniform their size distribution, the less significant they are for competition policy (and vice versa).

From the viewpoint of competition theory, the purpose of an investigation into the distribution of market shares outside the nucleus is to circumscribe the dominant group of firms, which need not always be identical with the four or eight largest firms selected for reasons of statistical practicability or on the basis of empirically determined threshold values.

These points will have to be borne in mind when examining the suitability of the various concentration measures for detecting concentration or critical areas of concentration; in other words, in attempting to measure probable (typical) relationships between the intensity of competition and the level of concentration, we should, if we do have to leave aside the influence of the other conditioning factors, take into account all the aspects of the morphological factor, i.e. number and disparity; when constructing the index. Concentration and disparity may here have opposite effects on competition:

- other things being equal, increasing concentration reduces the intensity of competition;[1)]

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1) In extreme cases, however, concentration that is increasing in a formal mathematical sense may add to the intensity of competition where, for example, some of the remaining firms combine to form a competitive entity; thereby loosening the oligopolistic nucleus. This restricts the remaining firms' formal room for manoeuvre, but augments their material freedom to take decisions.

- other things being equal, increasing disparity reduces the symmetry of interests (asymmetrical oligopoly) and thus increases the identity of competition; this holds good, however, only so long as the disparity does not become such that the dominant oligopolistic group develops into a dominant single firm.

II. Suitability of various measures of concentration for ascertaining concentration and critical areas of concentration [1]

1. Statistical measurement of concentration: basic concepts

Statistical measures of concentration[2] indicate how the population total of a variable (e.g. total sales on a particular market) is distributed among the population units (e.g. firms). The starting point is the values x_i ($i = 1, \ldots n$) of a concentration variable (sales) or the relative values p_i (market shares) of the n units. The classification of the relative shares and statistical indicators give or characterize the market morphology.[3]

A sharp distinction must here be made between disparity and concentration. Disparity inequality exists where a small proportion of the population units accounts for a large share of the population total and the market shares are therefore unevenly distributed between the units, as in the case of asymmetrical distribution within the oligopolistic group or within the competitive fringe. Concentration in the statistical sense occurs where, in absolute terms, a few units account for a large proportion of the total value of a variable. Where, for example, the four largest firms account for 50% and/or the eight largest firms for 70% of the total value of the concentration variable, there is said to be a high level of concentration.

From a statistical point of view, quasi-monopolistic market forms and tight oligopolies are regarded as being highly concentrated.

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1) The definitions, formulae and formal relationships which form the basis of this chapter are given in the annex.

2) For a detailed discussion of the statistical measurement of concentration, see W. PIESCH, Statistische Konzentrationsmasse, Tübingen, 1975.

3) In practice, data are often available for the largest units only. In order to obtain significant results, at least three quarters of the total value of the variable should be investigated.

Disparity is depicted by a Lorenz curve and concentration by a concentration curve.

For the Lorenz curve, the cumulative proportions of the population variable are plotted against the cumulative market shares, the summation starting with the smallest unit. It thus gives the market shares of the x% ($0 \leq x 0 \leq 100\%$) small firms (Fig. 1). The market share of the y% large firms can, of course, also be ascertained. The concentration curve, on the other hand, starts with the largest units, with their cumulative number being plotted against their cumulative market share. It thus gives the market share of the x largest firms ($1 \leq x \leq n$) (Fig. 2). Being the simplest measures of concentration, the values indicated by the concentration curve, i.e. the concentration ratios CR_i (e.g. CR_3, CR_4 and CR_8), play an important role.

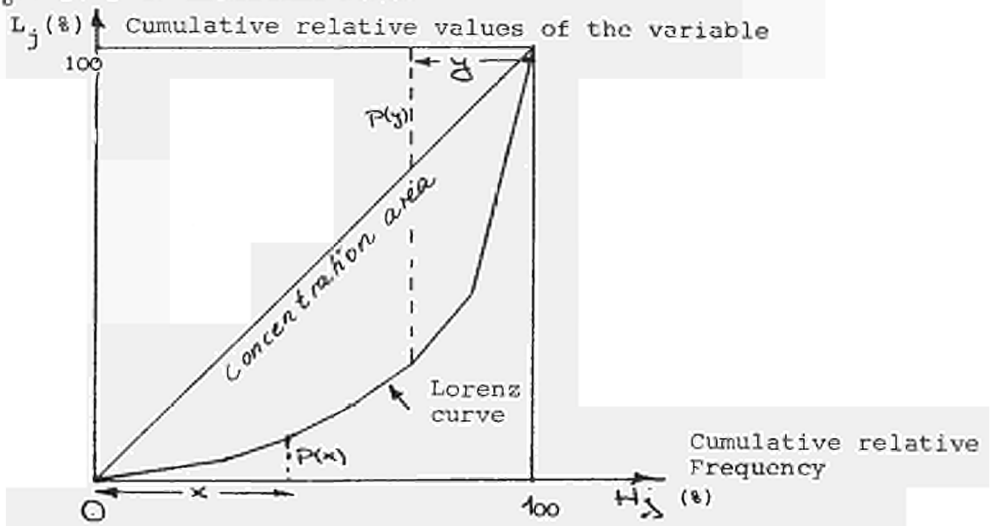

Fig. 1: Lorenz curve for a particular size distribution

Statistical indices are used to characterize the concentration and disparity of a given distribution. Concentration is closely related to the disparity and to the total number of the units. Given a particular size of population, any measure of concentration should respond to changes in the disparity by moving in the same direction. With constant disparity there should be a change

in the opposite direction when the number of units changes. In consequence, concentration is determined by the number of sellers and by the inequality in the distribution of market shares. In the case of oligopolies, however, it is conceivable that market power in particular fields may develop in a direction opposite to statistical concentration, i.e. increasing disparity may foster competition in an oligopoly.

In the statistical measurement of concentration, a number of extreme distributions are particularly important as borderline cases.

For instance, disparity is lowest in the case of uniform distribution (where all market shares are of equal size) and reaches its highest value where one market share is very large (equal to 1 in the extreme) and where all the others are very small (equal to 0 in the extreme). By contrast, concentration is greatest in a monopoly, i.e. where one unit has a market share equal to 1. The situation of complete non-concentration is not explained. In practice, attempts to explain it by introducing a number n_o for the case of uniform distribution between n_o units have been thwarted because of the difficulty of determining n_o.

Over the years, specialist literature on the measurement of concentration has put forward a multitude of concentration measures, certain advantages and disadvantages being ascribed to each of them. Describing the concentration of a particular size distribution by means of a single index raises the same problems as using mean values or coefficients of dispersion as the sole characteristic index of an empirical distribution. For any value of a concentration measure, there are always many possible distributions which yield that value if only because of the interaction of the disparity effect which may be offset by the number effect. For this reason, concentration analysis should rely not only on

an overall measure of concentration characterizing the entire distribution, but also on a number of other indices; their values can be used to reconstruct the concentration curve at its particularly interesting front end and yield information on the potential formation of oligopolies. We will therefore use a number of indices, with concentration ratios such as $CR_1 = 30\%$, $CR_4 = 50\%$ and $CR_8 = 70\%$ forming the framework; this will be supplemented by measures of inequality for the sub-groups of large or small firms and by a measure of dominance identifying any nucleus of "large firms" (see Fig. 2). Where possible, an index of overall concentration will also be given.

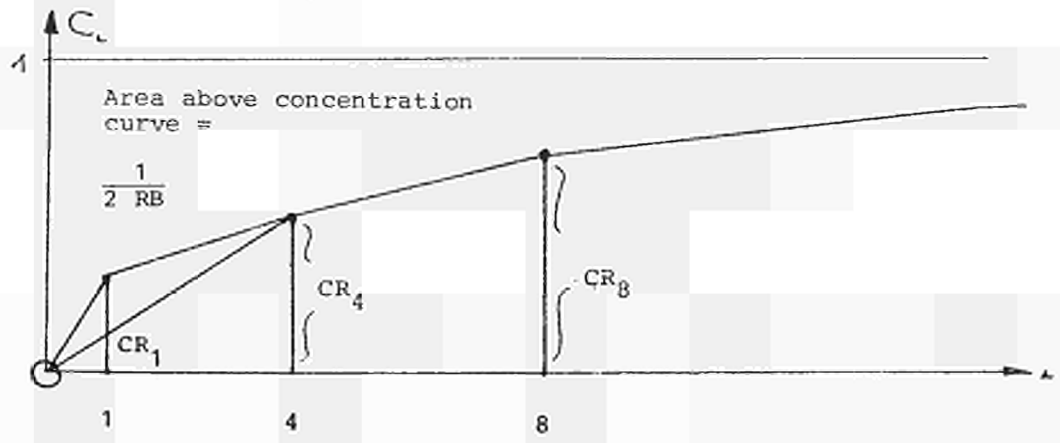

Fig. 2: Possible path of the concentration curve where there is a single dominant firm or an oligopolistic group.

2. Properties of concentration measures: uniformly standardized measures

Attempts have been made recently to substantiate measures of concentration (K) and measures of disparity (D) axiomatically. According to Jöhnk[1], a plausible category of simple concentration measures would have the following properties:

- Standardization: Measures of disparity and of concentration should take values in the region $\overline{/0}$-$1\overline{/}$. To make them more descriptive, the values can be multiplied by the factor 100 to yield a range of $\overline{/0}$-$10\underline{0}\overline{/}$. We use these values for practical calculations;
- Principle of transfers: A shift from small to large units should increase disparity and concentration, while a shift from large to small units should have the opposite effect; [2]
- Proportionality test (replication): If each statistical unit is divided into c units of equal size, inequality should not be affected, while concentration should decrease by the factor 1/c;
- Supplementary test: Supplementing a given distribution with units of zero size performs an important function. In practice, very small units are incorporated. By adding (c-1)n zero-size units in an existing distribution of n units, we obtain the distribution of cn units overall. This should not affect concentraion,[3] while disparity should approach its upper limit in a uniform manner.

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1) M.D. JOHNK, Eine axiomatisch begründete Methode der Konzentrationsmessung, Institut für Angewandte Statistik der Freien Universität Berlin, 1970.

2) As explained on pp. 22 et seq., an increase in inequality may foster competition in an oligopoly.

3) Where a given distribution is supplemented with small units, the larger n and the smaller the market share of a small unit, the less concentration is affected.

The principle of transfers is economically meaningful with an economic basis, the proportionality and the supplementary tests are clear enough and standardization is desirable for practical reasons.

Measures that possess the properties described and are continuous are referred to by JOHNK (1970) as uniformly standardized measures. This section and the following are concerned solely with simple measures of this kind. For a better understanding of the structure of such measures, the measure of disparity is replaced by a countermeasure, the measure of parity, the sum of the two measures being 1. The proportionality and the supplementary tests then display the following symmetrical properties: in the case of the proportionality test, concentration decreases by the factor 1/c and parity remains constant, while the situation is exactly the opposite in the case of the supplementary test, with concentration remaining constant and parity decreasing by the factor 1/c.

A simple relationship is obtained for the measures in question : the product of the measure of concentration, the measure of parity and the number of units is always 1. Thus, with a given number of units, there is a clearly-defined measure of disparity for each measure of concentration. The impact on concentration of changes in disparity and in the number of units can therefore be determined.

In the case of standardization, the limits derived are even more accurate than required:

$$0 \leqq D \leqq 1 - \frac{1}{n} \quad , \quad \frac{1}{n} \leqq K \leqq 1 \quad ,$$

which lie in $\overline{]0-1[}$ for large n.

A value for the minimum number of units 1/K present can be derived from the lower limit for K. This consideration is based on the principle of "numbers equivalent". We need to determine how many

firms of equal size would have to be present for there to be a given level of concentration. Another requirement imposed on concentration measures is concerned with the response to mergers and divisions. The measures under consideration react to mergers (regarded as transfers with subsequent withdrawal of a zero-sized unit) in the same direction: after a merger, concentration always increases, while disparity may increase or decrease depending on whether the positive transfer effect or negative withdrawal effect predominates.

3. Discussion of special measures of concentration

(a) Measures that can be derived directly from the concentration curve

The concentration ratios CR_i, read off the vertical axis of the concentration curve, are variables that are statistically easy to determine. Where criteria of market structure are applied, critical values for the concentration ratios are regarded as indicating the existence of market power; these values are CR_1= 50% and CR_4= 50-80% in the United States (KAYSEN-TURNER Bill 1959, HARRIS Bill 1968/71 and HART Bill 1972/73) and CR_1= 33%, CR_3= 50% and CR_5= 67% in Germany (Section 22(3) of the GWB-Act against Restraints of Competition. In order to determine the first concentration ratios, information is needed only on truncated partial distribution of the largest firms with a given total value of the variable. If several concentration ratios, e.g. CR_1, CR_4, CR_8 and CR_{20}, are given, the front end of the concentration curve can be broadly reconstructed.

The concentration ratio CR_i is a point measure, i.e. we need to know only a single point along the concentration curve in order to calculate it. Calculation of a summary measure takes in all market shares p_i. Supplying several point measures is, however, just as informative as description in the form of a single summary measure.

In addition to concentration ratios CR_i, average concentration ratios are also looked at. They give the average market share of the i largest firms and can be interpreted as secant slopes below the concentration curve. The average market share of the remaining smaller firms can similarly be determined. We will return to these average values when discussing measures of dominance. Lastly, marginal concentration ratios are simply the market shares P_i themselves. They can be depicted as slopes of tangents to the concentration curve.

(b) Generalized Herfindahl indices

The best-known and most widely used measures of concentration are the generalized Herfindahl indices H_α :[1)]

$$H_\alpha = \sqrt[\alpha-1]{\sum_{i=1}^{n} P_i}$$

Depending on the value given to α, we obtain a special measure of concentration:

Where $\alpha = 2$, we obtain the simple Herfindahl index

$$H_2 = \sum_{i=1}^{n} P_i^2$$

Where $\alpha = 3$, we obtain a higher-order Herfindahl index which gives even heavier weighting to the large units than does H_2, with the result that the impact of small units in the measure of concentration is even weaker than with H_2.

In the extreme case $\alpha = 1$, we obtain the exponential index, which is closely linked to the entropy:

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1) See G. BRUCKMANN, Einige Bemerkungen zur statistischen Messung der Konzentration, Metrika, Vol. 14 (1969), pp. 183-213, and in in particular pp. 195 et seq., W. PIESCH, loc. cit., p. 153, and L. HANNAH and J.A. KAY, Concentration in Modern Industry, London, 1976, pp. 55 et seq.

$$H_1 = E = \prod_{i=1}^{n} P_i^{P_i}$$

The larger the value attributed to , the more the corresponding Herfindahl index will approach the value of the largest market share, which thus represents the upper limit of all generalized Herfindahl indices. Herfindahl indices therefore display relatively small values, e.g. in the range of 10-20, even where there is considerable concentration. The reason for this is the upper limit CR_1. Where, CR_1 = 50%, for example, no measure of concentration H can yield values greater than 50. As a result, the values for all possible concentrated distributions are clustered together in the lower range of $\overline{/1\text{-}10\underline{0}/}$. The larger the value of , the greater the emphasis on the importance of the large firms, and in the extreme case only the largest market share will be taken into account. The Herfindahl index thus gives a heavier weighting to large firms than does the exponential index.

Another measure of concentration is the Rosenbluth index RB, which can be defined geometrically by reference to the area above the concentration curve A. It is in fact equal to the reciprocal of double the area above the concentration curve (see Fig. 2). Hence, the greater the curvature of the concentration curve, the greater the index will be. It attaches an even smaller weight to large firms than the exponential index. The associated measure of inequality is the well-known Gini coefficient R, which can be defined as being equal to double the concentration area (see Fig. 1). A new measure of concentration can be derived from two such measures by first taking as the appropriate measure of disparity the weighted arithmetic mean of the measure of disparity and then calculating the new measure of concentration on the basis of the relationship between concentration, disparity and the number of units. This establishes a balance between the two underlying weighting patterns. As a hybrid that combines aspects of the concentration approach (point measure) and Herfindahl indices as

summary measures, the Horvath index[1] has acquired some importance; it does not always satisfy the principle of transfers, is standardized in an unusual manner and does not satisfy the proportionality test. It is therefore of limited use as a measure of concentration.

(c) Measuring concentration when there is incomplete statistical data

In many cases, the data necessary for carrying out a statistical measurement of concentration are incomplete. Frequently, all that is available is individual values for the large firms, the total number of firms and the total value or individual points on the concentration curve. It is therefore important to know whether in these cases too concentration can be calculated or whether, at least, ranges can be established.

Taking the statistical data available, an upper limit for any measure of concentration, e.g. the Herfindahl index, is obtained if, starting from the points given on the concentration curve, all possible transfers are made to the largest firms (beginning with the largest) while maintaining the convexity of the curve. Where only the market shares of the largest firms are known, calculation of the Herfindahl index for this truncated - newly standardized - distribution generally produces an unduly rough estimate.[2] A lower limit is obtained by assuming the smallest possible inequality and in particular uniform distribution among the (unknown) small firms.

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1) See J. HORVATH, "Suggestion for a Comprehensive Measure of Concentration", Southern Economic Journal, Vol. 36 (1970), pp. 446-452.

2) See the unduly rough estimates made, for example, by C. MARFELS, A Study on evolution of concentration in the beverages industry in the Federal Republic of Germany, International sectoral comparisons including analyses on the beverages industries in Germany and Europe, Vol. 2, Commission of the European Communities, 1979.

Here are two examples:

Example 1

Data available:

$$P_1 = 32\%,\ P_2 = P_3 = P_4 = 6\ \%$$

Lower limit for the Herfindahl index: ($P_5 = P_6 = \ldots = 0\ \%$)

$$H_u = (0{,}32^2 + 3 \cdot 0{,}06^2) \cdot 100 = 11{,}32$$

Upper limit for the Herfindahl index:

$$(P_5 = P_6 = \ldots = P_{12} = 6\ \% \qquad P_{13} = 2\ \%)$$

$$H_o = (0{,}32^2 + 11 \cdot 0.06^2 + 0{,}02^2) \cdot 100 = 14{,}24.$$

This yields the range $\overline{\lfloor 11.32 - 14.24 \rfloor}$ for the Herfindahl index. The Herfindahl index for the truncated distribution of the four largest firms is 45.28, too rough an estimation.

Example 2

Data available: $CR_4 = 50\%$ $\qquad CR_8 = 70\%$

The two positions of the concentration curve giving extreme values for the Herfindahl index are illustrated in Fig. 3.

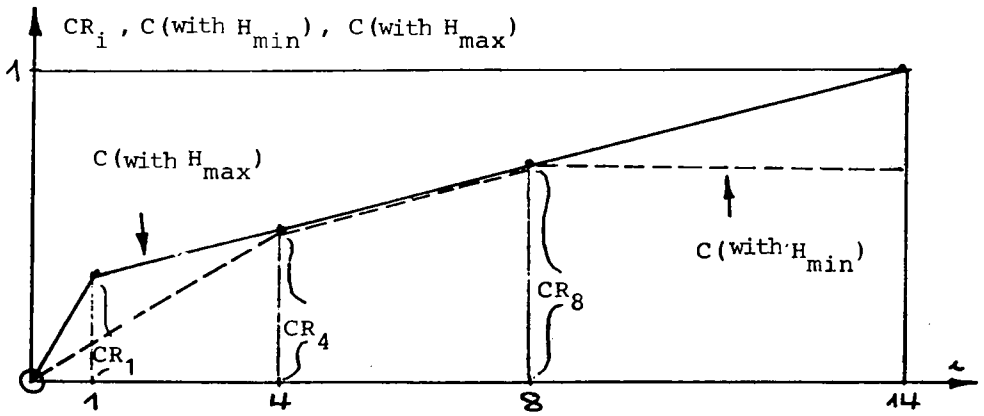

Fig. 3: Positions of the concentration curve that, with given concentration ratios, produce extreme values for the Herfindahl index. We find $H_{min} = 7.25$ and $H_{max} = 15.5$ and hence $7.25 \leq H \leq 15.5$.

4. Problems of aggregation

Most of the concentration studies carried out on behalf of the Commission are country studies and thus focus on national markets. To obtain a picture of concentration on the Community market as a whole, the country results need to be aggregated.

Where different firms are active on the market in all countries, concentration on the total Community market is always lower than the highest level of national concentration and may even be lower than the lowest level. Disparity, on the other hand, is always greater than the lowest national disparity and may even be greater than the highest national disparity. In short, the tendency in the event of aggregation is for concentration to decrease and for disparity to increase. If complete concentration curves are available for all countries and if we know the shares of the total market held by the individual countries (expressed in terms of the total value), we can construct the concentration curve for the aggregate by arranging the newly weighted market shares in order. Individual concentration ratios (with the exception of CR_1) cannot, however, be aggregated in this way.

Similarly, in the case of the simple Herfindahl index and the exponential index, to calculate the index for the aggregate from one, we need to know only the national index values and the national total values.

Difficulties arise both in calculating the overall indices and in estimating them against the individual indices where a firm operates on a number of national markets. In addition to the aggregation described above, additional calculations concerning theoretical mergers have to be performed. These adjustments are straightforward in the case of the Herfindahl index and the exponential index provided we know the market shares of the firms concerned on the individual national markets. The concentration-reducing effect of aggregation can be mitigated by the merger effects that have to be calculated.

5. Use of measures of dominance to identify oligopolistic nuclei

With a critical level of concentration of, say; CR_4 = 50% or value for the Herfindahl index ranging from 10 to 20, it is often useful to draw a dividing line between a potential group of large firms and the remaining smaller firms. A sudden drop of this kind in the size distribution is typical of various sorts of oligopoly. For a boundary value k a measure of dominance gives an index for the "dominance" of the k largest firms over the remaining smaller firms. By allowing k to vary and by identifying the point at which the measure of dominance is greatest, we are able to identify a potential oligopolistic nucleus. Structurally at least, an oligopolistic group exists where a sharp drop occurs at the front end of the size distribution, with a few large firms clearly outdistancing the following group or the small firms. The oligopolistic group can be easily identified by describing the drop in the size distribution in terms of the relationships $\frac{x_k}{x_{k+1}}$, i.e. the slope of the concentration curve, and by determining maximum values. This simple slope index D^A should be determined first.

We would recommend use of two other measures of dominance, which can be illustrated with the help of the concentration curve: the longest concentration curve chord (D^S) - S is here reminiscent of the Schutz coefficient, a widely used measure of disparity, which is represented by the longest Lorenz curve chord - and the Linda dominance D^Q (see Annex). Yet another measure of dominance can be derived from the Herfindahl index by classifying the k largest firms and the remaining firms into two homogenous groups in which the units in each case have the same market share and by calculating the (external) Herfindahl index for this situation. The limit k_H, at which this Herfindahl measure of dominance (D^H) is greatest, makes a clear line of demarcation between the group of large firms and the group of small firms.

Measures of dominance can also be used for truncated distributions. As the cut-off line approaches the total number of units, the boundaries of the oligipolistic nucleus, identified using a measure of dominance, stabilize.

Following on from Section 6, oligopolistic nuclei will be determined by way of a small model calculation; the threshold values broadly match one another in the case of the measures of dominance calculated.

The following section looks into the suitability for concentration analyses of the Linda indices, which are used in the EEC studies and which are, to some extent, also regarded as measures of dominance.

6. LINDA-Indices

Since 1972 or thereabouts, the analytical concentration studies carried out by or on behalf of the Commission have employed, in addition to concentration ratios, a large number of Linda indices. The basic building blocks for all Linda indices are the ratios of the mean value of a particular variable for the i largest firms to the mean value of that variable for the remaining k-i small firms. Dominance is the term we use to describe this ratio of an "upper mean value" to a "lower mean value"; Linda refers to the "ratio of oligopolistic dominance". The measure of dominance thus expresses the multiple by which the average of the i largest firms is larger than the average of the remaining k-i small firms.[1)]

Starting from the correct premises that for the most part information is available for the large units only, Linda calculates

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1) Measures for determining disparity that employ lower and upper mean values have been used in Italian statistics for quite some time. See. W. PIESCH, loc. cit., pp. 120 et seq.

two different indices L_k^* and L_k for each cut-off line k = 2, 3, ... The mean dominance L_k^* (the simple averaged Linda index) is the arithmic mean of all the dominance values (i.e. the arithmetic mean of all the "ratios of oligopolistic dominance"). It represents a formal average of the size proportions of the k largest firms. The averaging exercise is a complicated one because of multiple counting of the individual values.

Relating the average dominance L_k^* to the number of firms under investigation, we obtain the relative mean dominance L_k (the double averaged Linda index). Because of the double averaging, L_k cannot be graphically meaningfully interpreted.

In addition, L_k^* and L_k are used to construct other Linda indices, producing an entire system of Linda indices.

These indices were used in the EEC studies for measuring concentration and dominance, and in particular for identifying oligopolistic nuclei and characterizing various types of oligopoly.

Let us briefly examine just how useful Linda indices can be in resolving such problems.

The principle of transfers is satisfied by L_k^* and hence by L_k. An equivalent can be found in the position of the concentration curve if k is fixed. Where the concentration curve C^1 lies above the concentration curve C^2 without intersecting it, L_k^*1 is greater than L_k^*2. L_k^* is very sensitive to any sharp drop in the size distribution or to the addition of small units and assumes very large values. In the event of mergers, it may fall. Leaving aside the unusual standardization of the measure in the case of values between 1 and ∞, L_k^* always gives the upper limit ∞ for all distributions (1, 1,, 1,0), ... , (1,0, ... , 0) containing at least one zero. For this reason, L_k^* and L_k are not measures of concentration.

L_k^* = 1 in the case of all uniform distributions. As can be seen from the example of distributions (2,1) and (2,2,1,1) and (2,2,2,1,1,1) etc., mean dominance decreases steadily starting from 2 and heads for a value of 1.52. As a result, the proportionality test is not (exactly) satisfied. Since the supplementary test does not apply either, L_k^* and L_k are, strictly speaking, not measures of inequality. Nonetheless, an attempt could be made to use at least as an approximation mean dominances L_k^* for describing inequalities. For this, it would be advisable to introduce the transformed mean dominance $D_k = L_k^* - 1$ as a sort of unrestricted measure of inequality. However, the way the index is constructed (large firms related to small firms), it produces a particularly high value for the lower disparity (compared with the Lorenz curve). In particular, the use of traditional measures of disparity (e.g. the Gini coefficient or the Schutz coefficient) yields assessments different to those yielded by L_k^*-1. These objections lose some of their force where the study is restricted to dominance in oligopolistic nuclei since these do not contain any small firms. The different picture of disparity provided by L_k^* is apparent from the following example:

Example: Take two distributions:

$x_{11} = 1, \quad x_{21} = x_{31} = x_{41} = 0.2$ (distribution 1)

and $x_{12} = x_{22} = 1, \; x_{32} = x_{42} = 0.2$ (distribution 2)

Table 1: Measures of inequality for two selected distributions

Abscissa of the Lorenz curve $H_{i1} = H_{i2}$	Ordinate of the Lorenz curve	
	Distribution 1 : L_{i1}	Distribution 2 : L_{i2}
0.25	0.125	0.083
0.50	0.250	0.167
0.75	0.375	0.583
1	1	1
	$R_1 = 0.50$ $S_1 = 0.375$ $L_4^*(1) = 3.444$	$R_2 = 0.44$ $S_2 = 0.333$ $L_4^*(2) = 3.603$

We shall also investigate to what extent Linda indices are useful as measures of dominance for delimiting oligopolistic nuclei.

Cut-off lines can be determined by identifying points of maximum dominance (e.g. the "ratios of oligopolistic dominance" referred to by Linda). The mean dominance L_k^* is not, however, a suitable measure for identifying an oligopolistic group since, in most cases, it increases steadily.

The relative mean dominance L_k responds to a sharp drop in the size distribution in such a way that L_k takes on a relative minimum value. The following are some of the shortcomings of this measure:

- Empirical investigations show that the cut-off line identified using L_k does not always coincide with the largest drop in the size distribution;
- Since L_k can be determined only as of k = 2, partial monopolies are not measured;
- If a size distribution with a constant ratio $\frac{x_i}{x_{i+1}} = c < 1$ declines, L_k points to oligopolistic groups. The smaller c, the larger the group of oligopolists;
- In the case of a symmetrical oligopoly and a symmetrical fringe, the size distribution consists of k equally large firms ($x_1 = .. = x_k = a$) and n-k equally small firms ($x_{k+1} = . = x_n = b$). Here, the size distribution drops at k, and L_k should identify the oligopolistic group. Assume $\frac{b}{a} = \alpha < 1$ and we obtain a critical value α_k for each k (see Table 2). L_k has a minimum value only for $\alpha < \alpha_k$, and not for $\alpha \geq \alpha_k$, i.e. where only a small drop is observed in the size distribution.

Table 2: Response limits of the Linda index for two-point distributions

k	2	3	4	5	6	7	8
α_k	0.50	0.58	0.62	0.65	0.67	0.68	0.70

Where k = 2, the Linda index thus does not have a minimum value for (10, 10, 6) but does have one for (10, 10, 4). Assuming k = 4, no nucleus is indicated for (10, 10, 10, 10, 7) whereas one is indicated for (10, 10, 10, 10, 5). While such robust behaviour of the measure might be desirable, the response moves in the wrong direction. With a given value of α, the looser an oligopolistic nucleus, the more readily it will be identified.

These considerations show that, as a measure for detecting oligopolistic groups, L_k is no better than the slope index or other measures of dominance. Until such time as it is evident which measures of dominance are particularly well-suited to identifying oligopolistic nuclei, we suggest that several measures be used alongside one another, including L_k.

7. Model calculations

Various measures of concentration and of dominance have been determined for the following four size distributions of typical market structures (see Table 3).

The results can be interpreted as follows:

The high concentration ratios of CR_4 = 36%-50% and CR_8 = 70%-72% indicate the existence of oligopolistic groups. The size of these groups is expressed in terms of the threshold value k.[1] obtained using a measure of dominance. As an experiment, the measures of dominance D^A, D^S and D^H and the measures D^Q and L_K are used. In distribution 1, depending on the measure of dominance chosen, we obtain the threshold values k.= 1 and k.= 8, which focus on the partial monopoly and the competitive fringe group. In distributions 2 and 4, virtually all the measures identify the oligopolistic group correctly at k.= 8. In distribution 3, D^A, D^H and L_K point to the nucleus (k_H= 4), and the other measures identify the total oligopolistic group (k.= 8). The Linda index L_K and the slope index D^A, which yield relative extremes for k_L= 4 and k_L = 8, reveal interesting behaviour; k_L= 8 represents an absolute extreme. This index therefore identifies not only the nucleus but also the oligopolistic group or competitive fringe.

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1) k. stands for one of the threshold values k_A, k_S, k_H, k_Q or k_L.

Table 3: Measures of concentration and dominance for four typical structures

Distribution	1 Partial monopoly[1] with nucleus	2 Symmetrical oligopoly	3 Asymmetrical oligopoly	4 Asymmetrical oligopoly
	$x_{i1}(\%) = p_{i1}$	$x_{i2}(\%) = p_{i2}$	$x_{i3}(\%) = p_{i3}$	$x_{i4}(\%) = p_{i4}$
Eight largest	35 5 5 5 5 5 5 5	9 9 9 9 9 9 9 9	12 12 12 12 6 6 5 5	20 12 10 8 6 6 4 4
Small	1 . . . 1	1 . . . 1	1 . . . 1	1 . . . 1
Size of population	$n_1 = 38$	$n_2 = 36$	$n_3 = 38$	$n_4 = 38$
Measures of concentration	$H = 14.3$ $E = 6.1$	$H = 6.8$ $E = 4.9$	$H = 7.3$ $E = 4.8$	$H = 8.4$ $E = 5.1$
	$CR_1 = 35$ $CR_4 = 50$ $CR_8 = 70$	$CR_1 = 9$ $CR_4 = 36$ $CR_8 = 72$	$CR_1 = 12$ $CR_4 = 48$ $CR_8 = 70$	$CR_1 = 20$ $CR_4 = 50$ $CR_8 = 70$
Mean dominance	$L_4^* = 4.7$ $L_8^* = 3.2$ $L_{r\|8}^* = 1$ [2]	$L_4^* = 1$ $L_8^* = 1$ $L_{r\|8}^* = 1$	$L_4^* = 1$ $L_8^* = 1\ 8$ $L_{r\|8}^* = 1$	$L_4^* = 1.8$ $L_8^* = 2.5$ $L_{r\|8}^* = 1$
Threshold values k. derived from measures of dominance (oligopolistic nucleus[3])	$k_A = 1(8)$ $k_S = 8$ $k_H = 1$ $k_Q = 1$ $k_L = 8$	$k_A = 8$ $k_S = 8$ $k_H = 8$ $k_Q = 8$ $k_L = 8$	$k_A = 4(8)$ $k_S = 8$ $k_H = 4$ $k_Q = 8$ $k_L = 4(8)$	$k_A = 1(4;8)$ $k_S = 8$ $k_H = 4$ $k_Q = 8$ $k_L = 8$

1. Dominant firm with competitive fringe.
2. Dominance in the remaining group of small firms (beyond eight)
3. Position of the maximum values of D^A, D^S, D^H and D^Q and of the minimum value of the Linda index L_k. Where there is more than one extreme value, these are shown in brackets.

The measures of dominance L_4^* and L_8^* permit a rough assessment of disparities among the four or eight largest firms. Conclusions with varying implications for competition policy can in this way be drawn regarding the existence of symmetrical or asymmetrical oligopolies. Where group interests coincide in the case of symmetry, a reduction in the intensity of competition is presumed. For this reason, there is no point in indicating the Herfindahl index where group power exists since a direct correlation may be presumed, at least in certain areas, between statistical concentration and intensity of competition and an inverse correlation between statistical concentration and market-power concentration.

The examples presented should, where possible, be supplemented by observations on any inequalities in the remaining group.

8. Conclusions and results

The conventional statistical approach to measuring concentration starts from the idea of a firm holding a dominant position on the market, the so-called individual power concept of competition theory. When statistical concentration increases, the intensity of competition can then be presumed to decrease and market power to increase. In applying this concept, particular importance attaches to concentration ratios, to the dependence of concentration on disparity and the number of firms, and to the impact of transfers. It is also possible to employ simple summary measures of concentration such as the Herfindahl index and the exponential index.

A variant of the statistical measurement of concentration is needed for the group power concept (involving the existence of tight oligopolies characterized by spontaneous conscious parallelism) which has recently come to play a prominent role in competition theory. Where, given a concentration ratio of $CR_4 = 50\%$, we have, for example, a symmetrical and an asymmetrical oligopoly,

the distribution of group power in the symmetrical oligopoly (no inequality) is presumed to result in a lower intensity of competition than in the case of the asymmetrical oligopoly (existence of inequality).

Starting from the concept of group power, it cannot be concluded therefore that, at least within certain ranges, an assumed decrease in intensity of competition occurs where statistical concentration increases, since an increase in inequality within an oligopoly tends to promote competition. In this case, summary measures of statistical concentration are not suitable indicators of intensity of competition and market power. Nonetheless, the concentration ratios described can be used to characterize measures of inequality for partial distributions and measures of dominance for critical market structures, especially those types of oligopoly that threaten competition.

The following indicators should therefore be compiled in order to measure and identify such critical market structures: a high concentration ratio CR_1 (e.g. greater than 30%) and a low threshold value $k_. = 1$ point to the existence of a dominant firm. The inequality within the residual group should also be investigated using $L^*_{r/1}$.

If $CR_4 = 50\%$ and $CR_8 = 70\%$ and if the threshold value k. yields a small value ($k. < 10$), the size distribution in question indicates the existence of an oligopolistic group. The indicators L^*_k and $L^*_{r/k}$ provide further information on dominance in the nucleus and in the residual group.

Where the indicators have such critical values, this indicates a threat to competition. Closer investigation of other structural characteristics and of market conduct should then make it clear whether such a threat actually exists.

Table 4: Measures of concentration and dominance for identifying critical market structures

Indices	Values
Summary measures of concentration (× 100)	Herfindahl index H (Exponential index E)
Concentration ratios (%)	CR_1 CR_4 CR_8
Mean dominance	L_4^* L_8^* $L_{r/8}^*$
Threshold values $k_.$ (size of the oligopolistic nucleus)	$k_.$
Additional indices, if any	$CR_{k.}$, $L_{k.}^*$, $L_{r/k.}^*$

III. Suitability of the proposed measures of concentration and dominance for competition policy investigation based on individual cases and empirical studies

This part looks at the measures of concentration and dominance advocated in Part II in terms of their suitability for ascertaining market power.

We shall use the layout for measuring concentration proposed on page 41. The value 10 can be taken as the critical value for the Herfindahl index and for the exponential index,[1] 50% for CR_4 and 70% for CR_8 giving critical ranges for ascertaining in the distribution of market shares within a group comprising the largest firms is impracticable, since the values of all the proposed indices are influenced by group size. It is fair to say, however, that, from the viewpoint of competition policy, both a very low degree of inequality - symmetry of interests - and a very high degree of inequality - marked predominance of individual firms - pose a threat.

1. Examination of Decisions under Article 86 of the EEC Treaty

Article 86 of the EEC Treaty prohibits "any abuse by one or more undertakings of a dominant position within the common market or in a substantial part of it ... in so far as it may affect trade between Member States".

The Decisions taken under this Article in Continental Can, United Brands (Chiquita) and Hoffmann-La Roche are a particularly suitable basis for examining the usefulness for competition policy of the proposed measures of concentration and dominance, since

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1) This corresponds to an oligopoly made up of ten suppliers of equal size. Where there are more than ten or twelve oligopolists, oligopolistic interdependence and the scope for coordinated group behaviour are, generally speaking, sharply reduced. See SCHERER, op. cit., pp. 199 et seq.

most of the other Decisions have been concerned with de facto or de jure monopoly situations (CR_1 = 100%)[1].

a) The Continental Can Case[2]

(1) The facts

By 1969 Continental Can Company Inc. (Continental) of New York, a company operating in the packaging sector, had brought its share in Schmalbach-Lubeca-Werke AG (SLW) of Brunswick, Germany, up to 85.8% of the nominal capital. Europemballage, the holding company for packaging which was set up by Continental in 1970 and which was to manage all Continental's interests in Europe, purchased shares and convertible debentures of Thomassen & Drijver-Verblifa NV (TDV) of Deventer, thus bringing Continental's share in TDV to 91,07%.

In december 1971 the Commission found that Continental Can Company Inc. of New York had abused, within the meaning of Article 86 of the EEC Treaty, its dominant position on a substantial part of the common market for light packaging by the purchase made in April 1970 by its subsidiary Europemballage & Co. of approximately 80% of the shares and convertible debentures of TDV of Deventer, this purchase having the effect of practically eliminating competition in the aforementioned packaging on a substantial part of the common market. This was the first occasion on which the Commission made it clear that the merger between a market-dominating firm and its competitor constitutes an abuse within the meaning of Article 86 where it restricts

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1) See the cases involving GEMA, SABAM, SACEM (de facto) and SIAE (de jure).

2) Commission Decision of 9 December 1971, OJ No. L 7 of 8 January 1972, p. 25; Case 6/72 Europemballage and Continental Can v. Commission. /1973/ ECR 215.

the freedom of choice of consumers in a manner incompatible with the rules of competition laid down in the Treaty. Although the Court of Justice endorsed the Commission's legal standpoint in February 1973, namely that specific forms of merger or acquisition were also caught by Article 86, it quashed the Decision itself on the ground that it contained insufficient evidence regarding the delimitation of the relevant market and potential competition and hence a strengthening of a dominant position.

(2) Existence of a dominant position: the Commission's and the Court of Justice's arguments

The Commission's Decision was based on the view that "undertakings are in a dominant position when they have the power to behave independently, which puts them in a position to act without taking into account their competitors, purchasers or suppliers. That is the position when, because of their share of the market, or of their share of the market combined with the availability of technical knowledge, raw materials or capital, they have the power to determine prices or to control production or distribution for a significant part of the products in question".

In Continental Can the Commission considered that the company had a dominant position on the market for light metal containers for preserved meat and fish and on the market in metal caps for glass jars. It also examined possible substitutes for particular types of light metal containers and the factors that restrict substitutability. It took the view that the dominant position of Continental Can derived from the shares accounted for by its subsidiary SLW on the various sub-markets for light containers and from the group's economic, financial, and technical importance. The substantial market shares on the various sub-markets, together with these factors, would, the Commission maintained, enable Continental Can to behave independently, giving it a dominant position on the market for metal closures.

The Court, however, criticized the Commission's definition of market based on the uses of light metal containers and stressed that greater account should be taken of production flexibility (potential competition): "In order to be regarded as constituting a distinct market, the products in question must be individualized not only by the mere fact that they are used for packing certain products, but by particular characteristics of production which make them specifically suitable for this purpose.

A dominant position on the market for light metal containers for meat and fish cannot be decisive as long as it has not been proved that competitors from other sectors of the market for light metal containers are not in a position to enter this market by a simple adaptation, with sufficient adaptation, with sufficient strength to create a serious counterweight."

Since it took a different view of the material definition of the relevant market in stressing the need to take account of potential competitors, the Court ruled that Article 86 was not applicable to this case.

(3) Testing the measures of concentration and dominance proposed in Part II: the Continental Can Case

In the case in question, the Commission considered that the dominant position resulted from large market shares, the group's lead over most of its competitors and its size and economic, financial and technical importance. An analysis of the three relevant markets for light metal containers revealed the following individual market shares (= p), the relevant geographic market being defined as the northern and central parts of West Germany and the Benelux countries:

(a) Market for preserved meat:

- Germany: p_1 = 70-80% - Benelux: p_1 = 100%
  p_2 = 10%
  p_3 = 4.6%

(b) Market for preserved fish:

- Germany: p_1 = 80-90% - Benelux: p_1 = 100%
  p_2 = 8%
  p_3 = 4.6%

(c) Market for metal closures for glass jars:

- Germany: p_1 = at least 50% - Benelux: p_1 = at least 45%

No other information on market shares was supplied; twenty other firms of regional importance were active on the German market for containers for preserved food (meat and fish).

Table 5: Measures of concentration[1] for Continental Can Case (market: Germany)

Indices \ Market		Values for preserved meat	Values for preserved fish
Summary measures of concentration (x 100)	H	50.3 - 65.4	64.9 - 77.2
	E	23.7 - 48.2	37.9 - 63.0
Concentration ratios (%)	CR_1	70.0 - 80.0	80.0 - 87 4
	CR_3	84.6 - 94.6	92.6 - 100
	CR_4	85.1 - 99.2	92.9 - 100
	CR_8	87.2 - 100	93.9 - 100
Mean dominance	L_3^*	9.1 - 10.4	11.1 - 12.1
Threshold values	k_A	1	1
	k_H	1	1

1) Since the information available on the structure of market shares is not complete, no exact values can be given, particularly for summary measures of concentration, but merely ranges within which the (unknown exact) value falls. The methods of calculation is explained in Part II. 3(c); for practical reasons, we have assumed here that the smallest measurable market share is 0.1%.

The concentration analysis may be summarized as follows:

- The Herfindahl index H is of the order of 60 or 70, suggesting a very high level of overall concentration,
- Continental Can's market share on the different markets is very high (70% or 80%, 80% or 100%, and 50% or 45%),
- On the market for preserved meat and fish, the gap between Continental Can and the second-largest firm is so great that the threshold value on both markets is $k_A = k_H = 1$[1].
- The market shares within the group comprising the three largest firms (70%, 10% and 4.6%; 80%, 8% and 4.6%) are very unevenly distributed on the market for preserved meat and fish because of the high market share of the market leader. L_3^* lies between 9.1 and 10.4 or between 11.1 and 12.1.
- Since the remaining market shares are not known, the disparity in the remaining group cannot be quantified.

The high concentration ratios CR_1 and the low threshold values of $k_A = k_H = 1$ indicate that Continental Can holds a dominant position. The concentration ratios are unable to shed any light on the intensity of potential competition from new entrants; this would have to be determined as part of a wider analysis of market structures.

(b) The United Brands (Chiquita) Case[2]

(1) The facts

United Brands Company (UBC) is the largest group operating on the world banana market. Its European subsidiary, United Brands Continental BV (UBC BV), Rotterdam is responsible for coordinating

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1) Using the Linda index (L_k) would not have yielded any threshold value because of the existing partial monopoly (see p. 36).

2) Commission Decision of 17 December 1975, OJ No. L 95 of 9 April 1976, p. 1; Case 27/76 United Brands vs. Commission /1978/ ECR 207, 14 February 1978.

banana marketing in the Member States of the Community, save in the United Kingdom and Italy. Following numerous complaints, the Commission instituted proceedings against UBC BV in March 1975 for infringement of Article 86 of the EEC Treaty. It accused the firm of four types of abuse of its dominant position:

- ban on the resale of green bananas by independent ripeners/ distributors, which had resulted in market segregation,
- refusal to continue to supply a Danish ripener and distributor after the latter had taken part in an advertising campaign for bananas of a competing brand,
- discrimination against trading partners through the application of prices which, depending on the Member State in which customers customers are established, differ significantly,
- the charging of unfair prices to some of its customers.

In 1978 the Court upheld the Commission's Decision with regard to the first three types of abuse under Article 86.

(2) Existence of a dominant position: the Commission's and the Court of Justice's arguments

In its judgment, the Court added some essential elements to the concept of dominant position. It considered that a dominant position within the meaning of Article 86 was a position of economic strength enjoyed by an undertaking "which enables it to prevent effective competition being maintained on the relevant market by giving it the power to behave to an appreciable extent independently of its competitors, customers and ultimately of its customers." This definition covers not only cases in which a firm's market share is so large that this alone suggests the existence of a dominant position but also situations in which this position derives from a combination of several factors which, taken separately, are not necessarily determinative.

On the matter of UBC's position on the world banana market, the Court analysed a series of structural characteristics, stressing the firm's very extensive vertical integration (from plantations through refrigerator ships to ripeners), its ability to satisfy the demand for bananas at any moment, its comprehensive technical know-how and its market policy of promoting the Chiquita brand, which assured the firm of an unchanging group of customers and gave it control over all stages of distribution.

With regard to the competitive situation on the relevant market for bananas, the Court found that a trader can only be in a dominant position on the market for a product if he has succeeded in winning a large part of that market. It viewed the fact that UBC's market share was several times greater than that of its nearest competitor and that UBC also enjoyed essential structural advantages as the main indication of its dominant position. It also held that, in order to establish whether an undertaking is in a dominant position, it might be expedient to take account of any facts put forward as acts amounting to abuses (abuse as an indication of market dominance). In this respect, it drew attention to the clause covering the sale of green bananas, which gave UBC absolute control over the entire trade in its products. The Court considered that it was also typical of a dominant position that UBC had completely withstood the extremely keen competition which other producers had repeatedly unleashed against it, that it had successfully fought the appearance of new competitors on the entire relevant market, that it had been able to maintain its sales figures on all national markets in question and that customers continued to buy bananas from UBC even though it charged the highest prices.

(3) Testing the measures of concentration and dominance proposed in Part II: the United Brands Case

An analysis of the relevant market for bananas revealed the following individual market shares (= p), the relevant geographic market being defined as the entire Community market:

p_1 = 40%	p_5 = 5%
p_2 = 9%	p_6 = 5%
p_3 = 6%	p_7 = 3%
p_4 = 6%	p_8 = 2%

The market shares of the remaining suppliers were not specified.

Table 6: Measures of concentration for the United Brands Case

Indices		Values
Summary measures of concentration (x100)	H	18.2 - 18.6
	E	4.7 - 9.6
Concentration ratios (%)	CR_1	40
	CR_4	61
	CR_8	76
Mean dominance	L_4^*	4.3
	L_8^*	5.1
Threshold values	k_A	1
	k_H	1

* See footnote to Table 5.

The concentration analysis may be summarized as follows:

- The Herfindahl index H is of the order of 18, suggesting a very high level of overall concentration,
- UBC's market share is relatively high (40%),
- the gap between UBC and the next largest firm, which has 9% of the market, is so great that the threshold value is $k_A = k_H = 1$,
- the market shares within the group comprising the four and eight largest firms are very unevenly distributed because of the high market share of the market leader. L_4^* works out at 4.3 and L_8^* at 5.1,
- the market shares within the remaining group are relatively unevenly distributed; L_r^* cannot be calculated owing to a lack of information on the remaining market shares.

The relatively high concentration ratio of $CR_1 = 40\%$ and the low threshold value of $k_A = k_H = 1$ indicate that UBC holds a dominant position.

(c) The Hoffmann-La Roche Case[1)]

(1) The facts

In 1976 in a Decision under Article 86 of the EEC Treaty, the Commission ruled against Hoffmann-La Roche (Roche) based in Switzerland, which heads a multinational group and is the world's leading producer of vitamins.

Roche had agreements with twenty-two customers for the exclusive or preferential supply of vitamin preparations. In exchange for this exclusivity or as an incentive to establish preferential ties, these arrangements provided for discounts in the form of a "loyalty rebate". These "loyalty rebates" were granted where customers obtained from Roche all or most of their vitamin requirements. They were not calculated separately for the

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1) Commission Decision of 9 June 1976, OJ No. L 223 of 16 August 1976, p. 27; Case 85/76 Hoffmann-La Roche vs Commission /1979/ ECR 461.

individual group of vitamins, but on the basis of the total quantity of all vitamins purchased from Roche ("across-the-board" rebate). In this way, Roche secured itself a preferential position also on vitamin markets where it was not dominant.

In the Commission's view, each group of vitamins constituted a distinct market because each group was particularly suited to satisfy stable requirements and was not, or at least not to any significant extent, interchangeable with any other group or with any other products. The relevant product markets concerned by the Decision were seven groups of vitamins: A, B_2, B_6, C, E, Biotin (H) and pantothenic acid (B_3). The relevant geographic market was the entire common market.

In 1979 the Court upheld most of the Commission's Decision.

(2) Existence of a dominant position: the Commission's and the Court of Justice's arguments

The Commission found in its Decision that Roche was, all in all, so independent in its conduct on the relevant markets that it was able to prevent effective competition within the common market and, as a result, held a dominant position on those markets; this was apparent in particular from the following:

- Roche's market share for the different vitamins ranged from 47% to 95%; its turnover exceeded that of all other manufacturers combined,
- Roche produced a far wider range of vitamins than its competitors, and this enabled Roche to pursue a more independent sales and pricing strategy than other manufacturers,
- Roche enjoyed a technological and commercial lead over its competitors,
- Entry into the vitamins market was made very difficult by the fact that substantial investment was needed and capacities had to be programmed over long periods.

In its judgment, the Court acknowledged that the Commission had defined the relevant markets correctly in its disputed Decision. It took the view that, in determining whether there was a dominant position, a substantial market share was s significant indicator; other indicators were the relationship between the market share of the firm concerned and those of its competitors, the technological lead of a firm, a first-class sales network and the absence of potential competition.

These considerations led the Court to look into Roche's shares on each of the relevant markets and to examine the indicators which, in conjunction with market shares, can prove the existence of a dominant position. The Court's analysis of the various vitamin groups showed that the conditions for a dominant position on the markets of vitamin groups A, B_2. B_6, C, E and H were fulfilled, while no dominant position could be proved on the market for vitamin B_3.

(3) Testing the measures of concentration and dominance proposed in Part II: the Hoffmann-La Roche Case

(a) Vitamin group A

An analysis of the relevant market revealed the following individual market shares (= p):

p_1 = 47% p_4 = 7%
p_2 = 27% p_5 = 1%
p_3 = 18%

The concentration analysis (see Table 7) may be summarized as follows:

- The Herfindahl index H is 33.1, suggesting a very high level of overall concentration,
- Roche's market share is relatively high (47%),
- Though the gap between Roche and the next largest firm is relatively large, the threshold value is $k_H = 2$ or $k_L =$

Table 7: Measures of concentration* for the Hoffmann-La Roche Case
Market: vitamin group A

Indices		Values
Summary measures of concentration (x100)	H	33.1
	E	28.7
Concentration ratios (%)	CR_1	47
	CR_4	49
Mean dominance	L_4^*	3.4
Threshold values	k_A	4
	k_H	2
	k_L	3

* See footnote to Table 5.

- 3[1]. The market structure points more to an asymmetrical oligopoly than to a partial monopoly on the part of Roche,
- This asymmetry is apparent from the distribution of market shares within the group of the four largest firms. L_4^* works out at 3.4,
- Examination of the remaining group is pointless since there are only five suppliers.

The low threshold values of $k_H=2$ and $k_L=3$ indicate a tight oligopoly with market leadership by Roche.

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1) Using the slope index D^A, which expresses the relationship of the market share to the next smallest market share, gives an even greater threshold value of $k_A = 4$.

(b) Vitamin group B_2

An analysis of the relevant market revealed the following individual market shares (= p):

1972	1973	1974
$p_1 = CR_1 = 87.0\%$	$p_1 = 81.2\%$	$p_1 = 80.6\%$

Table 8: Measures of concentration* for the Hoffmann-La Roche Case
Market: vitamin group B_2 (1974)

Indices		Values
Summary measures of concentration (x100)	H	65.0 - 68.7
	E	22.0 - 61.1
Concentration ratio (%)	CR_1	80.6
Threshold value	k_H	1

* See footnote to Table 5.

The concentration analysis may be summarized as follows:

- The Herfindahl index H is of the order of 67, suggesting a very high level of overall concentration,
- Roche's market share is very high (80.6% in 1974),
- The gap between Roche and the second largest firm is so great that the threshold value is $k_H = 1$,
- L_4^* or L_8^* and L_r^* cannot be calculated owing to a lack of further information.

The very high concentration of Roche (80.6% in 1974) and the low

threshold value of $k_H = 1$ indicate that Roche holds a dominant position on the market.

(c) Vitamin group B_3 (pantothenic acid)

An analysis of the relevant market revealed the following individual markets shares (= p) of the market leader:

1972	1973	1974
$p_1 = CR_1 = 28.9\%$	$p_1 = 34.9\%$	$p_1 = 51.0\%$

In 1973, a Japanese importer had a market share of 30%, and the Court therefore rightly pointed out that such market shares were not in themselves enough to indicate a dominant position.

(d) Vitamin group B_6 [1)]

An analysis of the relevant market revealed the following individual market shares (= p)

1972	1973	1974
$p_1 = CR_1 = 87.0\%$	$p_1 = 90.0\%$	$p_1 = 83.9\%$

None of the four next smallest competitors had a market share of 10%, and the shares of some competitors were probably under 5%.

Table 9: Measures of concentration* for the Hoffmann-La Roche Case

Market: vitamin group B_6 (1974)

Indices		Values
Summary measures of concentration (x100)	H	70.4 - 71.8
	E	28.4 - 57.8
Concentration ratio (%)	CR_1	83.9
Threshold value	k_H	1

* See footnote to Table 5.

1) Vitamin B_6 and biotin (H) have been bracketed together, since they both come under the same customs tariff heading; this affects only slightly the market shares for vitamin B_6.

The concentration analysis may be summarized as follows:

- The Herfindahl index H is of the order of 71, suggesting a very high level of overall concentration,
- The market shares of the market leader are very high (83.9% in 1974),
- The gap between Roche and the next largest firm is so great that the threshold value is $k_H = 1$,
- L_4^* or L_8^* and L_r^* cannot be calculated owing to a lack of further information.

The very high concentration ratio of CR_1 and the low threshold value of $k_H = 1$ indicate that Roche holds a dominant position.

(e) Vitamin group C

An analysis of the relevant market revealed the following individual market shares (= p):

1972	1973	1974
$p_1 = CR_1 = 65.7\%$	$p_1 = 66.2\%$	$p_1 = 64.8\%$
		$p_2 = 14.8\%$
		$p_3 = 6.0\%$

No market shares are specified for other suppliers.

The concentration analysis (see Table 10) may be summarized as follows:

- The Herfindahl index H is of the order of 45, suggesting a very high level of overall concentration,
- Roche's market share is relatively high (64.8% in 1974),
- The gap between Roche and the next largest firm is so great that the threshold value is $k_A = k_H = 1$,
- Market shares among the three largest firms are very unevenly distributed because of the high market share of the market leader. L_3^* works out a 6.4.

Table 10: Measures of concentration* for the Hoffmann-La Roche Case

Market: vitamin group C (1974)

Indices		Values
Summary measures of concentration (x100)	H	44.6 - 45.3
	E	17.8 - 31.4
Concentration ratios (%)	CR_1	64.8
	CR_3	85.6
	CR_4	85.7 - 91.6
	CR_8	86.0 - 100
Mean dominance	L_3^*	6.4
Threshold values	k_A	1
	k_H	1

* See footnote to Table 5.

- Market shares within the remaining group are very small compared with the market leader; in addition, they are relatively unevenly distributed,
- L_4^* or L_8^* and L_r^* cannot be calculated owing to a lack of further information.

The relatively high concentration ratio of CR_1 = 64.8% and the low threshold vakue of $k_A = k_H = 1$ indicate that Roche holds a dominant position.

(f) Vitamin group E

An analysis of the relevant market revealed the following individual market shares (= p):

1972	1973	1974
$p_1 = CR_1 = 54\%$	$p_1 = 64\%$	$p_1 = 58\%$
		$p_2 = 16\%$
		$p_3 = 6\%$
		$p_4 = 1\%$[1)]

Table 11: Measures of concentration* for the Hoffmann-La Roche Case

Market: vitamin group E (1974)

Indices		Values
Summary measures of concentration (x100)	H	36.6 - 36.8
	E	11.8 - 18.3
Concentration ratios (%)	CR_1	58.0
	CR_4	81.0
	CR_8	81.0 - 85.0
Mean dominance	L_4^*	14.9
Threshold values	k_A	1
	k_H	1

* See footnote to Table 5.

The concentration analysis may be summarized as follows:

- The Herfindahl index H is of the order of 36, suggesting a very high level of overall concentration,
- Roche's market share is relatively high (58% in 1974),
- The gap between Roche and the next largest firm is so great that the threshold value is $k_A = k_H = 1$,
- Market shares among the four largest firms are very unevenly distributed because of the high market share of the market leader. L_4^* works out at 14.9.

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1) The remaining market shares amounting to 19% are held by importers.

- L_8^* and L_4^* cannot be calculated owing to a lack of further information.

Roche's high market share (58% in 1974) and the low threshold value of $k_A = k_H = 1$ indicate that Roche holds a dominant position.

(g) Decisions taken under Article 86 of the EEC Treaty: Result of examination

The analysis of the principal Decisions taken under Article 86 of the EEC Treaty has shown that the assessment criteria used by the Commission and the Court of Justice and the "measures of concentration for identifying concentration and critical concentration areas" proposed by us in Part II of this study all lead to largely the same conclusions for competition policy. Measures of concentration and of dominance therefore provide useful indices of whether or not a dominant position exists. These indices must then be scrutinized by applying a market structure and market conduct test so as to establish whether the threat to competition which they suggest does actually exist, especially since all values for the concentration indices usually depend on whether the relevant market is defined narrowly or broadly.

2. Examination of various empirical studies on the evolution of concentration

In the 1970s, the Commission of the European Communities had a series of studies carried out on the evolution of concentration in various industries. The measures of concentration and dominance proposed in Part II will be examined below in the light of some of these studies to see how useful they are in determining market power; the studies selected are those on the tyre, computer, ice-cream and coffee markets.

(a) Study of the evolution of concentration in the tyre industry in the Federal Republic of Germany[1)]

(1) Preliminary remarks

In June 1975 the Commission asked the consultancy firm "Kienbaum Unternehmensberatung" to carry out an investigation into concentration in the tyre industry. Since the information directly available was scant and imprecise, a small-scale survey was carried out among the tyre manufacturers in the Federal Republic of Germany using a questionnaire that asked for:

- information on the firm;
- figures (sales, employment, wages and salaries and gross investment);
- supplementary details.

In addition, five interviews were carried out with executives from:

- Continental AG, Hannover,
- Dunlop AG, Hanau,
- Metzeler Kautschuk AG, Munich,
- Phoenix AG, Hamburg,
- Veith-Pirelli AG, Breuberg/Odenwald.

Additional information was obtained from newspaper reports and other publications.

(2) Definition of the relevant market

The relevant product market was defined as the original equipment and replacement market in new tyres. Geographically, the study was confined to the Federal Republic of Germany. The statistics were completed in October 1976 and cover developments from 1968 to 1975.

The principal suppliers on the relevant product and geographic market were:

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1) Commission of the European Communities, "Untersuchung der Konzentrationsentwicklung in der Reifenindustrie sowie ein Branchenbild der Kraftfahrzeug-Elektrikindustrie in Deutschland", produced by Kienbaum Unternehmensberatung GmbH, Gummersbach.

References to this study are made by indicating page numbers in brackets.

- Continental
- Dunlop
- Goodrich
- Goodyear/Fulda
- Kleber
- Metzeler
- Michelin
- Phoenix
- Uniroyal
- Veith-Pirelli

(3) Concentration and competition in the tyre industry

The German tyre market may be described as an oligopoly; Michelin is in a relatively strong position with 23% of the market, followed by Continental with 18%. The other market shares range between 2% and 11%. Imports by outsiders amounted to 12%.

Despite the economic and financial strength of their parent companies, by 1975 the American firms had not managed to achieve a pre-eminent position on the market, although, with the exception of Goodrich, they had been established in the Federal Republic for well over ten years. Towards the end of the period, powerful foreign groups such as Firestone, General Tyre, Semperit, Ceat, Vreedestein and Trellenbog, were entering the new tyre market as importers, providing serious competition for existing suppliers.

Horizontal financial links were relatively few amongst the tyre manufacturers. In the case of vertical links, Continental stood out with holdings of up to 100% in numerous tyre distributors. Looking at the suppliers of the tyre manufacturers, the two joint ventures "Deutsche Gasrusswerke" and "Drahtcort Saar" had financial

links with a number of tyre manufacturers. In 1974 the Bayer chemicals group acquired full ownership of Metzeler.

As far as can be seen from the study, there was clearly effective competition on the German tyre market in the 1970s; this is indicated in particular by:
- excess capacities in the face of stagnating demand,
- relatively strong competition from outsiders and imports.

In view of the influence of these conditioning factors, the oligopolistic structure must therefore be regarded as relatively loose.

(4) Testing the measures of concentration and dominance proposed in Part II: the tyre industry

An analysis of the relevant market in new tyres by Kienbaum Unternehmensberatung revealed the following individual market shares (= p) for 1974[1]:

p_1 = 23%	p_6 = 6%
p_2 = 18%	p_7 = 5%
p_3 = 11%	p_8 = 5%
p_4 = 9%	p_9 = 2%
p_5 = 7%	p_{10} = 2%

The remaining market shares were held by various tyre importers, and these "outsider imports" amounted to a total of 12%.

The concentration analysis (see Table 12) may be summarized as follows:

- The Herfindahl index H, at 12, indicates moderate concentration,
- However, a look at the concentratition ratios shows that there is a relatively high level of overall concentration, with CR_4= 61% and CR_8= 84%,
- Disparity is relatively small among the four largest firms, but more marked among the eight largest firms.

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1) Estimates.

Table 12: Measures of concentration* for the tyre industry

Indices		Values
Summary measures of concentration (x100)	H	12.0 - 12.2
	E	6.4 - 9.2
Concentration ratios (%)	CR_1	23
	CR_4	61
	CR_8	84
Mean dominance	L_4^*	1.9
	L_8^*	2.6
Threshold values	k_A	2
	k_H	2
	k_L	8

* See footnote to Table 5.

- The threshold values of $k_A = k_H = 2$ and $k_L = 8$ show the partially oligopolistic structure of the market, though it is not possible to draw a clear dividing line between the oligopolistic group and the remaining group applying statistical procedures alone. The distribution of market shares would tend to suggest that $k_L = 8$ is the most appropriate value.

The market may be described as a partial oligopoly with two or eight oligopolists whose market shares are relatively uniformly disturbed in the case of the group of two, but unevenly distributed in the case of the group of eight. However, this analysis

is not sufficient for the purposes of assessing the competitive situation on the tyre market; other conditioning factors have to be taken into consideration. As a result it was found that, for the reasons stated in section (3), the tyre market in the 1970s was highly competitive.

(b) Study of the evolution of concentration in the data-processing industry (hardware) in the United Kingdom[1)]

(1) Preliminary remarks

At the Commission's request, Gareth Locksley of the Polytechnic of Central London carried out an investigation into the development of concentration in the data-processing industry (hardware and software) in the United Kingdom in the period 1970-77. Since multinational enterprises play a key role in the data-processing industry, the study of the British industry was supplemented by international analyses focusing in particular on the markets in the United States and Western Europe. The data on individual firms were taken from their annual reports. Since almost all the firms refused to provide more detailed information, the subdivision of the data-processing industry into the relevant submarkets was along very approximate lines. Locksley confines the breakdown to "hardware and related software" on the one hand, and "computer software and services" on the other. Only the first of these sectors will be looked at below.

(2) Definition of the relevant market

Because of the difficulties described, it was not possible to break the hardware market down into relevant sub-markets. "Hardware and related software" therefore comprises the following groups:

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1) Commission of the European Communities, "A Study of the Evolution of Concentration in the U.K. Data Processing Industry With Some International Comparisons", Evolution of Concentration and Competition Series: Collection: Working Papers, No. 15, compiled by G. Locksley, Brussels 1980.

References to this study are made by indicating page number in brackets.

- mainframe computers
- minicomputers
- small business computers
- peripherals (terminals, data collection equipment, printers, etc.)
- storage media.

Table 13 shows the shares of the leading manufacturers in the value of all installed systems in three market areas (p. 100):

Table 13: Percentage shares of the leading manufacturers (5% minimum share) in the value of all installed systems (U.K. 1977)

Main-frame computers		Minicomputers		Small business computers	
IBM	40.2%	DEC	28.3%	ICL	29.6%
ICL	35.1%	GEC	17.0%	Burroughs	9.9%
Honeywell	8.5%	Ferranti	10.8%	NCR	8.5%
Burroughs	6.6%	Honeywell	6.6%	Olivetti	7.2%
		Data General	6.1%	IBM	6.6%
		CTL	5.3%		

Important strutural differences are evident here, though they cannot be ascertained quantitatively with the available material. Because the relevant product market is defined too broadly, actual concentration on the relevant markets for individual data-processing products tends to be understated.

The relevant geographic market is the United Kingdom. This delimitation seems justified despite the high degree of international integration since the large multinational firms have

British subsidiaries and since the market, like other national markets, is subject to government intervention.

The investigations relate to the period 1970-77 and covered twenty-three undertakings (p. 99):

- Business Computers Ltd (withdrew from the market in 1972)
- Burroughs
- Commodore Business Machines
- Computer Technology Ltd
- Control Data
- Data Dynamics
- Data General (entered the market in 1971)
- Data Recording Instruments Ltd (entered the market in 1971)
- Digico Ltd
- Digital Equipment Co
- GEC Computers Ltd (entered the market in 1973)
- Hewlett-Packard
- Honeywell Information Systems
- IBM
- ICL
- ITT Creed (entered the market in 1972)
- Kalamazoo Ltd
- Philips Data Systems (entered the market in 1971)
- Prime Computers Ltd (entered the market in 1974)
- NCR
- Redifon (entered the market in 1972)
- Sperry Rand Univac
- Systime Ltd (entered the market in 1974).

Table 14: Data processing (hardware and software) in the United Kingdom
Market share structure (sales in %) 1970-77
Firms with a market share of over 1% [1]

Share \ year	1970	1971	1972	1973	1974	1975	1976	1977
p_1	37.2	32.6	38.3	41,8	42.6	41.1	41,9	38.6
p_2	23.0	28.9	27.4	25.4	24.8	24.9	24.5	27.9
p_3	15.6	12.1	8.2	7.9	8.1	7.5	7.2	7.2
p_4	10.7	8.4	8.0	6.8	7.2	7.4	5.6	5.1
p_5	4.8	6.4	5.3	4.5	4.1	4.1	3.9	3.9
p_6	2.9	2.5	2.6	2.5	2.4	2.4	3.1	3.4
p_7	1.6	2.2	2.1	1.9	2.2	2.3	2.8	3.4
p_8	1.5	1.5	1.7	1.5	1.8	1.7	1.6	1.2
p_9		1.4	1.4	1.5	1.4	1.5	1.4	1.2
p_{10}		1.3	1.3	1.4	1.3	1.4	1.3	1.2
p_{11}			1.2			1.1	1.2	1.2
p_{12}							1.1	1.1
Total number of firms surveyed	15	18	19	20	22	23	23	23

[1] The figures were kindly made available to us by Mr. Locksley via Directorate-General IV.

(3) Concentration and composition in the data-processing industry

In the United Kingdom as elsewhere, the data-processing market is significantly influenced by IBM, which has a market share of some 40%. Thanks to government policy on data-processing, the British company ICL has a relatively strong counter-position with a market share of approximately 25%. The market can therefore be described as a duopoly with a residual group. Both ICL and IBM have diversified within the broad field of data-processing and have significant holdings in the software sector in particular.

The conduct of IBM's competitors is quite aggressive and competitive (p. 6). However, IBM's dominant position is reflected in its market performance: economies of scale both in production and in marketing enable it to achieve distinctly higher profit-sales ratios than ICL.

Table 15: Profit-sales ratios of IBM and ICL in the United Kingdom, 1970-77
(pre-tax profits/sales in %)

Firm \ Year	1970	1971	1972	1973	1974	1975	1976	1977
IBM	19.13	21.18	17.15	19.32	17.51	18.25	17.57	19.04
ICL	7.35	5.69	2.13	6.46	6.68	6.75	8.01	7.23

Despite limited comparability, particularly as regards the figures for profits, it is evident from Table 15 that IBM is distinctly more profitable than ICL. The fairly small fluctuations in market shares between 1970 and 1977 (see Table 14) indicate a low degree of dynamism and are a further indicator that effective competition is threatened.

Table 16: Measures of concentration for the data-processing market (hardware and software) in the United Kingdom, 1970-77 (variable: sales)*

Indices \ Year		1970	1971	1972	1973	1974	1975	1976	1977
Summary measures of concentration (x100)	H	23.0	21.8	24.0	25.4	25.9	24.6	24.9	24.0
	E	17.2	15.6	15.9	15.9	16.2	15.0	14.8	14.6
Concentration ratios (%)	CR_1	37.2	32.6	38.3	41.8	42.6	41.1	41.9	38.6
	CR_4	86.3	82.1	81.9	81.9	82.7	80.8	79.2	78.8
	CR_8	97.1	94.7	93.5	92.3	93.8	91.3	90.5	90.7
Mean dominance**	L_4^*	2.3	2.6	3.3	3.8	3.7	3.6	4.3	4.4
	L_8^*	7.4	6.8	7.1	7.9	7.4	7.2	7.2	7.1
	L_r^*	32.3	33.1	13.4	10.8	15.1	10.5	8.8	8.3
Threshold values	k_A	4	2	2	2	2	2	2	2
	k_H	3	2	2	2	2	2	2	2
	k_L	4	2	2	2	2	2	2	2

*) Calculations by Locksley and our own calculations.

**) L_r^* was determined in accordance with the threshold value k_L.

(4) Testing the measures of concentration and dominance proposed in Part II: the data-processing industry

The measures of concentration put forward on page 41 are presented in Table 16 for the period 1970-77. The concentration analysis may be summarized as follows:

- Overall concentration, as measured by the Herfindahl index H, is very high at over 20 and fluctuates only slightly. The exponential index too is relatively high but is tending downwards owing to the stronger influence of small new entrants.
- The concentration ratios also indicate a high degree of market concentration, with the importance of the four or eight largest firms decreasing slightly but still remaining very great with almost 80% or 90% market share.
- The disparity among the four largest firms is considerable and shows a rising trend attributable primarily to the stronger growth of the two largest firms compared with the others. The disparity in the remaining group is very large and is due primarily to very small forms.
- From 1971 onwards, the duopolistic structure of the market emerges clearly; this is shown by the threshold values $k_A = k_H = k_L = 2$[1].

The market can therefore be described as a very tight partial duopoly (IBM and ICL) with some 20 smaller firms. Owing to the lack of a more detailed market breakdown, no conclusions can be drawn as to the importance of the small firms, e.g. on the market

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1) The determination of the minima of the Linda index curves differs from the calculations of Locksley, who does not include any boundary minima. His procedure results as a rule in induly large oligopolistic nuclei which do not properly reflect the existing duopolistic structure.

for minicomputers. To this extent, the study makes clear the need need for an exact market definition if measures of concentration and dominance are to be meaningfully applied.

(c) Study of the evolution of concentration in the ice-cream industry in the Federal Republic of Germany [1)]

(1) Preliminary remarks

As part of the programme of studies on the evolution of concentration and competition in selected sectors and markets, the Commission asked the IFO Institute in Munich to carry out a study of the development of concentration in selected branches and product groups in the German food industry. The study, compiled by M. Breitenacher, included an investigation of the ice-cream industry in the Federal Republic of Germany.

The follow-up study which the Commission subsequently asked C. Marfels to carry out is a revised and updated version of the Breitenacher study.

(2) Definition of the relevant market

The ice-cream industry is part of the confectionary industry. Ice-cream is subdivided into three types:

- proprietary brand ice-cream (industrially produced ice-cream),
- non-industrial ice-cream,
- soft ice-cream.

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1) Commission of the European Communities, "Untersuchung zur Konzentrationsentwicklung in ausgewählten Branchen und Produktgruppen der Ernährungsindustrie in Deutschland", compiled by M. Breitenacher, Brussels 1976, pp. 70 et seq. and 82 et seq.; Commission of the European Communities, "A Study on Evolution of Concentration in the Food Industry of the Federal Republic of Germany", Evolution of Concentration and Competition Series: Collection: "Working Papers", No. 14, compiled by C. Marfels, Brussels, 1980, pp. 122-129.

References to the Marfels study are made by indicating page numbers in brackets.

The study on the development of concentration in selected branches dealt only with manufacturers of propriety brand ice-cream, probably accounting for some 70% of the total ice-cream market.

The relevant geographic market was the Federal Republic of Germany. The main suppliers on the relevant market were:

- Dr. Oetker Eiskrem GmbH
- Langnese-Iglo GmbH
- Milchhof/Moha Group
- Milchwerke Wesermarsch eGmbH
- Schöller Lebensmittel GmbH & Co. KG
- Südmilch/Efa-Group
- Warncke Eiskrem KG.

(3) Concentration and competition in the ice-cream industry

The ice-cream industry is the most highly concentrated part of the food industry. The high level of concentration results from a wave of mergers in the 1970s and the elimination of smaller producers from the ice-cream market. The two main mergers were:
- Südmilch/Efa Eiskrem (1973)
- Südmilch/Schöller (1978).

The latter two had already been operating as a joint venture since 1976. The number of suppliers fell on the relevant market from 16 to 14.

The German ice-cream market in 1977 may be described as a tight oligopoly with Langnese the market leader (44.7% market share). Langnese is owned by two financially powerful groups, Unilever (75%) and Nestle (25%). The three next largest suppliers, Schöller/Südmilch (30.5%), Dr. Oetker (9.1%) and Moha GmbH (4.8%) together have a smaller market than the market leader.

(4) Testing the measures of concentration and dominance proposed in Part II: the ice-cream industry

An analysis of the relevant market in ice-cream revealed the following individual market shares (= p; in %):

Table 17: Market share structure on the ice-cream market in the period 1970 to 1977

Share \ Year	1970	1972	1974	1977
p_1	48.3	45.3	46.5	44.7
p_2	18.6	16.6	19.5	30.5
p_3	6.9	10.3	11.6	9.1
p_4	5.6	8.9	9.3	4.8
p_5	5.2	5.7	5.5	4.4
p_6	4.1	3.8	3.6	)
p_7	)	2.3	)	) 6.5
Others	) 11.3	7.0	) 4.0	)
Total number of firms	16	15	15	14

The concentration analysis (see Table 18) may be summarized as follows:

- The values of the Herfindahl index H, ranging between 25 and 31 over time, indicate a very high level of concentration.
- The concentration ratios are also very high. CR_1 at almost 50% points to the existence of a market leader, with the second largest firm having come relatively close to the market leader in 1977. The share of the four largest firms rose from some 80% to 90% by 1977.

Table 18: Measures of concentration* for the ice-cream industry 1970-77 (Variable: sales)[1)]

Indices \ Year		1970	1972	1974	1977
Summary measures of concentration (x100)	H	28.1 - 28.5	25.7 - 25.8	28.1 - 28.2	30.6 - 30.8
	E	16.5 - 18.9	16.3 - 17.4	19.4 - 20.9	21.4 - 23.7
Concentration ratios (%)	CR_1	48.3	45.3	46.5	44.7
	CR_4	79.4	81.1	86.9	89.1
	CR_8	91.0 - 96.9	93.8 - 95.2	96.9 - 100	95.7 - 100
Mean dominance	L_4^*	4.8	3.2	3.1	4.8
Threshold values	k_A	2	1	1	2
	k_H	1	1	1	2
	k_L	2	6	5	2

* See footnote to Table 5.

1) The figures given by Marfels (p. 28) substantially overestimate the Herfindahl and exponential indices.

- The disparity among the four largest firms is relatively high, as L_4^* shows.
- The threshold values of k_A and k_H demonstrate the existence over time of a dominant single firm and dominant duopolistic group.

The market in industrially manufactured ice-cream is one of the most highly concentrated markets in the Federal Republic of Germany. However, in contrast to the two previous market studies, the purely quantitative figures do not allow any conclusion to be drawn as to whether the market is characterized by effective competition or by an actual restriction of competition.

(d) Study of the evolution of concentration in the coffee market in the Federal Republic of Germany[1)]

(1) Preliminary remarks

As part of the programme of studies on the evolution of concentration and competition in selected sectors and branches, the Commission asked Christian Marfels, Professor at Dalhousie University in Canada, to carry out a study of the development of concentration in selected branches and product groups in the German food industry. The study included an investigation of the coffee market in the Federal Republic of Germany.

(2) Definition of the relevant market

Coffee is part of the "coffee and tea" branch of the food industry, and the coffee market may be divided into three sub-markets with the following shares in 1977:

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1) Commission of the European Communities, "A Study on Evolution of Concentration in the Food Industry of the Federal Republic of Germany", Evolution of Concentration and Competition Series: Collection: "Working Papers", No. 14, compiled by C. Marfels, Brussels 1980, pp. 175-191.

References to this study are made by indicating page numbers in brackets.

- roast coffee (85.1%)
- instant coffee (13.6%)
- coffee surrogates (1.3%).

In the Marfels study, the relevant product market comprises all the product types whose raw material basis is coffee. These include:

- roast coffee
- instant coffee

with the study assuming that the substitution relationships between the two are so close that they must be regarded as serving the same market.

The study, which is based on figures for the period from 1970 to 1977, focuses on the Federal Republic of Germany as the relevant geographic market. The main suppliers on the relevant market were:

- Albrecht
- A. Dallmayr
- J.J. Darboven
- Deutsche Nestle GmbH
- Eduscho E. Schopf GmbH & Co. KG
- General Foods GmbH
- Hag AG
- J. Jacobs & Co. KG
- Melitta-Werke Bentz & Sohn
- Tchibo Frisch-Röst-Kaffee Max Herz KG.

(3) Concentration and competition in the coffee processing industry

The ranking of the leading coffee processors remained unchanged during the period from 1970 (Jacobs, Tchibo, Eduscho, Kaffee Hag)[1]. The market share of the three largest firms on the overall coffee market (roast coffee and instant coffee) fell from 55% in 1970 to 44% in 1977. By contrast, these three firms increased their share on the roast coffee sub-market during the same period from 52% to 55%.

1) During the period 1970-77, Jacobs, the market leader, had only a slight lead over Tchibo, the next largest firm.

Jacobs is the only firm that was strong, both on the roast coffee market and on the instant coffee market (21% and 22% market shares respectively in 1977). Nestle and General Foods operate on the instant coffee market only (with market shares of 40% and 10% respectively in 1977). The market leader in instant coffee is Nestle. The market share of the three largest suppliers of instant coffee (Nestle, Jacobs and General Foods) rose from 63% in 1970 to 73% in 1977.

The most important event for the coffee processing industry was the abolition of resale price maintenance in 1973. Strong competition among coffee processors and the sale of leading brands through discount stores boosted coffee consumption, but at the same time resulted in a decimation of producers.

Horizontal links are not of major importance on the coffee market, but vertical integration in the case of the three largest suppliers is at a relatively advanced stage: Jacobs has a fleet of some 1.3000 vehicles supplying supermarkets and discount stores. Tchibo has more than 500 special Tchibo coffee shops and sells about 50% of its coffee through these. Eduscho has at present about 460 Eduscho coffee shops in the Federal Republic of Germany.

In sales of decaffeinated coffee, Kaffee Hag is the market leader with a market share of 56% in 1977. Since 1979, 95.5% of its shares have been held by General Foods.

(4) Testing the measures of concentration and dominance proposed in Part II: the coffee processing industry

An analysis of the relevant market in coffee revealed the following individual market shares (= p; in %):

Table 19: Market share structure on the coffee market in the period 1970 to 1977

Share \ Year	1970	1972	1974	1977
p_1	22.4	22.4	19.6	16.9
p_2	20.5	20.5	18.5	16.0
p_3	11.7	11.5	12.5	11.4
p_4	10.6	10.9	10.3	7.8
p_5	7.3	8.3	9.1	5.8
p_6	3.8	5.2	4.8	5.6
p_7	3.7	4.0	4.3	2.9
p_8	1.8	2.4	4.1	1.7
p_9	13.7	1.8	2.5	1.7
p_{10}		13.0	2.4	1.7
			11.9	28.5

The concentration analysis (see Table 20) may be summarized as follows (p. 190):

- The values of the Herfindahl index H, ranging between 8 and 13, point to moderate concentration.
- The concentration ratios for CR_4 and CR_8 indicate an oligopoly, especially since CR_1 is not particularly great. Both the Herfindahl index and the concentration ratios show a distinctly downward trend over time.
- The measures of dispaity L_4^* and L_8^* similarly show a slightly falling trend over time, indicating increasing symmetry in the oligopolistic group.

Table 20: Measures of concentration for the coffee processing industry 1970-77 (variable: sales)

Indices \ Year		1970	1972	1974	1977
Summary measures of concentration (x100)	H	12.6 - 12.8	13.0 - 13.2	11.4 - 11.7	8.2 - 8.6
	E	7.4 - 10.9	6.7 - 9.7	6.3 - 9.2	2.6 - 5.8
Concentration ratios (%)	CR_1	22.4	22.4	19.6	16.9
	CR_4	65.2	65.3	60.9	52.1
	CR_8	81.8	85.2	83.2	68.1
Measures of disparity	L_4^*	1.7	1.7	1.9	1.7
	L_8^*	4.1	3.5	2.7	3.6
Threshold values	k_A	2	2	2	3
	k_H	4	4	5	4
	k_L	5	5	5	6

- The threshold values range between 2 and 6, indicating a tight oligopoly with a duopolistic nucleus.

Though the concentration ratios of CR_4 = 52.1% and CR_8 = 68.1% in 1977 are relatively high, the market considered as a whole was competitive. This is indicated by the substantial loss of market shares by the leading firms and the increasing importance of the other firms. A look at the two sub-markets shows:

- a virtually unchanged level of concentration in the roast coffee market and
- a sharp increase in concentration in the instant coffee market.

These differences of development provide further evidence of the need for an exact definition of the relevant market.

Summary and conclusions for Community competition policy

1. Summary of reflections on competition theory and competition policy

Effective competition is determined by the characteristics of market structure, market conduct and market performance. The approach that has come to be adopted in US, German and Community competition policy in assessing the competition process is to apply a combination of structural and behavioural criteria; in so doing, greater emphasis is placed on the structural approach (e.g. for merger control) or on the behavioural approach (e.g. in dealing with predatory pricing or refusal to sell), depending on the rationale of the individual legal provision concerned.

Under the structural approach, particular importance attaches to the number of suppliers and to the size distribution of market shares. This market structure aspect is determined quantitatively by measuring the level of concentration.

The intensity of competition also depends on a fairly large number of conditioning factors and on actual market conduct. Analysis of the links between the morphological factor and intensity of competition is justified firstly by the particular importance and weight of the morphological factor in the market structure test (justification from the competition theory angle) and secondly by considerations regarding its operational and justiciable aspects (justification from the competition policy angle).

In price and competition theory, the significance of a rise in the level of concentration lies in the danger of an increasing symmetry of interests. Empirical studies and theoretical analysis reveal that beyond a specified level of concentration, it is possible and advantageous for the leading firms to pursue joint profit maximization rather than individual profit maximization as usually assumed in price theory. There is therefore

the danger that, above the specified level of concentration, firms may change their objectives and pursue a collective pricing policy on the basis of a quasi-agreement[1] involving either contract-like obligations falling within Article 85 of the EEC Treaty, or de facto parallel conduct based on group discipline or price leadership falling within Article 86 of the EEC Treaty. The market performance resulting from such conduct is no longer competitive.

Any further rise in the level of concentration creates a dominant position for a single firm which has wide room for manoeuvre vis-a-vis its competitors and is no longer controlled by effective competition, the ultimate stage being partial monopoly or full monopoly.

However, the main problem for competition policy today is not dominant positions held by individual firms, but those held by groups of firms which jointly control the market.

These price and competition theory notions, whereby a growth in concentration is seen as a threat to competition, have been examined empirically in a number of investigations (e.g. by Bain, Mann and Weiss); these showed the critical thresholds to be CR_4 = 50% and CR_8 = 70%. In view of the influence of the other conditioning factors, the critical level of concentration on individual markets does of course vary upwards or downwards, indicating that

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1) On joint profit maximization objectives with joint pricing policies, see in particular William FELLNER, "Competition Among the Few", New York 1949. According to this concept, oligopolists try to maximize profits jointly by setting a (joint) "monopoly price" and jointly selling the "monopoly puantity". The joint profits to be shared out amongst the individual oligopolists (distribution problem) is greater than the sum of individual profits in the case of individual profit maximization.

there is no exact link between market performance and concentration. Consequently, the only link that can be said to exist between the level of concentration and the effectiveness of competition is that competition is threatened as concentration increases. This formulation also covers the possibility of distortion in individual cases and focuses only on typical links, which in addition vary with the branch structure.

In attempting, on the sole basis of the size distribution of market shares, to find adequate measures of concentration for the purposes of identifying market structures that threaten competition, the following points are of importance:

- The measures of concentration used should have generally recognized properties; thus, for example, the level of concentration identified should rise where mergers occur and where the market share of a large firm increases at the expense of a smaller firm. However, in certain areas (e.g. transformation of an oligopoly that tends to be asymmetrical into a symmetrical oligopoly with spontaneously-coordinated conduct), it must be supposed that competition intensifies as the level of concentration rises; use of the concept of concentration is to that extent neutral as regards competition.
- Particular importance must be attached to the largest firms in determining overall concentration in a market; it is for this reason that the Herfindahl index is proposed.
- Measures of dominance must be used to distinguish any nucleus of dominant firms from other firms so as to capture any oligopolistic or partially monopolistic structures.
- Where the concept of individual power is applied, indications must be given of the market share of the largest firm and the gap between it and the market share of the other firms as well as the degree of unevenness in the distribution of market shares (disparity).
- Where the group power concept is applied, the market share of the nucleus group or of the four and eight largest firms must be indicated; in addition, the degree of unevenness in the market shares of these firms and the gap between them and the market shares of the other firms not belonging to the nucleus

group must be determined plus the degree of unevenness in the market shares of such other firms (disparity).

For the purposes of ascertaining and defining critical market structures, therefore, the following statistical characteristics should be determined under the Commission's existing programme of concentration analyses:

Indices	Critical Values
Summary measures of concentration Herfindahl index H (x100)	10
Concentration ratios (%) CR_1 CR_4 CR_8	35 50 70
Mean dominance L^*_4 L^*_8 $L^*_{r/8}$	Small values ($\geqq 1$) and Large values
Threshold values k_A, k_H, k_L possibly: $CR_{k.}$, $L^*_{k.}$	$\leqq 10$

- The Herfindahl index indicates the overall concentration of the market investigated; here, a value of 10, which means an oligopoly with ten suppliers of equal size, is to be regarded as critical.
- To establish the importance of the one, four and eight largest firms, the relevant concentration ratios are given; critical values here are 35%, 50% and 70%.

- The unevenness of market share distribution among the largest firms may be assessed with the help of the mean dominance indices L_4^* and L_8^*. Low values here indicate symmetry of interests, while very high values indicate clear dominance by individual firms. Both these situations are undesirable from a competition policy point of view. However, it is difficult to specify exact figures for the critical areas. If all the market shares are known, the mean dominance for the remaining group L_r^* may also be shown.

- Threshold values of 10 or less suggest, in the case of a high level of concentration, that oligopolistic nuclei may be distinguished. Where an oligopolistic group may be clearly identified, the relevant market share and the mean dominance in the nucleus may also be indicated.

2. Early detection of structures that threaten competition

(a) Market structure and market phase

In ascertaining whether or not structures exist that threaten competition, reference must be made to the market in the expansionary phase, since there may still be effective competition during such a phase even in a duopolistic situation; in the long run, all markets as a rule enter a phase of stagnation or contraction in which the number of suppliers (morphology) takes on greater importance.[1)]

Consequently, policy on concentration should, as part of long-term regulatory policy, focus on that number of firms which experience shows to be the minimum necessary on stagnating markets in order to maintain effective competition. Otherwise, it would be necessary to split up firms during the stagnation phase in the interests of restoring the morphological conditions for effective competition.

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1) On the links between competition and market phase, see Ernst HEUSS, "Allgemeine Markttheorie", Tübingen, 1965.

(b) Competition policy must seek to prevent concentration from reaching a critical level

In addition, concentration must be prevented in good time from reaching the critical level so as not to jeopardize the effetiveness of competition. A concentration policy that allows mergers to take place up to the threshold of market dominance within the meaning of Section 22 of the German Act against Restraints of Competition or of Article 86 of the EEC Treaty falls short on competition policy grounds, since the slightest change in market structure (e.g. through disproportionately strong internal growth or a change of market phase) would tip the balance, transforming a market structure that was still just about competitive into one that was no longer competitive[1].

3. To what extent does a high level of concentration indicate restriction of competition?

On the question of whether and to what extent a high level of concentration indicates restriction of competition, empirical studies permit the following conclusions:

- Measures of concentration and dominance are fairly indicative where there is a single dominant firm (individual power concept). If a firm has, for example, a 40% market share and the next largest a significantly smaller market share, reflected in a threshold value of 1, a dominant position is highly probable.

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1) BARTLING, op. cit., p. 84: "The fact that (applying the market dominance criterion as defined in Section 22 of the German Act against Restraints of Competition) mergers may be prohibited at much too late a stage becomes apparent if, on the basis of statutory criteria for presuming dominance one calculates the number to which competitors may without hindrance be reduced through mergers. Market dominance is presumed under Section 22(3) of the German Act against Re-Restraints of Competition where a single firm has a market share of one third or more, or three firms have a combined market share of 50% or more, or five firms have a combined market share of two thirds or more. This means that, through mergers, a market share of up to two thirds could be concentrated on the five largest firms, and the remaining third could be shared amongst another three firms, with the result that the number of firms could be reduced to eight without any measures having to be taken to prevent such concentration under present merger control arrangements. It is obvious that, where there are only eight firms, learning processes easily occur in the competition area which ultimately lead to parallel conduct based on spontaneous coordination".

- However, measures of concentration and dominance are obviously less indicative in the case of oligopolistic groups, since the influence of the other conditioning factors is greater than in the case of a single dominant firm: competition is less likely to be threatened in such market structures (cf. the empirical analysis of the tyre and coffee markets where, despite high values for the concentration ratio and Herfindahl index, substantial competition existed.

4. Recommendations for Community competition policy

In the light of the investigation carried out in Part III into the suitability of measures of concentration and dominance for competition policy purposes, it would seem advisable for horizontal mergers within the European Community to be assessed as follows:

(a) It should be possible to prohibit mergers where there is a threat of a substantial impairment of effective competition within the common market or in a substantial part of it.

(b) In accordance with the conclusions of Part III of the study, the threat of a substantial impairment of effective competition could be defined as regards its operational and justiciable aspects using measures of concentration and dominance.

A threat of a substantial impairment of effective competition should be assumed where:

(1) a firm acquires through a merger a market share of one third or more and
(2) the next largest firm has less than a quarter of the market share of the leading firm, or where:

(3) the group comprising the four largest firms acquires through a merger a market share of 50% or more or
(4) the group comprising the eight largest firms acquires through a merger a market share of 70% or more.

In cases (3) and (4), account must be taken of any oligopolistic nuclei revealed using measures of dominance; i.e. the oligopolistic nucleus may vary in tightness or looseness from case to case.

The following in particular are arguments for using rebuttable legal presumptions based on measures of concentration and dominance:

- In view of the difficulties in defining the relevant product market, use of measures of concentration and dominance involves uncertainties.
- The influence of the other conditioning factors may be so strong as to ensure effective competition despite a high level of concentration.

The level at which the critical measures of concentration and dominance are set should depend on whether the relevant geographic market is to be the whole of the common market or only a substantial part of it; that is to say, the wider the definition of the relevant geographic market, the lower the relevant critical values selected may be.

(c) In the interests of legal certainty, the obligation to notify mergers should be based on absolute criteria. Under this obligation, firms would have to provide information on their own market positions, allowing the Commission to decide whether or not there was a danger of a substantial impairment of effective competition.

Annex: Formulae used in the statistical measurement of concentration

1. Basic concepts

Values of variable: $x_i \quad (x_i \geq x_{i+1}) \quad i = 1,\ldots,n; \; x_{n+1} \equiv 0$

Population total: $$X = \sum_{i=1}^{n} x_i = n\mu$$

Relative values of variable: Market shares $$p_i = \frac{x_i}{\sum_{i=1}^{n} x_i} = \frac{x_i}{X} = \frac{x_i}{n\mu}$$

Size distribution of all market shares:

$$p = (p_1, p_2 \ldots, p_n)$$

Size distribution of the market shares of the m largest firms:

$$p' = (p_1 \ldots, p_m)$$

Uniform distribution:

$$p = (\tfrac{1}{n}, \ldots, \tfrac{1}{n})$$

Uneven distribution:

$$p = (1, 0, \ldots, 0) \quad .$$

Measure of concentration: $K(p,n)$

Measure of disparity: $D(p,n)$

(1) $$K = K(D,n)$$

Disparity effect:

$$\frac{\Delta K}{\Delta D} > 0$$

Number effect:

$$\frac{\Delta K}{\Delta n} < 0 \quad .$$

Lorenz curve:

(2) $$H_j = \frac{j}{n} \longrightarrow L_j = \sum_{\nu=1}^{j} p_{n-\nu+1} \quad , \quad H_0 = L_0 = 0 \quad .$$

Concentration curve:

(3) $$i \longrightarrow C_i = \sum_{\nu=1}^{i} p_\nu$$

Relationship between Lorenz curve and concentration curve:

$$(4) \qquad i = n(1-H_j) \quad , \quad C_i = 1 - L_j$$

2. Properties of concentration measures

According to JOHNK (1970), measures of concentration and disparity can be described by reference to a few characteristic properties.

Standardization:

$$(5) \qquad 0 \leq K,\ D \leq 1$$

Principle of transfers:

Transfer vector $\Delta = (0,\ldots,+\varepsilon,\ldots,-\varepsilon,\ldots,0)$

$$(6) \qquad K(p+\Delta) \gtrless K(p) \quad , \quad D(p+\Delta) \gtrless D(p) \quad \text{for} \quad \varepsilon \gtrless 0$$

In addition to this strong principle of transfers, a weak principle of transfers (with equal-signs) is also considered.

Proportionality test (replication):

Size distribution in the case of proportional breakdown

$$p_c = \left(\frac{p_1}{c}, \ldots, \frac{p_1}{c}, \ldots\ldots\ldots, \frac{p_n}{c}, \ldots \frac{p_n}{c}\right)$$

$$(7) \qquad K(p_c) = \frac{1}{c} K(p) \quad , \quad D(p_c) = D(p) \quad .$$

Supplementary test:

Size distribution in the case of addition - incorporation of $(c-1)n$ zero-size units.

$$(8) \qquad K(p_e) = K(p) \quad , \quad D(p_e) = 1 - \frac{1}{c}[1-D(p)] \ .$$

Measures which display these four properties and are continuous in p are referred to as:

Uniformly standardized measures:

Symmetry is achieved by introducing a measure of equality

$$(9) \qquad G(p) = 1 - D(p)$$

Proportionality test and supplementary test:

$$(10)\qquad \begin{cases} K(p_c) = \frac{1}{c}\,K(p) & G(p_c) = G(p) \\ K(p_e) = K(p) & G(p_e) = \frac{1}{c}\,G(p) \end{cases}$$

The following in particular applies for $c \to \infty$: $K(p_c) \to 0$, $G(p_e) \to 0$

$$(11)\qquad nKG = nK(1-D) = 1$$

Conversion formula - Special case of (1):

$$(12)\qquad K = \frac{1}{nG} = \frac{1}{n(1-D)}$$

Disparity effect and number effect:

$$(13)\qquad \Delta K \approx \frac{1}{n(1-D)^2}\,\Delta D - \frac{1}{n^2(1-D)} \cdot \Delta n$$

$$(14)\qquad \frac{\Delta K}{K} \approx \frac{\Delta D}{1-D} - \frac{\Delta n}{n} \quad .$$

Standardization:

$$(15)\qquad \frac{1}{n} \le K \le 1 \quad , \quad 0 \le D \le 1 - \frac{1}{n} \quad .$$

"Numbers Equivalent" = minimum number of units; equal distribution yields a value of concentration K.

$$(16)\qquad n \ge \frac{1}{K}$$

Impact of mergers:

$$(17)\qquad K_f > K \quad , \qquad D_f \gtrless D \quad .$$

Geometrical interpretation of the properties of uniformly standardized measures:

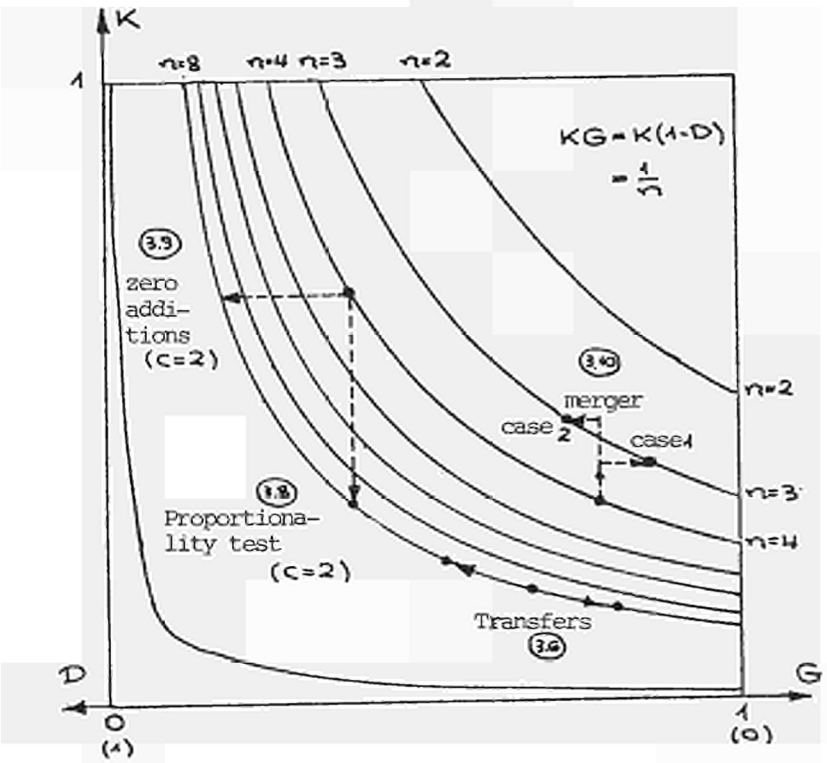

Fig. 4 Disparity (and parity) and concentration in the case of uniformly standardized measures - Graphical interpretation of effects

3. Special concentration measures

Summary measures: all p_i or C_i are included in the calculation of K.

Point measures = discrete measures ; only some p_i or C_i are used in calculating K.

3.1 Measures derived direct from the concentration curve

Concentration ratio:[1)]

(18) $$CR_i = C_i$$

Average concentration ratio:

(19) $$\bar{C}_i = \frac{C_i}{i} = \frac{p_1+\ldots+p_i}{i} = \frac{1}{X}\,\frac{x_1+\ldots+x_i}{i}$$

$\bar{C}_i$ is the average market share of the large firms or mean value for the large firms divided by X.

---

1) In the case of concentration ratios, the double notation C_i (ordinate of the concentration curve) = CR_i (concentra-

(20) $$\overline{C_k - C_i} = \frac{C_k - C_i}{k-i} = \frac{k}{k-i}\,\overline{C}_k - \frac{i}{k-i}\,\overline{C}_i = \frac{1}{x}\,\frac{x_{i+1}+..x_k}{k-i}$$

Applied using: $k = n$ i.e. $C_k = 1$, $k = m$ or $k > i$.

Interpreted as average market share of small firms or mean value of small firms.

Marginal concentration ratio:

(21) $$\Delta C_i = p_i$$

3.2 Some uniformly standardized measures of concentration

Generalized Herfindahl index H_α: [1)]

(22) $$(H_\alpha)^{\alpha-1} = \sum_{i=1}^{n} p_i^{\alpha}$$

Herfindahl index (α=2):

(23) $$H = H_2 = \sum_{i=1}^{n} p_i^{2} = \frac{1+V^2}{n}$$

where $V = \frac{\sigma}{\mu}$ is the coefficient of variation.

Exponential-Index (α=1):

(24) $$E = \prod_{i=1}^{n} p_i^{p_i} = H_1$$

---

1) H_α can be related to the comprehensive concept of the quasi-linear mean, which is used in measuring disparity and concentration. A quasi-linear mean

$$f(K) = \sum_{i=1}^{n} p_i f(p_i) \quad \text{yields for} \quad f(x) = x^{\alpha-1}$$

$$K = H_\alpha \quad .$$

All H_α measures are closely related to the entropy of the α th order

$I_\alpha(p) = \frac{1}{1-\alpha}\log(\Sigma p_i^\alpha)$ since $\longleftarrow H_\alpha = \exp(-I_\alpha)$

Higher-order Herfindahl index (e.g. $\alpha = 3$)

$$H_3 = \sqrt[3]{\sum_{i=1}^{n} p_i^3} \tag{25}$$

Increasing of H_α (mean value disparity)

$$\frac{1}{n} \leq E \leq H_2 \leq H_3 < p_1 \tag{26}$$

Rosenbluth index:

$$RB = \frac{1}{2A} = \frac{1}{n(1-R)} \tag{27}$$

An area above the concentration curve and

Gini coefficient (measure of disparity):

$$R = \sum_{i=1}^{n} \frac{2i-n-1}{n} p_i \tag{28}$$

R can be interpreted as double the area between the Lorenz curve and the line bisecting the angle.

Table 3: Uniformly standardized counterpart measures of concentration and disparity

K	D
Herfindahl index	Standardized square of coefficient of variation $\frac{V^2}{V^2+1}$
Exponential index	$\left(1 - \frac{1}{nE}\right)$
Rosenbluth index	Gini coefficient

Supplement:

Schutz coefficient (measure of disparity):

$$S = \sum_{p_i \geq \frac{1}{n}} (p_i - \frac{1}{n}) \leq R \tag{29}$$

Interpreted as the longest Lorenz curve chord.
With two-point distribution, S = R. Weak principle of transfers.

3.3 Hybrid measures

Combination of uniformly standardized measures:

(30)
$$\begin{cases} D = \alpha D_1 + (1-\alpha) D_2 & 0<\alpha<1 \\ K = \dfrac{1}{\dfrac{\alpha}{K_1} + \dfrac{1-\alpha}{K_2}} \end{cases}$$

Horvath index:

(31)
$$CI = p_1 + \sum_{i=1}^{n} p_i^2 [1+(1-p_i)]$$

(32)
$$CI = C_1(1-C_1)^2 + 2H_2 - H_3^2$$

4. Problems of aggregation

Aggregation of industry data (e.g. for countries) to obtain overall results (e.g. for the EEC)

Industries $j=1, \ldots, k$:

Values of variable: (in industry j): x_{ij} $i= 1,\ldots,n_j$ - classified in descending order of size.

Total value in industry
$$X_j = \sum_{i=1}^{n_j} x_{ij} = n_j \mu_j$$

Overall market shares:
$$p_{ij} = \frac{x_{ij}}{X} \quad , \quad \sum_{i=1}^{n_j} p_{ij} = p_j \quad , \quad \sum_{j=1}^{k} p_j = 1$$

Market shares in industry j:
$$p_{ij}^* = \frac{x_{ij}}{X_j} \qquad \sum_{i=1}^{n_j} p_{ij}^* = 1 \quad .$$

Measure of concentration K_j

Measure of disparity: D_j

Aggregate:

Notation as before (p_i, n, K, D)

(33) $K < \max_j K_j$, $K < \min_j K_j$ possible

(34) $D > \min_j D_j$, $D > \max_j D_j$ possible

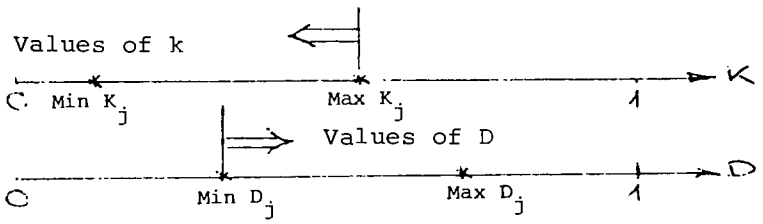

Fig. 5: Concentration and disparity of industries and aggregate

Aggregation of concentration ratios:

$CR_{ij} = C_{ij}$ $(i=1,..n_j)$ concentration ratio in the jth industry

$p_{ij} = \Delta C_{ij} \frac{X_j}{X}$ classified in descending order of size: p_i $(i=1,..,n)$

with

$C_i = CR_i$ being derived for the aggregate.

Typical aggregation formula for measures of disparity:

(e.g. Gini coefficient R)

(35) $$D = \sum_{j=1}^{k} g_j D_j + Z \quad , Z > 0, \quad g_j > 0, \quad \sum_{j=1}^{k} g_j = 1$$

Aggregation of Herfindahl indices:

(36) $$H = \sum_{j=1}^{k} \left(\frac{X_j}{X}\right)^2 H_j$$

Aggregation of exponential indices:

(37) $$E = E_o \prod_{j=1}^{k} E_j^{p_j} \quad \text{with} \quad E_o = \prod_{j=1}^{k} p_j^{p_j} \quad .$$

Taking mergers into account in the event of aggregation

Merger of the k th and l th units

Herfindahl index:

$$(38) \quad H_f = H + 2\, p_k \cdot p_l$$

Exponential index:

$$(39) \quad E_f = E \; \frac{(p_k+p_l)^{(p_k+p_l)}}{p_k^{p_k} \cdot p_l^{p_l}}$$

5. Measures of dominance

5.1 Calculating measures of dominance where the entire concentration curve is given (fixed horizon n)

Slope index D^A:

$$(40) \quad D_i^A = \frac{x_i}{x_{i+1}} = \frac{\Delta C_i}{\Delta C_{i+1}} \qquad \max_{i=1,..,n} D_i^A = D_{k_A}^A$$

Longest concentration curve chord D^S:

$$(41) \quad D_i^S = C_i - \frac{i}{n} \quad , \qquad \max_{i=1,..,n} D_i^S = D_{k_S}^S$$

Herfindahl measure of dominance D^H:

Maximum value of the Herfindahl index for two groups of i equally large firms and n-i equally small firms.

$$(42) \quad D_i^H = \frac{C_i^2}{i} + \frac{(1-C_i)^2}{n-i} \quad , \qquad \max_{i=1,..,n} D_i^H = D_{k_H}^H \quad .$$

Linda measure of dominance D^Q:

$$(43) \quad D_i^Q = \frac{C_i}{i} \, \frac{n-i}{1-C_i} \qquad \max_{i=1,..,n} D_i^Q = D_{k_Q}^Q$$

N.B. The slope index can be understood intuitively and should be the first index used for obtaining rough information. D^H tends to yield tighter nuclei than D^S. D^A and D^Q respond in a relatively sensitive manner; several cut-off lines may be obtained.

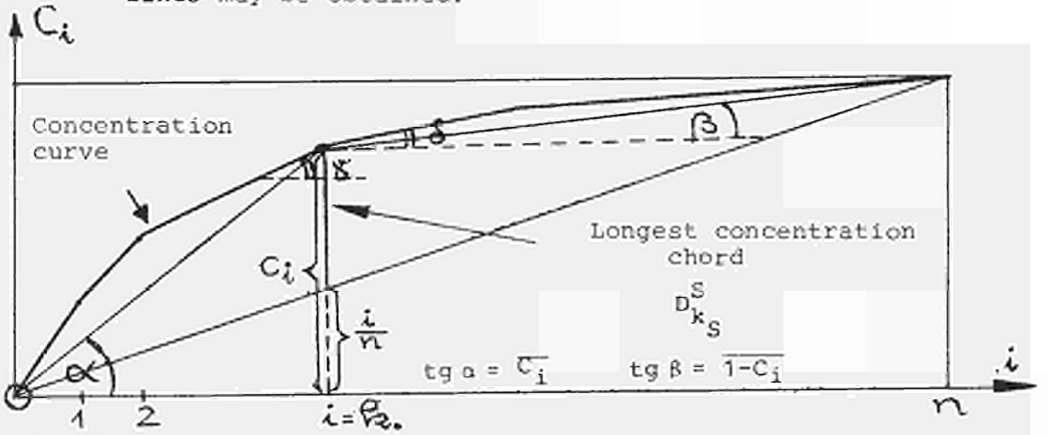

Fig. 6:

On the interpretation of the measures of dominance $D^A = \frac{tg\,\gamma}{tg\,\delta}$, D^S, D^H $D^Q = \frac{tg\,\alpha}{tg\,\beta}$

5.2 Calculating measures of dominance with incomplete statistical data (values of variable for the large firms - moving horizons)

Longest concentration curve chord D^S_{im} :

$$(44) \quad D^S_{im} = \frac{x_1 + .. + x_i}{x_1 + .. + x_m} - \frac{i}{m} \qquad i = 1, .., m$$

$$(45) \quad \max_{i=1,..,m} D^S_{im} = D^S_{k_S(m)} \quad , \quad k_S(m) \xrightarrow{m \to n} k_S$$

Herfindahl measure of dominance D^H_{im} :

$$D^H_{im} = \frac{1}{i}\left(\frac{x_1+..+x_i}{x_1+..+x_n}\right)^2 + \frac{1}{m-i}\left(\frac{x_{i+1}+..+x_m}{x_1+..+x_n}\right)^2$$

$$(46) \qquad = \frac{1}{\sum_{\nu=1}^{m} x_\nu} \cdot \left[\frac{(x_1+..+x_i)^2}{i} + \frac{(x_{i+1}+..+x_m)^2}{m-i}\right]$$

$$(47) \quad \max_{i=1,..,m} \sum_{\nu=1}^{m} x_\nu \, D^H_{im} = D^H_{k_H(m)} \quad , \quad k_H(m) \xrightarrow{m \to n} k_H$$

Linda measure of dominance D^Q_{im} :

$$(48) \quad D^Q_{im} = \frac{C_i}{i} \cdot \frac{m-i}{C_m - C_i} \quad , \quad D^Q_{in} = D^Q_i$$

$$(49) \quad \max_{i=1,..,m} D^Q_{im} = D^Q_{k_Q(m)} \quad , \quad k_Q(m) \xrightarrow{m \to n} k_Q \quad .$$

6. Linda indices

Upper mean value:

$$(50) \quad {}_1M^O_i = \frac{x_1+..+x_i}{i} \qquad i=1,...,k-1$$

Lower mean value:

$$(51) \quad {}_{i+1}M^U_k = \frac{x_{i+1}+...+x_k}{k-i}$$

Possible options: k=n, k=m, or k= any number $< n$,

Dominance (ratio of mean values)

$$(52) \quad V_{ik} = \frac{{}_1M^O_i}{{}_{i+1}M^u_k} \geq 1 \qquad V_{in} = D^Q_i$$

N.B. "Ratio of oligopolistic dominance" (Linda)

${}_iDO_{k-i}$.

Mean dominance (simple arithmetic Linda index)

$$(53) \qquad L_k^* = \frac{1}{k-1} \sum_{i=1}^{k-1} V_{ik} \qquad k = 2,3,\ldots$$

Range of values:

$$(54) \qquad 1 \leqq L_k^* < \infty$$

Relative mean dominance (double averaged Linda index)

$$(55) \qquad L_k = \frac{1}{k} \frac{1}{k-1} \sum_{i=1}^{k-1} V_{ik} \qquad k = 2,3,..$$

Range of values:

$$(56) \qquad \frac{1}{k} \leqq L_k < \infty$$

$$(57) \qquad L_k^* = kL_k$$

Relationship with concentration ratios and average concentration ratios:

$$(58) \qquad L_k^* = \frac{1}{k-1} \sum_{i=1}^{k-1} \frac{p_1+..+p_i}{p_{i+1}+...+p_k} \cdot \frac{k-i}{i}$$

$$= \frac{1}{k-1} \sum_{i=1}^{k-1} \frac{C_i}{C_k-C_i} \frac{k-i}{i} = \frac{1}{k-1} \sum_{i=1}^{k-i} \frac{\overline{C_i}}{\overline{C_k-C_i}}$$

L_k used as inverse measure of dominance for detecting oligopolistic nuclei:

Moving horizons k:

$$(59) \qquad D_k^L = L_k \qquad \min_{k=2,3,\ldots} L_k = L_{k_L}$$

k_L is the position of the first minimum value of relative mean dominance L_k. Linda also interprets other relative minimum values.

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This study completes the 'Competition' series; this will be succeeded by a new series called 'Competition — Approximation of legislation'.

[1] The abbreviations after each title indicate the languages in which the documents have been published: DA = Danish, DE = German, EN = English, FR = French, IT = Italian, NL = Dutch.

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