

Measuring Trends in Sales Concentration in American Business

Edward Nissan*

University of Southern Mississippi

Four indexes are employed to measure trends in sales concentration of large business in the United States between 1967 and 1992 using Fortune 500 data. This paper also investigates whether a perceptible change occurred during the 1980s. Each of the indexes confirms increasing concentration for the whole period 1967 to 1992 for all 500, the top 100, and the second 100 firms. The increase in the trend of concentration during the 1980s was not statistically significant for all the 500 firms as well as sets of 100 firms of lower rank.

INTRODUCTION

Corporate mergers and acquisitions from 1887 to 1929 were predominately mergers for monopolies and oligopolies, while those after World War II were primarily conglomerate mergers. The merger trend peaked in 1968, only to be followed by another cycle in the late 1970s and 1980s (Geithman, 1987). The value of these mergers increased in nominal dollars from \$33 billion in 1980 to \$190 billion in 1986 with a total value of \$600 billion (Krattenmaker and Pitofsky, 1988). Madrick (1987) contends that a significant proportion of the increase in outstanding U.S. debt during the 1980s was created to make these mergers and acquisitions. The mergers may have resulted in an increase in concentration, which, as pointed out by Schutz (1995), is the acquisition of social power. The conglomerate corporation, for instance, may apply tools such as risk diversification and cross-market subsidization that enhance their social power. Financial and directorship interlocks and joint ventures further increase this concentration of social power.

Concentration may be either industry or aggregate. According to Mueller (1990), industry concentration relates to a single industry where a few sellers dominate. Aggregate concentration is where a few conglomerate firms may control large segments of an economy. The power of a conglomerate extends beyond a particular industry and includes

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many other lines of business, but may or may not be associated with high concentration in any particular industry or line of business.

While mergers and acquisitions within a specific industry lead to greater control and concentration within that industry, the effects of conglomerate mergers and acquisitions are unclear. Conglomerate mergers often involve companies in unrelated industries. There may be little or no effect on sales concentration within a particular industry, but an increase in aggregate sales concentration may result.

Brozen (1982) argues that effects from conglomerate mergers and acquisitions are limited or nonexistent because the competitive markets of the different industries still reward efficient firms. If government interfered with such mergers and activities, it would distort the normal decisions of businesses.

In contrast, Weiss (1983) believes that conglomerate mergers and acquisitions result in increasing rates of sales concentration. He claims that such mergers could lead to a few large firms that together could control activity in large segments of the national economy. Such firms would exercise power because of their capacity for social and political lobbying, cross subsidization, competitive advantages, and mutual interdependence. Mutual interdependence develops when large diversified firms interact with each other as competitors, buyers, and/or suppliers of needed raw materials, components, or finished products.

Adams and Brock (1990) agree that conglomerate mergers and acquisitions result in big firms that undermine economic performance, erode production efficiency, and stifle innovation and technological progress. Adams and Brock further contend (1995, p. 314) "that the single most important source of international competitiveness is intense competition in the home market." Peterson (1988) emphasizes that sheer size gives big corporations the power to administer prices that have far-reaching consequences on inflation, employment, and the distribution of income.

This paper measures aggregate concentration among the *Fortune* 500 companies from 1976 to 1992 to observe if an increase in aggregate concentration occurred. This study extends the work by Nissan and Caveny (1988, 1993) by:

- Using four measures of concentration suggested by Krause and Lothian (1988);
- Including all *Fortune* 500 companies; and
- Extending the time period to 1992.

The rationale for choosing more than one measure of concentration as explained by O'Neill is to overcome the drawback (1996, p. 199) that "there does not exist any generally accepted 'correct' way to assess aggregate concentration." Therefore, the probability is high (close to 1.00) that when all four measures indicate a long-term trend, the concentration tendency is strong.

Aggregate sales data are used as units of measurement rather than assets, employment, profits, or value added. Hannah and Kay (1977) and White (1981) support this choice by identifying a number of weaknesses associated with the latter measures that distort changes in concentration. Hanna and Kay explain that assets may suffer from deficiencies of the accounting data because of the way they are compiled, i.e., variant costs of purchases at different dates and depreciation by arbitrary methods. Employment is favored if the interest is the impact of concentration of employees. Brozen (1982) argues that

when using value added, an observed increase may reflect an increase in efficiency as a result of competitive conditions.

PRIOR WORK AND MEASUREMENT ISSUES

Many other similar studies use data derived from the *Fortune* 500. Notable among these is the work of Hexter and Snow (1970), who measure asset concentration from 1955 to 1966. Nissan and Caveny (1985, 1988) update this work by extending the analysis to 1967 to 1982 and 1967 to 1986, respectively. Nissan and Caveny (1988) also show that the use of assets or sales as criteria provide similar results. Attaran and Saghaifi (1988) use assets, sales, and equity for 1970 through 1984 to examine the impact of concentration on return and risk. Finally, Saghaifi and Attaran (1990) examine the effect of the increase in concentration in recent years on business competition.

MEASUREMENT

Clarke (1985) suggests that a firm's share rather than a firm's size should be used in the computation of concentration. The requirement ensures that the index of concentration is independent of market size, thus providing an element of consistency for comparisons throughout the years. For this purpose, let S_i ($\sum_i S_i = 1.00$) refer to the share of the i th firm and n to the number of firms under consideration. As explained above, no single measure of concentration is completely satisfactory. Consequently, several measures as a mix provide better information about concentration. The most commonly used mix of measures (Hannah and Kay, 1977) is:

(1) The Coefficient of Variation

$$V = \frac{S}{\bar{X}},$$

where:

$$\begin{aligned} S &= \text{Standard deviation; and} \\ \bar{X} &= \text{The mean.} \end{aligned}$$

It is a unit free measure of relative dispersion, smallest when dispersion is least.

There is an algebraic relationship between the coefficient of variation and the well-known Herfindahl (H) index, computed as

$$H = \sum_i S_i^2, \quad \frac{1}{n} \leq H \leq 1.00.$$

When one company holds all shares, H equals one. When shares are held equally, H equals $1/n$. Clarke (1985) shows that an alternative form of H is

$$H = \frac{(V^2 + 1)}{n}.$$

An intuitive understanding of the extent of concentration is provided by what is known as an equally sized firms *numbers equivalent* corresponding to a given concentration index. For H its reciprocal is the numbers equivalent because when all firms m are of equal size, the variance $S^2 = 0$ and by implication $V^2 = 0$. Hence,

$$H = \frac{(0 + 1)}{m},$$

implying that

$$m = \frac{1}{H}.$$

By virtue of the relationship between H and V above,

$$V = [nH - 1]^{1/2},$$

and the knowledge that when all m firms are of equal size, $H = 1/m$, it follows that the numbers equivalent for the coefficient of variation is obtained by solving for m corresponding to a given V as

$$V = \left[n \left(\frac{1}{m} \right) - 1 \right]^{1/2}.$$

The solution for m for a given V is therefore

$$m = \frac{n}{(V^2 + 1)}.$$

(2) The Gini Coefficient

$$G = 1 + \left(\frac{1}{n} \right) - \left(\frac{2}{n} \right) \sum_i i S_i, \quad 0 \leq G < 1.00$$

for $S_1 \geq S_2 \geq \dots \geq S_n$. When all shares are held by one company, G equals $1 - (1/n)$, which approaches 1 as $n \rightarrow \infty$. When shares are held equally, G equals zero regardless of the number of firms. According to Sherman (1974) the Gini coefficient is a summary representation of the Lorenz curve, whereby cumulative percentages of shares are plotted against the cumulative percentages of firms.

No readily available formulation exists for calculating the number of equally sized firms m (numbers equivalent) which yields a corresponding G value. A plausible

approach¹ is to let m be equally sized firms inside the summation sign in the equation of G above. Now under the assumption that all $S_i = 1/m$ and because

$$\sum_{i=1}^m i = \frac{m(m+1)}{2},$$

then

$$\sum_{i=1}^m iS_i = \frac{(m+1)}{2},$$

From these, the number of equally sized firms m corresponding to a given G and n is obtained by solving for m in the equation

$$G = 1 + \frac{1}{n} - \frac{2}{n} \frac{(m+1)}{2},$$

which simplifies to

$$m = n(1 - G).$$

Hence the numbers equivalent for all 500 *Fortune* firms for a given G , $n = 500$, and for subsets of 100, for a given G , $n = 100$.

(3) Theil's Entropy

$$E = \sum iS_i \log \frac{1}{S_i}, \quad 0 \leq E \leq \log n.$$

If all firms have an equal share, $E = \log n$. When one firm controls all shares, $E = 0$. For $n = 100$ the maximum value of E is 2.00, while for $n = 500$ the maximum value of E is approximately 2.70. The index weights shares S_i by $\log (1/S_i)$. The numbers equivalent that yields a corresponding E value is obtained by computing the antilogarithms of E .

Sen (1973) describes Theil's entropy as an interesting measure of inequality that is derived from the notion of entropy in information theory. Assume that S and $h(S)$ are the probability that a certain event will occur and the information content when the event occurs, respectively. Then $h(S)$ ought to be a decreasing function of S because the more unlikely an event (the smaller the probability), the more interesting it is to know that it has occurred. Many formulas satisfy this property of $h(S)$. The one unanimously chosen is

¹ I am grateful for an anonymous reviewer for suggesting the approach.

$$h(S) = \log \frac{1}{S}.$$

Thus, if there are n events, the entropy (the expected information content) equals the sum of the contents of the n events weighted by the respective probabilities.

$$E = \sum_i S_i \log \frac{1}{S_i}.$$

An analogy is the *Fortune* 500 directory where the share S_i of firm i , $\sum_i S_i = 1.0$, serves as the probability of the event in the above modeling. Attaran and Zwick (1987) provide further insight on the entropy concept used to measure industrial diversification and concentration.

(4) The Variance of Logarithms

$$J = \frac{1}{n} \sum_i (\log S_i)^2 - \frac{1}{n^2} (\sum_i \log S_i)^2$$

This measure is useful in cases when the shares of the firms have a lognormal distribution. When relatively few firms are large, resulting in skewed distribution, the J index is an appropriate measure. The lognormal distribution according to Creedy (1985) describes a growth process known as the *Gibrat's law of proportionate effect*. If growth of firms follows the lognormal distribution, then the variance of this distribution will increase steadily.

It is desirable, as pointed out by Caswell (1987), to use more than one statistical index because of some inherent weaknesses and strengths of each. Therefore, the estimates below use all four measures of concentration which are expected to correlate well (Sherman 1974).

EMPIRICAL RESULTS

Table 1 reports the quintile sales shares of *Fortune* 500 firms. Column (2) provides the total sales of the 500 enterprises in current dollars between 1967 and 1992, followed by the distribution of these sales split into five groups of 100 enterprises. Column (3) contains the proportions of total sales of the top 100 relative to the set of 500 firms. The percentages range between 62.3 in 1970 and 71.6 in 1990. The average for the 26 year period is 66.9 percent, with a noticeable increase in the level of percentages (especially in the later years). The second group of 100 companies account on average for 16.0 percent of the set of 500 firms.

The remaining 300 firms account for an average of 8.4 percent, 5.2 percent, and 3.5 percent of the set of 500 firms, respectively. In recent years the top 100 firms controlled nearly 71 percent of sales, increasing from approximately 63 percent in the late 1960s and early 1970s. Table 1 reveals that the increase in shares of sales for the largest 100 firms

Table 1—Total Value of Sales of the *Fortune* 500 Firms and Proportion Held by Five 100 Firm Subsets 1967-1992

Year	Total Sales (\$ millions)	Set 1 001-100	Set 2 101-200	Set 3 201-300	Set 4 301-400	Set 5 401-500
1967	358,885	0.637	0.168	0.094	0.059	0.042
1968	405,284	0.639	0.169	0.093	0.058	0.040
1969	444,719	0.630	0.176	0.093	0.059	0.042
1970	461,503	0.623	0.178	0.094	0.062	0.043
1971	503,165	0.626	0.174	0.095	0.062	0.043
1972	557,821	0.624	0.175	0.096	0.061	0.044
1973	667,451	0.625	0.173	0.095	0.062	0.045
1974	830,765	0.645	0.164	0.093	0.058	0.040
1975	865,229	0.649	0.164	0.091	0.057	0.040
1976	970,230	0.655	0.160	0.091	0.055	0.039
1977	1,086,586	0.660	0.160	0.089	0.054	0.038
1978	1,216,085	0.660	0.164	0.087	0.053	0.036
1979	1,444,894	0.667	0.164	0.085	0.051	0.034
1980	1,650,453	0.676	0.158	0.083	0.049	0.033
1981	1,772,635	0.681	0.160	0.081	0.048	0.031
1982	1,672,220	0.686	0.158	0.079	0.046	0.030
1983	1,685,697	0.689	0.156	0.079	0.046	0.030
1984	1,753,129	0.698	0.150	0.079	0.046	0.028
1985	1,807,800	0.700	0.147	0.078	0.046	0.029
1986	1,712,292	0.697	0.152	0.076	0.046	0.028
1987	1,878,912	0.696	0.153	0.076	0.047	0.029
1988	2,022,595	0.697	0.151	0.077	0.046	0.029
1989	2,164,348	0.701	0.148	0.076	0.045	0.030
1990	2,312,352	0.716	0.142	0.071	0.043	0.028
1991	2,262,652	0.715	0.143	0.071	0.042	0.029
1992	2,364,700	0.711	0.144	0.072	0.044	0.029
MEAN		0.669	0.160	0.084	0.052	0.035

Set 1 includes the top 100 firms, set 2 the second 100, etc.

Source: *Fortune*, 1968-1993

corresponds to a decline in the shares of every subset of the bottom 400 firms where their total share in sales has been reduced from approximately 37 percent in the late 1960s to around 29 percent in 1992.

Linear trend regressions may substantiate these observations using yearly proportions as the dependent variable and time as the independent variable according to the formula

$$(1) Y_i = b_0 + b_1 T_i.$$

Y_i is the share of year i of the top 100, the next 100, etc. In these equations b_0 is the intercept, b_1 is the slope (positive if percentage change is on the increase, negative otherwise), and T_i is time variable for year i for the years 1967 to 1992. The time series data in Table 1 for the period 1967 to 1992 can suffer from autocorrelation. Consequently, the data must be checked with the Durbin-Watson (D-W) test.

The regression coefficients in Table 2 result from using a first order autoregressive scheme of the Cochrane-Orcutt method (Dougherty, 1992, pp. 223-225) and eliminating the autocorrelation initially indicated by the Durbin-Watson test measured by DW_1 . The DW_2 column in Table 2 indicates that the autocorrelation correction is successful.

Table 2—Linear Regression of Trend in Concentration 1967-1992 by Five 100 Firm Subsets (t-values in parentheses)

$$Y_i = b_0 + b_1 T_i$$

where:

Y_i = Share held by a set of 100 firms in year i
 T_i = Time trend from 1967 through 1992

Group of Firms	b_0	b_1	R^2	DW_1	DW_2	$\hat{\rho}$
Set 1: 001-100	0.605	0.0044* (7.43)	0.93	0.53	1.70	0.73*
Set 2: 101-200	0.170	-0.0010* (-4.32)	0.88	0.01	1.85	0.99*
Set 3: 201-300	0.103	-0.0012* (-7.00)	0.93	0.42	1.45	0.79*
Set 4: 301-400	0.065	-0.0009* (-4.71)	0.89	0.38	1.56	0.81*
Set 5: 401-500	0.045	-0.0007* (-3.20)	0.86	0.42	2.12	0.81*

DW_1 and DW_2 denote the Durbin-Watson statistic before and after correcting data for autocorrelation and $\hat{\rho}$ is the estimate of the autocorrelation coefficient. Also see notes to Table 1

* Significant at $\alpha = .05$ or better

The results in Table 2 support the claims that the proportion of sales among the largest 100 firms from 1967 to 1992 increased at the expense of the smaller firms. The regression coefficients b_1 are all statistically significant at the 5 percent level or better. It is positive for the top 100, indicating a rise in the percentage of sales controlled. The slopes of the other regressions are all negative and significant, indicating a corresponding decrease in percentages for the four sets of the bottom 400 companies. Although the percentages of sales decreased for the bottom 400 companies, concentration among these groups may have persisted or increased.

Table 3 presents the concentration indexes of the coefficient of variation (V), the Gini (G), the Theil (E), and the variance of logarithms (J) for sales of the 500 firms. A useful alternative of the information provided in Table 3 is to obtain the number of firms m of equal size (the numbers equivalent) corresponding to the indexes V, G, and E. A convenient way to observe the decline in m as a consequence of the increase in concentration, if any, is to use the summary statistics given by the minimum and maximum of these indexes. $m = n/(V^2 + 1)$ corresponds to the coefficient of variation, $m = n(1 - G)$ corresponds to the Gini, and $m = \text{antilogarithms } E$ corresponds to the Theil. Accordingly, the numbers equivalent m corresponding to V decreased from approximately 120 to 76 firms, a reduction of 37 percent. For G the range is between 211 and 168, a reduction of 20 percent. For E the range is between 255 to 185, a reduction of 27 percent.

Figure 1 graphs the results of Table 2. The decline of the E index indicates an increase in the level of concentration and is, therefore, consistent with the other graphs. The graphs show little or no increase prior to 1973, considerable increase in concentration from 1973 to 1983, and a slight tapering thereafter. The graphs indicate the combined

Table 3—Measures of Concentration of Sales of the *Fortune* 500 Firms 1967-1992

Year	V	G	E	J
1967	1.96409	0.57790	2.38198	0.15784
1968	1.99104	0.58243	2.37670	0.16252
1969	1.92273	0.57450	2.38985	0.16032
1970	1.77381	0.56465	2.40595	0.15510
1971	1.97876	0.57009	2.38640	0.15347
1972	1.98374	0.56819	2.38622	0.15097
1973	1.98457	0.56853	2.38473	0.14959
1974	2.01848	0.58802	2.36268	0.16036
1975	2.05333	0.59228	2.35838	0.16330
1976	2.13787	0.59887	2.34352	0.16529
1977	2.19359	0.60541	2.33324	0.16984
1978	2.18285	0.60633	2.33363	0.17335
1979	2.18591	0.61642	2.32807	0.18508
1980	2.25115	0.62499	2.31462	0.18848
1981	2.26163	0.63358	2.30587	0.19811
1982	2.23818	0.64052	2.30062	0.20349
1983	2.20879	0.64076	2.30243	0.20433
1984	2.26871	0.64592	2.28669	0.20620
1985	2.30293	0.64918	2.28536	0.20562
1986	2.27931	0.64314	2.28825	0.20340
1987	2.23405	0.64432	2.29828	0.20749
1988	2.34096	0.64684	2.28867	0.20796
1989	2.33832	0.64948	2.28536	0.20795
1990	2.36435	0.66340	2.26771	0.21870
1991	2.33682	0.66152	2.27278	0.21813
1992	2.34668	0.65738	2.27567	0.21279
MEAN	2.15933	0.61595	2.32860	0.18422
MIN	1.77381	0.56465	2.26771	0.14959
MAX	2.36435	0.66340	2.40595	0.21870

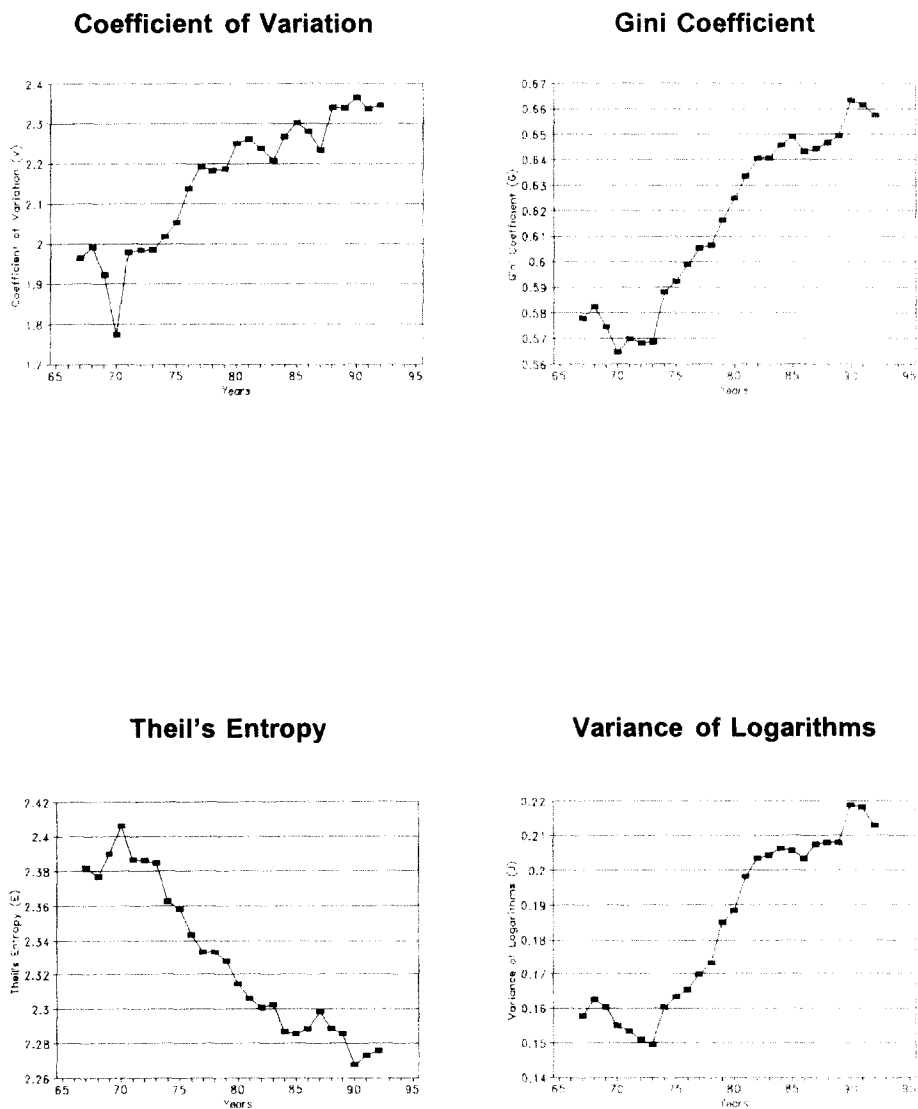
V (Coefficient of Variation); G (Gini); E (Theil's Entropy); J (Variance of Logarithms)

effects on concentration of factors such as antitrust policies and the strategic implementation of acquisitions, mergers, and divestitures.

From 1976 to 1990 some 35,000 mergers and acquisitions occurred with total market value of \$2.6 trillion (Liebeskind, Opler, and Hatfield, 1996), but the wave of mergers in the 1980s differs from earlier mergers. Prior to the 1980s the strict administration of the antitrust laws meant that acquisitions were of diverse unrelated businesses, creating conglomerates that may have resulted in an increase in concentration (Shleifer and Vishny, 1988 and 1991; Sikora, 1995).

The 1980s takeover wave, by contrast, exemplified a bulldown phenomenon coinciding with relaxed enforcement of antitrust policies. The bulldown resulted from a widespread failure of ill-fitting and poorly managed subsidiaries that were selling nonprofitable lines of business and closing plants. The relaxed enforcement of antitrust policies resulted in buyouts of lines of business by firms in the same industry (horizontal mergers). The graphs do not provide evidence that the horizontal mergers and corporate restructuring in the 1980s were associated with increasing industry concentration. This confirms the findings of Golbe and White (1988).

Figure 1—Measure of Concentration of Sales of the *Fortune* 500 Firms 1967-1992



Similar calculations are made for each set. Table 4 shows the results listed in five year intervals. The number of firms m of equal size for the top 100 decreased from $m = 50$ to $m = 38$, a reduction of 24 percent. The reduction is 13 percent from $m = 61$ to $m = 53$ for the Gini. The range is from $m = 73$ to $m = 64$ for the Theil, a reduction of 12 percent.

Do the four indexes of Tables 3 and 4 correlate? Table 5 shows correlation coefficients. For all sets other than 1 and 5 all correlation coefficients are higher than 90 percent. For set 1 all correlation coefficients are higher than 70 percent. For set 5 correlation coefficients are as low as 27 percent.

Table 4—Concentration of Sales of the *Fortune* 500 Firms in Five 100 Firm Subsets in Five Year Intervals 1967-1992

Group of Firms	Year	V	G	E	J
Set 1: 001-100	1967	1.13799	0.40739	1.84667	0.07467
	1972	1.19475	0.41424	1.83409	0.07425
	1977	1.26267	0.45096	1.80905	0.08846
	1982	1.21965	0.46994	1.80936	0.10199
	1987	1.19246	0.45239	1.81996	0.09312
	1992	1.23635	0.46090	1.80986	0.09496
	MEAN	1.20598	0.44265	1.82159	0.08787
	MIN	1.01227	0.38555	1.80531	0.06786
	MAX	1.26973	0.47415	1.86646	0.10363
Set 2: 101-200	1967	0.20804	0.11802	1.99081	0.00793
	1972	0.21177	0.11964	1.99055	0.00806
	1977	0.19709	0.11179	1.99176	0.00709
	1982	0.21961	0.12562	1.98957	0.00940
	1987	0.24611	0.13898	1.98721	0.01103
	1992	0.25653	0.14277	1.98636	0.01142
	MEAN	0.21937	0.12395	1.98973	0.00884
	MIN	0.19125	0.10863	1.98599	0.00670
	MAX	0.26011	0.14357	1.99223	0.01165
Set 3: 201-300	1967	0.14510	0.08299	1.99549	0.00392
	1972	0.15157	0.08676	1.99507	0.00432
	1977	0.15267	0.08748	1.99498	0.00443
	1982	0.17630	0.10069	1.99332	0.00587
	1987	0.14844	0.08330	1.99536	0.00392
	1992	0.17300	0.09825	1.99364	0.00550
	MEAN	0.16408	0.09326	1.99423	0.00500
	MIN	0.14510	0.08299	1.99259	0.00392
	MAX	0.18614	0.10611	1.99549	0.00646
Set 4: 301-400	1967	0.12413	0.07023	1.99673	0.00279
	1972	0.09695	0.05513	1.99797	0.00178
	1977	0.11655	0.05966	1.99698	0.00288
	1982	0.13261	0.07593	1.99623	0.00300
	1987	0.15268	0.08727	1.99499	0.00440
	1992	0.12353	0.07065	1.99673	0.00285
	MEAN	0.12137	0.06902	1.99677	0.00282
	MIN	0.09442	0.05400	1.99480	0.00166
	MAX	0.15563	0.08905	1.99809	0.00457
Set 5: 401-500	1967	0.07681	0.04386	1.99874	0.00109
	1972	0.10372	0.05941	1.99769	0.00202
	1977	0.09452	0.05377	1.99373	0.00165
	1982	0.11954	0.05930	1.99698	0.00256
	1987	0.10096	0.05781	1.99344	0.00192
	1992	0.10215	0.05813	1.99777	0.00191
	MEAN	0.10852	0.06045	1.99282	0.00218
	MIN	0.07681	0.04386	1.95602	0.00109
	MAX	0.15494	0.07053	1.99874	0.00337

See notes to Tables 1 and 3

Table 5—Correlation Coefficients Between Indexes of Concentration Measures of Sales of *Fortune* 500 Firms and Five 100 Firm Subsets

Group of Firms	Index	G	E	V
All 500: 001-500	E	-0.99		
	V	0.95	-0.98	
	J	0.99	-0.97	0.91
Set 1: 001-100	E	-0.97		
	V	0.81	-0.92	
	J	0.98	-0.91	0.70
Set 2: 101-200	E	-0.99		
	V	0.98	-0.99	
	J	0.99	-0.99	0.97
Set 3: 201-300	E	-0.99		
	V	0.98	-0.99	
	J	0.99	-0.99	0.97
Set 4: 301-400	E	-0.99		
	V	0.99	-0.99	
	J	0.98	-0.99	0.99
Set 5: 401-500	E	0.39		
	V	0.87	-0.27	
	J	0.94	-0.37	0.98

See notes to Tables 1 and 3

The simple linear time trend of equation (1) is used again where Y_i serves as a concentration index (V, G, E, J). Table 6 shows the t-values, obtained after the elimination of autocorrelation, for testing the significance of the regression coefficients for all 500 and by sets of 100 companies. The signs of the t-values for b_1 should be positive for trends toward more concentration for all the measures with the exception of Theil's E, in which case a negative sign indicates more concentration. Table 6 also provides the results of D-W tests measured by DW_1 and DW_2 as well as the estimate.

The unanimity among all the indexes when all 500 companies considered indicates that concentration increased during the 26 year period. All the t-values are significant at the 5 percent level or better. Similar conclusions emerge for the group of 100 companies of set 1 and set 2. Unanimity among the four indexes for sets 3 and 5 corroborates that no increase in concentration occurred. For set 4 only the Gini and the coefficient of variation are significant.

CONCENTRATION DURING THE 1980S

The question now is whether concentration increased during the 1980s. In the first approach data for concentration of sales calculated from the coefficient of variation, Gini, Theil entropy, and variance of logarithms are grouped into two sets. The first set encompasses the 14 years between 1967 and 1980, period 1, and the second covers the 12 years between 1981 and 1992, period 2. The appropriate test for equality of means uses

$$(2) t = \frac{(\bar{X}_2 - \bar{X}_1)}{s_{\bar{X}_2 - \bar{X}_1}}$$

where:

Table 6—t-Values of Regressions Relating Concentration Measures of Sales of Fortune 500 Firms by Five 100 Firm Subsets From 1967 to 1992

$$Y_i = b_0 + b_1 T_i$$

where:

 Y_i = A concentration index (V, G, E, J) T_i = Time trend 1967 through 1992

Group of Firms	Y_i	b_0	b_1	R^2	DW_1	DW_2	$\hat{\rho}$
All 500: 001-500	V	41.25*	7.22*	0.86	1.13	1.99	0.43*
	G	39.25*	6.04*	0.92	0.46	1.74	0.77*
	E	172.36*	-7.17*	0.92	0.64	1.95	0.67*
	J	9.93*	4.62*	0.90	0.37	1.66	0.82*
Set 1: 001-100	V	37.73*	2.33*	0.40	1.26	1.94	0.37*
	G	17.80*	1.83*	0.73	0.47	1.83	0.79*
	E	161.93*	-2.34*	0.65	0.73	1.98	0.65*
	J	7.82*	1.98*	0.72	0.46	1.73	0.79*
Set 2: 101-200	V	6.81*	2.85*	0.59	0.38	2.30	0.81*
	G	7.62*	2.88*	0.60	0.37	2.23	0.81*
	E	970.11*	-3.02*	0.62	0.38	2.30	0.81*
	J	3.31*	3.14*	0.64	0.42	2.20	0.79*
Set 3: 201-300	V	34.65*	1.12	0.11	1.96	2.17	0.29
	G	33.02*	1.18	0.13	1.80	2.18	0.11
	E	a	a	a	-	-	-
	J	a	a	a	-	-	-
Set 4: 301-400	V	5.38*	2.79*	0.61	0.50	1.59	0.74*
	G	19.61*	2.62*	0.61	0.45	1.60	0.77*
	E	a	a	a	-	-	-
	J	a	a	a	-	-	-
Set 5: 401-500	V	10.67*	-0.46	0.13	1.19	2.42	0.40*
	G	10.87*	-0.32	0.09	0.85	2.22	0.57*
	E	503.32*	-0.84	0.35	2.13	2.01	0.06
	J	a	a	a	-	-	-

See notes to Tables 1, 2, and 3

*Significant at $\alpha = .05$ or better $\bar{X}_1$ = The mean for period 1; $\bar{X}_2$ = The mean for period 2; and

the denominator is the estimated standard error for the difference between the two means.

Summary information from the t-tests appears in Table 7. In all instances the t-values and their signs for all 500, the top 100 (set 1), and sets 2 (101-200) and 4 (301-400) are significant, indicating that the level of concentration increased in the 1980s. For the third set of 100 companies (201-300) and the fifth set (401-500) none of the measures changed significantly. A plausible explanation for the evident increase in the level of concentration in the 1980s is provided by Jarrell, Brickley, and Netter (1988). They explain that antitrust regulators, realizing the effect of international competition, allowed vertical combinations and horizontal mergers that were forbidden before the 1980s. Furthermore, the period witnessed a substantial increase in the largest transactions of related acquisitions induced by innovative skills and strategies of new management teams.

Table 7—t-Values for Differences in Means of Indexes of Concentration Measures of Sales of Fortune 500 and by Five 100 Firm Subsets for 1967 to 1980 and 1981 to 1992

Index	All 500	Set 1 001-100	Set 2 101-200	Set 3 201-300	Set 4 301-400	Set 5 401-500
V	6.17*	2.22*	6.94*	1.99	6.70*	0.73
G	9.76*	5.63*	7.69*	2.16	7.01*	1.49
E	-8.55*	-4.02*	-7.48*	-2.03	-6.57*	-1.11
J	11.64*	6.93*	9.07*	2.00	6.38*	1.19

See notes to Tables 1 and 3

*Significant at $\alpha = .05$ or better

While the above investigation compares levels of concentration means of the indexes for the two periods, a useful follow-up is to test whether the slopes of the indexes increased significantly during the 1980s by a time series trend regression

$$(3) Y_i = b_0 + b_1 T_{1i} + b_2 T_{2i}$$

where:

- Y_i = An index (V, G, E, J);
- T_{1i} = A time trend running from 1967 through 1992; and
- T_{2i} = A dummy variable for the years between 1981 and 1992.

If b_2 is statistically significant, the rate of concentration increased during the 1980s.

The results shown in Table 8 may shed some light on the effect of antitrust policies on aggregate concentration during the 1980s. None of the regressions generates a statistically significant b_2 . This finding is consistent with Golbe and White (1988) who find that the absolute numbers of mergers during the 1980s, though large, did not stand out from previous waves. A picture emerges from the combined results of equations (2) and (3) that the levels of concentration shifted upward for all 500 and some groups of 100, but that the rate of increase in concentration did not change during the 1980s.

CONCLUDING REMARKS

This paper compares aggregate concentration of sales of *Fortune* 500 companies as measured by various indexes for the period 1967 to 1992 to determine whether patterns of concentration lessened or widened, especially during the 1980s. All four indexes routinely used in measuring business concentration and inequality of income detect an increase in relative concentration among the 500 companies and by groups of 100 each ranked between 001 to 100 and 101 to 200. All four indexes show that the rate of increase in concentration did not increase during the last decade for all 500, as well as by subsets of 100, suggesting that the antitrust policy of the 1980s did not raise the rate of increase in aggregate concentration.

Table 8—t-Values of Regressions Relating Increase in Rate of Growth in Concentration Measures of Sales of Fortune 500 Firms and by Five 100 Firm Subsets From 1981 to 1992 Compared to 1967 to 1980

$$Y_i = b_0 + b_1 T_{1i} + b_2 T_{2i}$$

where:

Y_i = A concentration index (V, G, E, J)

T_{1i} = Time trend 1967 through 1992

T_{2i} = Dummy variable for 1981 through 1992

Group of Firms	Y_i	b_0	b_1	b_2	R^2	DW_1	DW_2	$\hat{\rho}$
All 500: 001-500	V	36.43*	4.65*	-0.36	0.86	1.15	2.00	0.43*
	G	54.50*	5.79*	1.00	0.93	0.63	1.83	0.68*
	E	177.28*	-5.46*	-0.55	0.92	0.70	1.97	0.64*
	J	13.06*	4.18*	1.73	0.93	0.69	1.74	0.78*
Set 1: 001-100	V	37.44*	2.45*	-1.13	0.46	1.45	1.92	0.27
	G	17.35*	1.29*	0.69	0.72	0.47	1.93	0.79*
	E	159.37*	-1.77*	0.02	0.66	0.80	1.97	0.65*
	J	8.10*	1.30	1.09	0.75	0.50	1.95	0.78*
Set 2: 101-200	V	5.69*	2.19*	0.56	0.68	0.59	2.39	0.83*
	G	7.51*	2.30*	0.65	0.73	0.68	2.35	0.82*
	E	854.57*	-2.32*	-0.66	0.72	0.62	2.42	0.82*
	J	4.48*	2.42*	1.14	0.78	0.26	2.38	0.75*
Set 3: 201-300	V	4.38*	-0.33	1.37	0.17	2.08	2.08	0.03
	G	30.42*	-0.39	1.21	0.57	1.90	2.27	0.06
	E	a	a	a	-	-	-	-
	J	a	a	a	-	-	-	-
Set 4: 301-400	V	7.22*	2.16*	0.92	0.68	0.63	1.53	0.68*
	G	7.37*	2.23*	0.09	0.69	0.63	1.36	0.68*
	E	a	a	a	-	-	-	-
	J	a	a	a	-	-	-	-
Set 5: 401-500	V	9.80*	-0.87	0.75	0.22	1.20	2.45	0.39*
	G	10.29*	-0.74	0.72	0.09	0.85	2.18	0.57*
	E	419.86*	0.18	-0.69	0.48	2.17	2.01	0.08
	J	a	a	a	-	-	-	-

See notes to Tables 1, 2, and 3

a Insufficient variation in data to calculate b_i

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DATA APPENDIX

The data for sales of the 500 largest U.S. industrial firms for the years 1976 to 1992 used in this study are from the magazine *Fortune*. *Fortune* has been publishing such data annually since 1955. There is a one year lag in reporting the data for a particular year.

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