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The Financial Consequences of Corporate Growth

BENTON E. GUP*

IT IS GENERALLY RECOGNIZED that there is a high degree of economic concentration in the United States and elsewhere.[1] The term economic concentration refers to the extent to which an industry's assets, output, or sales are distributed among the firms in that industry. Economic concentration frequently results in a distribution of assets in an industry that is similar to log normal distributions. In other words, a few firms hold a large share of an industry's assets while many firms hold small shares of the assets. Such skewed distributions are readily observable in the steel, banking, and automobile industries to name a few. Log normal distributions have been replicated by a variety of simulation techniques which has led some observers to conclude that market structure may be determined stochastically [2, 6, 14, 15, 16].

This article uses a Monte Carlo simulation growth process and a financial model developed by Lerner and Carleton [8] to assess the relationships between selected financial variables and economic concentration. The variables are financial leverage, rate of return on assets, interest rates, proportion of earnings retained, and income tax rates. As an outgrowth of the simulations, it was also possible to examine some financial characteristics of the fastest and slowest growing firms in a hypothetical industry.

The article is divided into four parts. Part one defines two measures of economic concentration and simulates a growth process. In Part two, growth is measured by a financial model, and Monte Carlo simulations are used to examine the impact of growth on economic concentration. The third part presents selected financial characteristics of the fastest growth firms and those that are growing at a slower rate. The final part concerns some institutional factors.

Economic Concentration and Growth

Two widely used measures of economic concentration are the 3-firm concentration ratio, and the entropy concentration index [3, 9, 10].[2]

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[1] The Committee on The Judiciary, U.S. Senate, has held many hearings on economic concentration. Only a few hearings are listed here [1, 17, 18, 19, 20].

[2] The Gini and Herfindahl concentration ratios were also computed. Because they produced similar results to the measures presented here, they are not included in this article.

3-Firm Concentration Ratio

The 3-firm concentration ratio C_3 measures the share of an industry's assets held by the three largest firms.

$$C_3 = \sum_{i=1}^{3} S_i$$

where

S_i = ratio of ith firm's market share of assets to the industry total.

This concentration ratio is used extensively because it is well known and easy to calculate. Moreover, data for the largest firms in an industry are more readily available than data for all firms that are required to calculate the other measure of concentration. Thus, the concentration ratio is an absolute measure because it accounts for an absolute number of firms (3 or 5) and gives no weight to the total number of firms. This shortcoming is overcome by the entropy concentration index.

Entropy Concentration Index

The entropy concentration index is a relative measure of concentration because it accounts for all firms in the industry. The equation for determining the entropy concentration index E is

$$E = \pi_{i=1}^{n} \left(\frac{1}{S_i} \right)^{S_i}$$

where

n = number of firms in the industry.

The numerical value of the entropy index is inversely related to the degree of concentration and directly related to the number of firms in the industry. If there is one firm in the industry, the value of the entropy index is 1. If there are a large number of firms, such as 100, each having an equal share of the assets (.01), the value of the entropy index is equal to the number of firms or 100. If there is strong concentration, the value of the index will be relatively low, for example, 25. The entropy index that is presented here has been normalized. That is, the index was divided by the total number of firms in the industry so that the maximum degree of concentration is 1.

Growth

Consider the following example that is used to illustrate the effect of growth on economic concentration. Assume that a hypothetical industry consists of 50 firms, each having two percent of the total assets in the industry. There is no entry or exit from the industry. Further assume that each firm faces the same normal

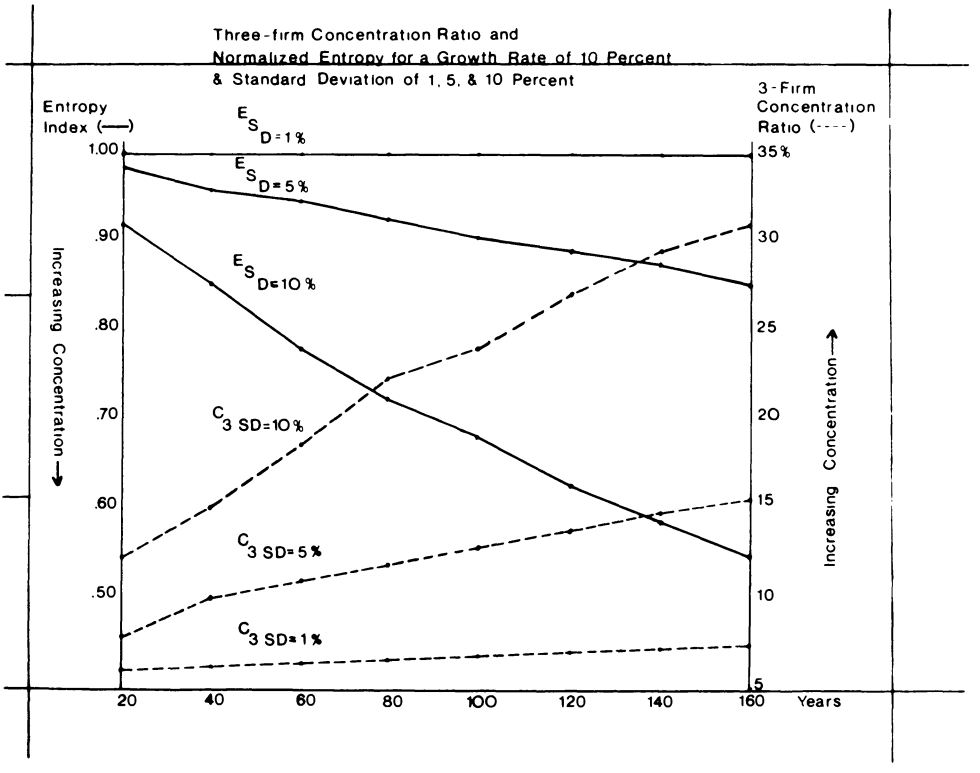

Figure 1. Three-firm Concentration Ratio and Normalized Entropy for a Growth Rate of 10 Percent

distribution of growth possibilities. In this example, the normal distribution has a mean growth rate of 10 percent and a standard deviation of five percent.[3]

The actual growth rate that is used in the calculation is determined by random selection from the distribution of growth possibilities. This growth process conforms to Gibrat's law of proportionate growth that is commonly used to explain skewed distributions of the size of firms in many industries [5, 7]. According to Gibrat's law as applied here, the asset size of a firm at the end of a time period (S_{t+1}) is determined by the growth rate g of the firm's size at the beginning of the period, or

$$S_{t+1} = g(S_t)$$

where g is determined randomly.

Figure 1 depicts the entropy and concentration ratios that resulted from 250 simulation runs for each of the hypothetical firms for 160 years. The termination of the simulation at 160 years was an arbitrary decision. The word "year" is used for convenience and refers to any period of time. A growth rate of 10 and standard

[3] During the 1973 (4th quarter)–1978 (4th quarter) period, the average compound rate of change of the GNP was 10.1% and the standard deviation was 4.7%.

deviations of 1, 5, and 10 percent were used to produce the results shown. The figure reveals that economic concentration increased over time, and is affected by the size of the standard deviation. When there is a large standard deviation (10%) compared to the growth rate (10%), economic concentration is greater than when the standard deviation is small (1%).

The Financial Model and Monte Carlo Simulations

Financial Model

We now redefine the measure of growth used in the previous example to include financial variables. This is accomplished by using the financial model developed by Lerner and Carleton [8]. In this model, growth g is defined as the after tax growth rate of assets, or

$$g = b(1 - T)\left[r + (r - i)\frac{L}{E}\right]$$

where

g = growth rate of assets after taxes,
b = proportion of earnings retained after cash dividends,
r = rate of return on assets,
T = income tax rate,
i = interest rate on borrowed funds,
L = total liabilities, and
E = shareholders equity.

This model includes variables that are influenced by management (b, L/E, and r), as well as externally controlled variables (T and i). It can be used to determine the after tax growth rate of a firm's assets in any period assuming that the debt-to-equity ratio remains constant during that period.

Data

The parameters for the data used in the model are presented in Table I. They are based on data from the Department of Treasury, *Corporate Income Tax Returns* and Robert Morris Associates *Annual Statement Studies.* Judgment was

Table I

Parameters for the Model

	Values		
Variables	Minimum	Most Likely	Maximum
b	.00	.60	1.00
T	.30	.40	.50
r	.04	.08	.12
i	.03	.05	.08
L/E	.80	1.40	3.00

used to determine the upper and lower limits of the data because there are no precise limits. For example, the *Annual Statement Studies* revealed that the L/E ratios for manufacturers ranged from 0.6 to 2.3, while the same ratio for retailers ranged from 0.5 to 15.0 and higher. The L/E ratios for wholesalers, contractor, and firms of different asset sizes were different too. Nevertheless, a close examination of the data suggested that the range of .80 to 3.00 covered most of the industries and firms adequately. Absolute precision of values is not required here because each of the values will be changed to test their sensitivity.

Monte Carlo Simulation

The data listed in Table I were used in a Monte Carlo simulation to determine the growth rate of assets g for each of the 50 firms in the hypothetical industry. A total of 250 simulations was run for each firm for a 160-year period. The Monte Carlo simulation differs from the one that was explained previously in the number of variables that were used [11, 12]. In this example, the growth of assets g is decomposed and there are probability distributions for each of the variables (b, T, r, i, L/E) that were defined in connection with the model. The minimum, most likely, and maximum values listed in Table I are the input data for the triangular distribution that was used in the simulations.[4] The triangular distribution is simple to use because only three values (minimum, most likely, and maximum) must be specified. In each of the 250 simulation runs, values were selected at random from the frequency distribution for each variable and were used to calculate the growth rate g. The author recognized that there may be some dependency between i and L/E, but they were not built into these simulations.

Economic Concentration: The results of the Monte Carlo simulations are presented in Table II, column 2. The simulations using the parameters listed in Table I are called the average data. At the end of year 160, the 3-firm concentration ratio indicates that the three largest firms in the hypothetical industry account for almost 10 percent of the industry's total assets, an increase of four percentage points from the beginning. Therefore, the data suggest that there is a tendency toward economic concentration, albeit not strong. This conclusion is confirmed by the entropy concentration ratio that is .9625 in year 160.

Sensitivity: To determine the sensitivity of the variables in the financial model on economic concentration, two additional Monte Carlo simulations were run for each variable. With the exception of b, all of the remaining parameters listed in Table I were (a) reduced by about 10 percent, and (b) increased by about 10 percent so that the variance between the average value and the increased and decreased values was held constant. To clarify what was done, the value of variable T was reduced (increased) by about 10 percent while the values of the remaining variables remained unchanged and the simulation was run. This was repeated for each variable. In the case of the retention rate b, 0 and 1 are

[4] A variety of frequency distributions may be used in Monte Carlo simulation. Other frequency distributions that may be used include uniform, beta, normal trapezoidal, and others. Except for extreme values, triangular distributions produce about the same results as other types of distributions. For comparisons of results of simulations using different types of distributions, see Pouliquen [11].

Table II

Concentration Ratios for Financial Variables in Year 160

Variables	−10% (1)	Average (2)	+10% (3)	Spread (4)=(1)−(3)
	Entropy Concentration Ratio			
b	.9640	.9625	.9609	.0031
T	.9578	.9625	.9783	−.0205
r	.9710	.9625	.9528	.0182
i	.9554	.9625	.9862	−.0308
L/E	.9648	.9625	.9566	.0082
	3-Firm Concentration Ratio			
b	.0984	.0993	.1004	−.0020
T	.1023	.0993	.0884	.0139
r	.0937	.0993	.1053	−.0116
i	.1038	.0993	.0956	.0082
L/E	.0954	.0993	.1031	−.0077

considered the absolute limits because a firm can payout all of its earnings and retain nothing 0, or retain all of its earnings (100% or 1) and payout nothing.

The results of the additional simulations are listed in Table II, columns 1, 3, and 4. The data for i and r suggest that economic concentration is particularly sensitive to changes in interest costs and returns on assets. Thus, if firms could increase their returns on assets, they would grow at a faster pace and become increasingly concentrated.[5] This conclusion also follows from the widely known relationship that $g = br$. To a lesser degree, increases in L/E also increased economic concentration. In addition, the data suggest that high interest rates and taxes can retard growth, which in turn results in lower economic concentration. More will be said about this shortly. In a statistical sense, there is a significant difference at the five-percent level between the values listed in columns 1 and 3 and the average values listed in column 2. As noted above, r and i are the most significant, followed by L/E, T and b in that order.

Financial Characteristics

As a spinoff of the study on growth and economic concentration, it was also possible to examine selected financial characteristics of the fastest growing one-third of the firms, middle third, and slowest growing third in year 160.

Growth Rates

The data presented in Table III show the mean growth rates of the various firms. The fastest growing third of the industry grew at a rate of 6.6 percent. The

[5] John Blair [1] examined the relationship between asset size and profitability of 290 manufacturing corporations and found that in slightly less than one-quarter of the 30 industries was increasing size accompanied by rising profit rates; in the remaining industries, the tendency was in the opposite direction or there was no relationship at all.

Table III

Average Growth Rates of Firms in Year 160

		Average	Coefficient of Variation
Fastest Growing	1/3 (firms 1–17)	.0663	.2428
Middle	1/3 (firms 18–34)	.0365	.1616
Slowest Growing	1/3 (firms 34–50)	.0173	.3988

Table IV

Selected Financial Characteristics of Firms in Year 160

Variables		Fastest growing one-third	Middle	Slowest growing one-third
b	$\bar{X}$	.6812	.5356	.3756
	CV	.1820	.2699	.4723
T	$\bar{X}$	.3945	.4012	.4038
	CV	.0978	.0992	.0973
r	$\bar{X}$	.0913	.0791	.0690
	CV	.1303	.1580	.2072
i	$\bar{X}$	.0508	.0533	.0560
	CV	.1870	.1819	.1767
L/E	$\bar{X}$	1.8137	1.6884	1.6828
	CV	.2474	.2598	.2676

$\bar{X}$ = mean
CV = coefficient of variation

middle third grew at a rate of 3.6 percent, and the slowest growing firms grew at a rate of 1.7 percent. The dispersion of the growth rates is measured by the coefficient of variation. There is greater dispersion for the slowest growing firms than for the fastest growing firms.

Financial Data

The financial characteristics that are presented here are limited to the variables in the financial model. Nevertheless, they provide some additional insights into the nature of firms growing at different rates. The data presented in Table IV show the mean values and coefficient of variation for each of the variables for firms growing at different rates in year 160.

The data reveal that the fastest growing firms had higher retention rates b, higher returns on assets r, and higher financial leverage L/E than firms that grew at a slower pace. The differences between values were particularly large for b and r in terms of both the means and the coefficients of variation. These findings support the concept that internal financial policies of a firm have a marked impact on its growth rate.

Institutional Factors

Several simulations that were used in the preparation of this article, but are not presented here, deserve attention because they shed some light on important institutional factors. The simulations used in this article assumed that, on average, the rate of return on assets was greater than the interest cost on borrowed funds ($r > i$). Although this is generally the situation, the reverse was true for many companies when market rates of interest soared to record levels in the late 1970s. When simulations were run with the interest cost exceeding the return on assets on average, it was discovered that the fastest growing firms had lower financial leverage L/E than slower growing firms. Since the number of firms in the hypothetical industry was fixed, the combination of i exceeding r and high financial leverage contributed to greater variability of growth rates. The result was that the firms with the strongest balance sheets tended to grow the fastest.

In addition, the relative importance of taxes T was somewhat stronger than the results presented here. The policy implications of these simulations are that high interest costs relative to returns on assets, high financial leverage, and high taxes tend to retard economic growth and concentration.

Conclusion

Although the subject of stochastically determined industry growth has received considerable attention from academicians, the financial aspects of growth have been neglected. To the best of my knowledge, this is the first attempt to examine them. Future attempts should allow for the number of firms in the industries to change and take interdependencies of financial variables into account. Growth g, as defined here, is the after-tax growth rate of assets. Using a financial model developed by Lerner and Carleton, Monte Carlo simulations and data representing a rough approximation of corporate financial data, it was shown that there is a tendency toward economic concentration in our system. It was also shown that economic concentration is particularly sensitive to returns on assets r and interest rates i. Furthermore, the data from the Monte Carlo simulations shed limited insights into the financial behavior of the fastest growing firms. It revealed that when returns on assets are greater than the cost of borrowed funds ($r > i$), the fastest growing firms had higher retention rates b, returns on assets r, and financial leverage L/E than firms that grew at a slower rate. However, when $r < i$, the fastest growing firms had lower financial leverage than firms growing at a slower rate.

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